Reassessing the Effectiveness and Transmission of Monetary Policy

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The Contributors

Ida Wolden Bache, *Governor, Norges Bank*

Ms. Bache was appointed governor of Norges Bank from March 2022 to 2028. Ms. Wolden Bache is chair of the Executive Board and the Monetary Policy and Financial Stability Committee.

Her work experience includes posts as executive director of Norges Bank Monetary Policy and Norges Bank Financial Stability and as a macroeconomist at Handelsbanken Capital Markets. Since 2017, Ms. Wolden Bache has been a member of the Systemic Risk Council in Denmark. Ms. Wolden Bache holds a doctorate in economics from the University of Oslo and a master's degree from the London School of Economics.

Andrew Bailey, *Governor, Bank of England*

Mr. Bailey was appointed Governor of the Bank of England in March 2020 to a term that expires in 2028. Before becoming Governor, Mr. Bailey had been Chief Executive Officer of the Financial Conduct Authority (FCA), which he joined in 2016. Prior to joining the FCA, Mr. Bailey had worked more than 30 years for the Bank of England.

As Chief Executive of the FCA, Mr. Bailey also was a member of the Prudential Regulation Committee, the Financial Policy Committee and the Board of the Financial Conduct Authority.

Anna Cieslak, *Associate Professor, Duke University*

Ms. Cieslak is an Associate Professor of Finance at Duke University's Fuqua School of Business, working at the intersection of asset pricing, macro, and monetary economics. Her agenda spans the dynamics of interest rates and the interactions between central banks and financial markets. She has recently focused on central bank communication, particularly understanding the channels through which the Federal Reserve impacts financial markets.

Ms. Cieslak is a research associate at the National Bureau of Economic Research and a research affiliate at the Centre for Economic Policy Research. She currently serves as an Associate Editor at the Journal of Finance, American Economic Journal: Macroeconomics, Review of Finance, and Journal of Financial Econometrics, and was previously an Associate Editor at the Review of Financial Studies. Before joining Duke, she served on the finance faculty at Northwestern University's Kellogg School of Management.

Karen Dynan, *Professor of Practice, Harvard University*

Ms. Dynan is a Professor of the Practice in the Harvard University Department of Economics and at the Harvard Kennedy School. She is also a senior fellow at the Peterson Institute for International Economics and the chair of the American Economic Association Committee on Economic Statistics. She previously served as assistant secretary for economic policy and chief economist at the U.S. Department of the Treasury from 2014 to 2017. From 2009 to 2013, Ms. Dynan was vice president and co-director of the Economic Studies program at the Brookings Institution. Before that, she was on the staff of the Federal Reserve Board, leading work in macroeconomic forecasting, household finances, and the Fed's response to the financial crisis.

Ms. Dynan has also served as a senior economist at the White House Council of Economic Advisers (2003–2004) and as a visiting assistant professor at Johns Hopkins University (1998). Her current research focuses on macroeconomic policy, consumer behavior, and household finances. Ms. Dynan received her Ph.D. in economics from Harvard University and her A.B. from Brown University.

Janice Eberly, *Professor, Northwestern University and Massachusetts Institute of Technology*

Ms. Eberly is the James R. and Helen D. Russell Professor of Finance in the Kellogg School of Management at Northwestern University, and Golub Distinguished Scholar in Finance and Policy at MIT. Her research studies finance and macroeconomics, including firms' investment decisions and household consumption and portfolio choice.

From 2011 to 2013, Ms. Eberly was the Assistant Secretary for economic policy at the U.S. Treasury Department, where she was the chief economist. Before joining the Kellogg faculty, she was a faculty member at the Wharton School of the University of Pennsylvania.

Gauti Eggertsson, *Professor, Brown University*

Mr. Eggertsson is a professor in the Economics Department of Brown University. His work focuses on the analysis of monetary and fiscal policy over the business cycle, both from a modern and historical perspective.

He has worked in the Research Departments of the International Monetary Fund and the Federal Reserve Bank of New York and been a visiting faculty member at Princeton University, Yale University and Columbia University. Mr. Eggertsson has published in a variety of professional journals, including the American Economic Review, Review of Economic Studies, and the Quarterly Journal of Economics.

Kristin J. Forbes, *Professor, Massachusetts Institute of Technology*

Ms. Forbes is the Jerome and Dorothy Lemelson Professor of Management and Global Economics at Massachusetts Institute of Technology Sloan School of Management. She is the convener of the Bellagio Group, a research associate at the National Bureau of

Economic Research and the Center for Economic Policy Research, and a member of the Aspen Economic Strategy Group and Council on Foreign Relations. Her academic research addresses policy-related questions in international macroeconomics.

From 2014 to 2017 she was an external member of the Monetary Policy Committee for the Bank of England; from 2003 to 2005, she was a member of the Council of Economic Advisers; and from 2001 to 2002, she was a deputy assistant secretary in the U.S. Treasury Department. In 2019, Ms. Forbes was named an Honorary Commander of the Order of the British Empire. She also currently serves in a number of advisory positions, such as on the Monetary Policy Advisory Panel of the New York Federal Reserve Bank, the Advisory Panel for the Bank for International Settlements, and on the External Advisory Group of the Managing Director for the International Monetary Fund. Ms. Forbes' research focuses on international finance and monetary economics and she currently teaches one of the most popular classes at MIT-Sloan. She received her Ph.D. in economics from MIT and graduated summa cum laude with highest honors from Williams College.

Anil Kashyap, *Professor, University of Chicago*

Mr. Kashyap is the Stevens Distinguished Service Professor of Economics and Finance at the University of Chicago's Booth School of Business. His research focuses on financial intermediation and regulation, the Japanese economy, macroeconomics and monetary policy. He co-founded the U.S. Monetary Policy Forum and is a research associate for the National Bureau of Economic Research, and a research fellow for the Centre for Economic Policy Research. He is co-director of the Chicago Booth Kent A. Clark Center on Global Market.

He has advised numerous organizations, including the Cabinet Office of the Japanese Prime Minister, the European Central Bank, the Swedish Riksbank, the International Monetary Fund, the U.S. Congressional Budget Office and the Federal Reserve Banks of Chicago and New York. From 2016–22, he was an external member of the Bank of England's Financial Policy Committee.

Philip R. Lane, *Member of the Executive Board, European Central Bank*

Mr. Lane joined the European Central Bank (ECB) as a member of the Executive Board in 2019. He is responsible for the Directorate General Economics and the Directorate General Monetary Policy.

Before joining the ECB, he was the governor of the Central Bank of Ireland. He has also chaired the Advisory Scientific Committee and Advisory Technical Committee of the European Systemic Risk Board and was Whately Professor of Political Economy at Trinity College Dublin. He is also a research fellow at the Centre for Economic Policy Research.

A graduate of Trinity College Dublin, he was awarded a Ph.D. in economics from Harvard University in 1995 and was assistant professor of economics and international affairs at Columbia University from 1995 to 1997, before returning to Dublin. In 2001 he was the inaugural recipient of the Bernacer Prize for outstanding contributions to European monetary economics.

Guido Lorenzoni, *Professor, University of Chicago*

Mr. Lorenzoni is the Robert W. Fogel Distinguished Service Professor of Economics at the University of Chicago Booth School of Business. He is also a Research Associate at the National Bureau for Economic Research and a consultant for the Federal Reserve Bank of Chicago. His fields of research are macroeconomics and international finance. His recent work has focused on financial crises, on sovereign debt, and on the effects of housing wealth and household debt on aggregate consumption.

Mr. Lorenzoni received a Ph.D. in Economics from the Massachusetts Institute of Technology (MIT) in 2001. Before joining the University of Chicago in 2022 he worked at Princeton, MIT and Northwestern. In 2009, he received the Alfred P. Sloan Research Fellowship. In 2019, he was elected a Fellow of the Econometric Society. He is a co-editor of the Journal of the European Economic Association and an associate editor of the American Economic Review. In 2021 he served as consultant for the Italian Prime Minister Mario Draghi.

Hanno Lustig, *Professor, Stanford University and Senior Fellow, Stanford Institute for Economic Policy Research*

Mr. Lustig is the Mizuho Financial Group Professor of Finance in the Graduate School of Business at Stanford University. He also is a senior fellow in the Stanford Institute for Economic Policy Research. He has worked at the intersection of macroeconomics and finance. His recent work focuses on fiscal sustainability.

Prior to joining Stanford in 2015, Mr. Lustig taught at the University of Chicago and the University of California, Los Angeles. He is a faculty research fellow at the National Bureau of Economic Research.

Andréa Maechler, *Deputy General Manager, Bank for International Settlements*

Ms. Maechler was appointed to a five-year term as deputy general manager of the Bank for International Settlements in 2023. Previously, she was a member of the Governing Board of the Swiss National Bank, a position to which she was appointed in 2015. At the Swiss National Bank, she was also head of money market and foreign exchange, asset management, banking operations and information technology. She was also chair of the Global Foreign Exchange Committee of central banks from 2021–23.

Prior to joining the Swiss National Bank, she was deputy division chief in the global markets analysis division of the International Monetary Fund. She also worked at other international organizations, including the European Systemic Risk Board and the Organization for Economic Cooperation and Development.

Patricia C. Mosser, *Director, MPA Program in Economic Policy Management, Columbia University*

Ms. Mosser is the director of the MPA Program in Economic Policy Management and leads the School's Initiative on Central Banking and Financial Policy. She is Senior Research Scholar at Columbia University's School of International and Public Affairs. Previously she was head of research and analysis at the Office of Financial Research at the U.S. Treasury. She spent over 20 years at the Federal Reserve Bank of New York where she was senior manager at the open market desk overseeing financial market analysis, monetary policy implementation, crisis related facilities, foreign exchange and investment, and analysis of financial stability and reform.

She previously served as an economist and manager in the New York Fed's Research Department and as an assistant professor in the Economics Department at Columbia University. Ms. Mosser has written on financial stability and monetary policy topics including financial reform, crisis policy tools, cyber risks to financial stability, and the monetary transmission mechanism. She previously served on FSOC Deputies and on the Board of the AEA's Committee on the Status of Women in the Economic Profession. She is currently an independent outside director of Nomura Holdings. She received a B.A. from Wellesley College, an M.Sc. with Distinction from the LSE and a Ph.D. from MIT.

Roberto de Oliveira Campos Neto, *Governor,*
Banco Central do Brasil

Mr. Campos Neto serves as Governor of Banco Central do Brasil (BCB) since February 2019. He holds a Bachelor's and Master's Degree in Economics from the University of California, Los Angeles (UCLA) and has extensive professional experience in the financial sector. For over two decades, he held positions and leadership roles in financial institutions, in Brazil and abroad, such as Bozano Simonsen, Claritas, B3 and Santander, where he headed the Global Treasury for the Americas.

Ahead of the Banco Central do Brasil, he launched the BC# Agenda, a set of structuring measures that aim to foster competition, inclusion, transparency, education, and sustainability in the national financial system. Among the highlights of the BC# Agenda are the creation of the Pix instant payment system, the implementation of Open Finance, the pilot project of the Brazilian digital money (Drex), in addition to the incentive and modernization of actions in microcredit, cooperatives, rural and real estate credit and the development of the financial green agenda. BCB earned important national and international distinctions due to the BC# Agenda. The main highlight has been Pix and its various awards, recognized as a model of innovation and for its impact on promoting financial inclusion, competition, and transparency.

Mr. Campos Neto was nominated by the British magazine, The Banker, Central Banker of the Year 2021. He also received the distinction Central Bank Governor of the Year in 2022 and 2023 from the North American magazine LatinFinance. In the same years, his performance was classified with an "A" grade by the European publication Global Finance Magazine in an annual assessment of more than 90 central bankers. In 2024, under his leadership, Central Banking magazine awarded Banco Central do Brasil with the title of Central Bank of the Year.

Carolin Pflueger, *Associate Professor, University of Chicago*

Ms. Pflueger is an associate professor at the Harris School of Public Policy at the University of Chicago. She is also a faculty research fellow at the National Bureau of Economic Research and a research affiliate at the Centre for Economic Policy Research. Her research is at the intersection of macroeconomics and finance, with a particular focus on understanding how inflation and monetary policy are linked to financial markets.

Before joining the faculty at the University of Chicago in 2019, she was an assistant professor of finance at the University of British Columbia from 2012–19. She received her Ph.D. in business economics from Harvard University.

Jerome H. Powell, *Chair,*
Board of Governors of the Federal Reserve System

Mr. Powell is chair of the Board of Governors of the Federal Reserve System. Mr. Powell also is chair of the Federal Open Market Committee, the System's principal monetary policymaking body. Mr. Powell has been a member of the Board of Governors since 2012 and chairman since 2018.

Prior to his appointment to the Board, Mr. Powell was a visiting scholar at the Bipartisan Policy Center in Washington, D.C., where he focused on federal and state fiscal issues. From 1997 through 2005, Mr. Powell was a partner at The Carlyle Group. Mr. Powell was an assistant secretary and undersecretary of the Treasury under President George H.W. Bush. Prior to joining the administration, he worked as a lawyer and investment banker in New York City.

Philipp Schnabl, *Professor, New York University*

Mr. Schnabl is the Martin J. Gruber Professor in Asset Management and Professor of Finance at the New York University Stern School of Business, as well as the Sidney Homer Director of the Salomon Center for the Study of Financial Institutions. He is a research associate in corporate finance at the National Bureau of Economic Research and a research affiliate in financial economics at the Centre for Economic Policy Research.

Mr. Schnabl studies financial intermediation, monetary policy and corporate finance. His work has been published in leading academic journals including the Quarterly Journal of Economics, the Review of Economic Studies, the Journal of Finance, the Journal of Financial Economics, and the Review of Financial Studies.

Eric Swanson, *Professor, University of California, Irvine*

Mr. Swanson is a professor in the Economics Department at the University of California, Irvine. Prior to joining the faculty at UC Irvine, he was a senior research advisor at the Federal Reserve Bank of San Francisco and a senior economist at the Federal Reserve's Board of Governors. He is a research associate at the National Bureau of Economic Research and co-editor-in-chief of the Journal of Monetary Economics.

Mr. Swanson's research fields include monetary economics, macroeconomics, macro-finance, and time series econometrics.

Iván Werning, *Professor of Economics,*
Massachusetts Institute of Technology

Mr. Werning has served as the Robert M. Solow Professor of Economics in the Department of Economics at the Massachusetts Institute of Technology since 2014. He joined the Department of Economics at MIT as an assistant professor in 2007. He has been a visiting professor at Harvard University and at the Federal Reserve Bank of Minneapolis.

Mr. Werning is a research fellow at the National Bureau of Economic Research, a fellow of the Econometric Society, and was elected to the American Academy of Arts and Sciences. His research is focused on macroeconomics, public economics and international economics.

Reassessing the Effectiveness and Transmission of Monetary Policy: An Introduction to the Bank's 2024 Economic Symposium

Andrew Glover and Joseph Gruber

So far, the 2020s have witnessed some of the most forceful monetary policy actions on record. First, central banks worldwide adopted historically accommodative policies to offset the pandemic shock. Then, as inflation surged to multi-decade highs, monetary policymakers responded with one of the most rapid tightening cycles in recent memory. Although outcomes have varied, inflation has eased across many economies even as growth has remained surprisingly resilient, suggesting supply developments have influenced recent inflation dynamics. The resilience of growth and the relative importance of supply factors in explaining inflation raise questions about the transmission of monetary policy. Are there lessons to be learned from this period of extraordinary monetary policy action? Throughout the 2010s, monetary policy was perceived to be very accommodative even as growth lagged and inflation often ran below central bank targets. How does the effectiveness and transmission of policy in recent years compare to that prior to the pandemic? Is monetary policy more effective in some states of the economy than others? What are the factors that might determine the efficacy of policy?

Opening Keynote Address

The symposium opened with a keynote address from Federal Reserve Chair Jerome Powell. The Chair reviewed the post-pandemic evolution of inflation and monetary policy. Supply disruptions following the pandemic had collided with a shift in consumption towards goods and away from services, creating imbalances in the economy that led to rapid price increases starting in 2021. The surge in inflation was initially thought to be short-lived, and therefore appropriately looked through from the standpoint of monetary policy. However, by late 2021 it was clear that the rise in inflation was becoming more widespread and persistent, leading to a strong reaction from the Federal Reserve with monetary policy tightening rapidly through out 2022 and into 2023.

The tightening of monetary policy worked to slow the pace of demand growth as fading disruptions to product and labor markets allowed for an increase in supply. The ensuing closing of imbalances in the economy eased pressure on prices, allowing inflation to decline rapidly from the 40-year highs reached in mid-2022. Throughout, strong action on the part of Fed was successful in keeping inflation expectations anchored, allowing for inflation to come down without a recession or a significant shortfall in activity.

Looking ahead, the Chair emphasized that labor market tightness had eased past pre-pandemic benchmarks, and the labor market was no longer a source of upward pressure on inflation. As such, the Chair stated that a further weakening of the labor market would be unwelcome. Given the recent trajectory of inflation and the labor market, the time had come for policy to adjust.

Insights from the 2020s Inflation Surge?

In the Symposium's first presentation, Gauti Eggertsson presented "Revisiting the Phillips and Beveridge Curves: Insights from the 2020s Inflation Surge", joint with Pierpaolo Benigno. They argue that exceptionally tight labor markets—where job openings exceed job seekers—steepen the Phillips curve, making inflation more sensitive to economic activity. These conditions also amplify the economy's reaction to supply shocks, such as the disruption of and subsequent healing of supply chains, which helps their framework explain both the inflation surge of 2021–2022 and its decline in 2023–2024. Furthermore, the Beveridge Curve steepens in exceptionally tight labor markets, allowing vacancies to fall without significantly increasing unemployment.

The authors show that exceptionally tight labor markets have nearly always coincided with inflation surges in the U.S. (the one exception being the 2018–2019 period). However, the persistence of inflation after labor markets normalize varies. For example, in the 1970s, high inflation continued even after labor market tightness fell because inflation expectations increased in response to the initial burst in inflation. However, expectations remained stable in 2021–22, allowing inflation to quickly fall as supply shocks eased and job openings fell toward parity with job seekers.

Guido Lorenzoni and Ivan Werning, in their discussion, emphasized the role of sectoral shifts from 2022–2024. They argued that the pandemic created asymmetric demand across sectors which, coupled with constraints on input reallocation, caused inflation to rise in waves—first for goods, then services. Importantly, they highlighted the role of non-labor inputs, pointing out that inflation rose even in countries without exceptionally tight labor markets.

These differences have significant policy implications. Eggertsson and Benigno's framework calls for contractionary monetary policy to normalize labor markets and reduce inflation. In contrast, Lorenzoni and Werning, referencing their paper from the 2022 Symposium (Guerrieri and others, 2022), argue for accommodative policies to speed sectoral reallocation, even in the face of inflation.

Government Debt in Mature Markets

Next, Hanno Lustig presented "Government Debt in Mature Economies: Safe or Risky?", joint with Roberto Gómez-Cram and Howard Kung. They observe that government spending can be financed either through higher taxes or higher inflation. From a bondholder's perspective, the former makes government debt's real yield "safe" and the latter makes it "risky". How then, the authors ask, can we tell whether the safe or risky regime prevails and how does monetary policy, via asset purchases, affect our ability to distinguish between them?

In the safe regime, the value of government debt should remain stable (or even increase) following an increase in deficits since bondholders expect it to be repaid with future taxes. The authors document that the real value of U.S. treasuries fell by 26% between March 2020 and October 2023, entirely on days when high deficit news was released. Based on these findings, along with additional evidence from financial markets, the authors argue that the U.S. has been in the risky regime since March 2020.

The authors caution that central bank purchases of government debt can distort the signal of which regime prevails. If the monetary authority responds to bond market stress with large scale purchases of bonds, then it will prevent the price from declining and therefore make it harder to distinguish between the risky and safe regimes. Furthermore, if the central bank purchases bonds during the risky regime, then it will accrue unrealized losses on its balance sheet.

In her discussion, Anna Cieslak provided an alternative explanation for bond valuations. She argues that the initial bond-market distress in March 2020 was a “dash for cash” as investors sold bonds to hold currency, which is consistent with concerns that Covid-19 would be deflationary rather than the fiscal response being inflationary. She accounts for the post-2021 decline in Treasury values through a recovery in inflation coupled with a monetary policy “mistake” as interest rates remained at the effective lower bound even as inflation rose above 6 percent.

Panel: Monetary Policy and the Evolving Structure of Financial Markets

The first panel discussion on Monetary Policy and the Evolving Structure of Financial Markets featured Anil Kashyap, Patricia Moser, and Eric Swanson.

Anil Kashyap kicked off the first panel discussion with remarks on central bank asset purchases, their effects on financial stability, monetary policy, and the intertwining or separation of the two. Central bank purchases of government bonds can promote financial stability by offsetting technical distortions that introduce mispricing that can then spillover to financial markets more widely. Central bank purchases of private assets might also be justified in order to prevent a fire sale drop in pricing and issuance. Through a discussion of the Fed's Covid asset purchases and the Bank of England's purchases in the fall of 2022, he highlighted the advantages of being able to separate asset purchases for financial stability from monetary policy purchases. He recommended that the Fed take steps to allow such a distinction.

Patricia Moser discussed how three factors determine the transmission of monetary policy through financial markets: regulation, central bank liquidity provision, and technical innovations in financial markets. On regulation, she highlighted research showing that monetary policy is more likely to affect banks' behavior if their assets are priced based on current rather than historical market conditions. On liquidity, she cautioned that the sizes of central banks' balance sheets have weakened private inter-bank lending markets. Finally, she pointed to financial innovations, most recently in payments, that allow for rapid reallocation of funds as a potential source for volatility and an important factor for determining the "correct" level of reserves provided by central banks.

Eric Swanson focused on the role of central bank communications in the transmission of policy. He provided evidence that policy decisions have become more predictable in recent years as central banks have become more transparent about their decision-making processes. At the same time, he argued that central bank communication itself has become more influential on financial markets, even when unaccompanied by interest rate changes. Despite this increase in transparency and communication by central banks, he estimated that central banks have become more responsive to economic and financial market conditions over time, which has surprised financial markets. Given the importance of communication, he urged central banks to be clear and to use simple frameworks that can be understood easily by the private sector.

Afternoon Remarks

In the afternoon session, Governor Andrew Bailey discussed the monetary response to the economic shocks originating in the pandemic and Russia's invasion of Ukraine. Both shocks were unprecedented and extraordinary, boosting inflation and presenting policymakers with difficult tradeoffs in setting policy. In the United Kingdom, the policy response to increased inflation was measured as policymakers learned about the shocks, their economic impact, and how monetary policy was being transmitted to the economy. As the shocks had little precedent, there was much uncertainty as to how the economy would be affected and how the shocks would play out.

In particular, the persistence of the pandemic and Ukraine shocks were unknown to policymakers. Governor Bailey distinguished between the external persistence of the shocks themselves and the persistent effects of the shocks on the structure of the economy. Monetary policy had to react to keep inflation expectations anchored while not overreacting to temporary shocks and contributing unnecessary and painful income volatility. In assessing the current situation Governor Bailey distinguished between scenarios where inflation would come down on its own as shocks faded, or if an output gap would be necessary to bring inflation back down, or, most concerning, had inflation become embedded in the economy requiring a lengthy period of restrictive policy to return inflation to target.

The Governor also discussed the need to distinguish policy actions taken in response to financial stability concerns relative to actions taken to support the economy and conduct monetary policy. Though the lines between the two policies could be blurring, separating the two allows for clearer communication and more effective policy.

Changing Perceptions of the Transmission of Monetary Policy

Day 2 of the Symposium began with "Changing Perceptions and Post-Pandemic Monetary Policy" presented by Carolin Pflueger, joint with Michael Bauer and Adi Sunderam. The authors estimate that professional forecasters and financial markets perceived the federal funds rate as unresponsive to inflation until from March

2020–22 and only expected policy to respond to inflation the federal funds rate lifted off from the effective lower bound. They argue that forecasters and markets were highly uncertain about how the Fed would react to inflation before liftoff and suggest that central banks should better communicate their policy rules, especially at the effective lower bound.

Empirically, the authors use Blue Chip Financial Forecasts to estimate how individual forecasters think the Fed would change interest rates given their own assumed paths of growth and inflation for the next six quarters (including the present). They estimate Taylor Rules for each month from the six quarters of forecasts available across all survey participants. According to their estimates, forecasters did not believe that inflation would induce the Federal Reserve to raise rates even as inflation peaked above 6 percent. Only after the first hike in March 2022 did these perceptions change, after which forecasters quickly perceived a significant response of rates to inflation. Similarly, the authors estimate that both treasury yields and federal funds futures became significantly more responsive to inflation surprises post lift off.

In her discussion, Janice Eberly drew attention to the pre-pandemic survey estimates for the Taylor Rule: the estimates are volatile, never satisfy the Taylor Principal, and are even sometimes negative. She pointed to alternative estimates from inflation-protected Treasury yields that found a strong, stable response of rates to inflation pre-pandemic, but also a decline from 2020–22. She urged the authors to use their data to look at how forecasters revise their expectations of policy rates in response to changes in their forecasts for growth and inflation.

The Transmission of Monetary Policy Through Bank Balance Sheets

In our final paper, Philipp Schnabl presented "Monetary Policy and the Mortgage Market" (joint with Drechsler, Savov, and Supera). They study the mortgage market's response to central bank purchases of mortgage-backed securities (MBS) and rate changes. First, central bank MBS purchases lead to a net increase in demand for these assets, leading to lower mortgage rates relative to the 10-year Treasury yield and more mortgage originations. Second, when the policy rate falls, deposits increase at banks, who then purchase more mortgage-backed securities to balance the interest rate sensitivity of their income and expenses. Through these channels, the authors find that monetary policy played a large role in the expansion and contraction of mortgage credit between 2020–24.

The authors use pre-pandemic data to estimate how mortgage spreads and originations respond to Fed MBS purchases. They find that a 10-percentage point increase in the Fed's share of MBS purchases leads to a 40-basis point decline in the mortgage rate spread (relative to the 10-year Treasury yield). They infer that Fed purchases cause a net increase in MBS demand, despite an offsetting decline in private purchases due to lower spreads. Furthermore, they estimate that mortgage originations rise 6.5 percent for each 100 basis point increase in mortgage rates. Together, these estimates imply that monetary policy raised both Fed and bank demand for MBS from 2020–21, thereby reducing mortgage spreads by 80-basis points and increasing mortgage originations by over $2 Trillion. The authors also note that rate increases and the start of quantitative tightening have reversed some of this decline in mortgage spreads and slowed originations.

In her discussion, Kristin Forbes noted that the estimated effect of policy on spreads is large, both relative to their overall change and compared to other estimates. She suggested that evidence from pre-pandemic, largely driven by data surrounding the financial crisis, may not generalize to the recent episode. Similarly, the mortgage market's response to contractionary monetary policy may not simply mirror the response to expansionary policy. She presented her own finding that quantitative tightening has very little effect on mortgage spreads: although it does raise mortgage rates significantly, the 10-year treasury rate rises by nearly the same magnitude, leaving spreads little changed.

Panel: Reassessing the Effectiveness and Transmission of Monetary Policy

Governor Ida Wolden Bache led off the final panel of the Symposium with a discussion of the cash-flow channel of monetary policy and how the strength of this particular channel can vary across countries and time. The cash-flow channel is the direct of effect of monetary policy on household disposable income through the interest paid on debt. The strength of the channel will depend on household indebtedness as well as the speed with which monetary policy adjustments passthrough to the interest rates households pay on their debts. Countries with high household indebtedness and fewer long-duration fixed rate mortgages are likely to have a more pronounced cash-flow channel of policy. Understanding the transmission mechanisms are important both for explaining policy and also for awareness of how policy transmission might change over time.

Philip Lane, executive board member of the European Central Bank, zoomed in on monetary policy transmission and effectiveness in the Euro area. He argued that tighter policy has contributed to disinflation by dampening demand and stabilizing inflation expectations. He showed that banks have increased lending standards and reduced credit to both households and firms as the ECB raised rates, which has reduced GDP growth relative to projections. In addition, professional forecasts of near-term inflation have become concentrated around the ECB's two percent target after initially drifting upward during 2022, which is also reflected in household and business surveys. While he assessed monetary policy to have been effective at reducing inflation in a timely matter, he cautioned that the return to target was not yet secure and reiterated that policy would remain restrictive for as long as needed to sustainably return inflation to target.

Governor Roberto Campos Neto argued that monetary policy may not have been as effective post-pandemic as expected. He emphasized that many economies, such as Brazil, had seen inflation fall slowly despite significant rate increases. Even countries that have seen more progress on inflation have done so despite strong economic growth and labor markets. He proposed that fiscal policy, both in terms of spending and transfers, have buoyed demand in face of higher rates while higher neutral rates have offset higher policy rates. His baseline projection was for a global soft landing in which policy remains tight long enough to slow activity and bring inflation to target but acknowledged risks such as protectionism and a faster deceleration of growth in China.

Welcoming Remarks

Good evening, and welcome to the 2024 Jackson Hole Economic Policy Symposium. This is the 47th year that the Kansas City Fed has hosted this event.

It is our honor to host you here in the Tenth Federal Reserve District that we so proudly serve.

This year, our focus is on the effectiveness and transmission of monetary policy. I offer my deep appreciation to our Director of Research Joe Gruber and his team for putting together what we believe will be a timely and insightful discussion.

Some of you may remember that this event last year was the start of my Fed career. I want to thank the other Reserve Bank Presidents and the Governors for everything they have done over the past year to ease my transition from community banker to central banker. I also want to thank those of you who I met last year and let you know how appreciative I am of the insights you provided. I look forward to continuing to build on our relationships as well as developing many new ones over the next few days.

I don't have an economics degree, so I always look forward to these discussions as an opportunity to continue to learn. In fact, it feels like every time I am in Wyoming I learn a little bit more about monetary policy.

Only a few weeks ago I was in the town of Cody, which is just northeast of here. Because of some travel issues, I ended up having to drive across the state in the middle of the night to meet a commitment with some colleagues the following day.

Allegedly, this is a drive that can be completed in a little under six hours. However, based on my experience I can tell you that there is a high likelihood of long and variable lags.

That's not all, I also learned that it is always a good idea to let everyone know where you are headed and why. Even if they don't particularly like it or even agree with your journey, it is helpful if they understand.

I discovered that in some places, the path can become unexpectedly rough, so it is a good idea to make sure you are holding firmly to the wheel. Remember: If you end up off the road, there is the very real risk of a bear encounter.

And maybe the most important lesson I learned: Resist the temptation to hit the accelerator too aggressively. There will be a lot of people who will want you to do that. Some might suggest you should have started along the path sooner. But just keep in mind, you want to make this trip safely without causing long-term damage.

I know that many of you traveled great distance to be here. I hope your journey here was pleasant, that you will find the next few days to be thought provoking and insightful, and that your travels home will be safe.

I also want to express my appreciation to those on the program for their preparation and ensuring that our Symposium has depth and texture. We all very much look forward to the discussions of the next few days.

And, importantly, I want to thank the support staff and team here at Jackson Lake Lodge. For years, the Lodge has provided exemplary service to this event to ensure that our guests our comfortable. They are an extremely important part of the event's success.

Thank you, and good evening.

Jeffrey R. Schmid
President and Chief Executive Officer
Federal Reserve Bank of Kansas City

Opening Remarks: Review and Outlook

Jerome H. Powell

Four and a half years after COVID-19's arrival, the worst of the pandemic-related economic distortions are fading. Inflation has declined significantly. The labor market is no longer overheated, and conditions are now less tight than those that prevailed before the pandemic. Supply constraints have normalized. And the balance of the risks to our two mandates has changed. Our objective has been to restore price stability while maintaining a strong labor market, avoiding the sharp increases in unemployment that characterized earlier disinflationary episodes when inflation expectations were less well anchored. While the task is not complete, we have made a good deal of progress toward that outcome.

Today, I will begin by addressing the current economic situation and the path ahead for monetary policy. I will then turn to a discussion of economic events since the pandemic arrived, exploring why inflation rose to levels not seen in a generation, and why it has fallen so much while unemployment has remained low.

1. Near-Term Outlook for Policy

Let's begin with the current situation and the near-term outlook for policy.

For much of the past three years, inflation ran well above our 2 percent goal, and labor market conditions were extremely tight. The Federal Open Market Committee's (FOMC) primary focus has been on bringing down inflation, and appropriately so. Prior to this episode, most Americans alive today had not experienced the pain of high inflation for a sustained period. Inflation brought substantial hardship, especially for those least able to meet the higher costs of essentials like food, housing, and transportation. High inflation triggered stress and a sense of unfairness that linger today.[1]

Our restrictive monetary policy helped restore balance between aggregate supply and demand, easing inflationary pressures and ensuring that inflation expectations remained well anchored. Inflation is now much closer to our objective, with prices having risen 2.5 percent over the past 12 months (Figure 1).[2] After a pause earlier this year, progress toward our 2 percent objective has resumed. My confidence has grown that inflation is on a sustainable path back to 2 percent.

Turning to employment, in the years just prior to the pandemic, we saw the significant benefits to society that can come from a long period of strong labor market conditions: low unemployment, high participation, historically low racial employment gaps, and, with inflation low and stable, healthy real wage gains that were increasingly concentrated among those with lower incomes.[3]

Today, the labor market has cooled considerably from its formerly overheated state. The unemployment rate began to rise over a year ago and is now at 4.3 percent— still low by historical standards, but almost a full percentage point above its level in early 2023 (Figure 2). Most of that increase has come over the past six months. So far, rising unemployment has not been the result of elevated layoffs, as is typically the case in an economic downturn. Rather, the increase mainly reflects a substantial increase in the supply of workers and a slowdown from the previously frantic pace of hiring. Even so, the cooling in labor market conditions is unmistakable. Job gains remain solid but have slowed this year.[4] Job vacancies have fallen, and the ratio of vacancies to unemployment has returned to its pre-pandemic range. The hiring and quits rates are now below the levels that prevailed in

2018 and 2019. Nominal wage gains have moderated. All told, labor market conditions are now less tight than just before the pandemic in 2019—a year when inflation ran below 2 percent. It seems unlikely that the labor market will be a source of elevated inflationary pressures anytime soon. We do not seek or welcome further cooling in labor market conditions.

Overall, the economy continues to grow at a solid pace. But the inflation and labor market data show an evolving situation. The upside risks to inflation have diminished. And the downside risks to employment have increased. As we highlighted in our last FOMC statement, we are attentive to the risks to both sides of our dual mandate.

The time has come for policy to adjust. The direction of travel is clear, and the timing and pace of rate cuts will depend on incoming data, the evolving outlook, and the balance of risks.

We will do everything we can to support a strong labor market as we make further progress toward price stability. With an appropriate dialing back of policy restraint, there is good reason to think that the economy will get back to 2 percent inflation while maintaining a strong labor market. The current level of our policy rate gives us ample room to respond to any risks we may face, including the risk of unwelcome further weakening in labor market conditions.

2. The Rise and Fall of Inflation

Let's now turn to the questions of why inflation rose, and why it has fallen so significantly even as unemployment has remained low. There is a growing body of research on these questions, and this is a good time for this discussion.[5] It is, of course, too soon to make definitive assessments. This period will be analyzed and debated long after we are gone.

The arrival of the COVID-19 pandemic led quickly to shutdowns in economies around the world. It was a time of radical uncertainty and severe downside risks. As so often happens in times of crisis, Americans adapted and innovated. Governments responded with extraordinary force, especially in the U.S. Congress unanimously passed the CARES Act. At the Fed, we used our powers to an unprecedented extent to stabilize the financial system and help stave off an economic depression.

After a historically deep but brief recession, in mid-2020 the economy began to grow again. As the risks of a severe, extended downturn receded, and as the economy reopened, we faced the risk of replaying the painfully slow recovery that followed the Global Financial Crisis.

Congress delivered substantial additional fiscal support in late 2020 and again in early 2021. Spending recovered strongly in the first half of 2021. The ongoing pandemic shaped the pattern of the recovery. Lingering concerns over COVID weighed on spending on in-person services. But pent-up demand, stimulative policies, pandemic changes in work and leisure practices, and the additional savings associated with constrained services spending all contributed to a historic surge in consumer spending on goods.

The pandemic also wreaked havoc on supply conditions. Eight million people left the workforce at its onset, and the size of the labor force was still 4 million below its pre-pandemic level in early 2021. The labor force would not return to its pre-pandemic trend until mid-2023 (Figure 3).[6] Supply chains were snarled by a combination of lost workers, disrupted international trade linkages, and tectonic shifts in the composition and level of demand (Figure 4). Clearly, this was nothing like the slow recovery after the Global Financial Crisis.

Enter inflation. After running below target through 2020, inflation spiked in March and April 2021. The initial burst of inflation was concentrated rather than broad based, with extremely large price increases for goods in short supply, such as motor vehicles. My colleagues and I judged at the outset that these pandemic-related factors would not be persistent and, thus, that the sudden rise in inflation was likely to pass through fairly quickly without the need for a monetary policy response — in short, that the inflation would be transitory. Standard thinking has long been that, as long as inflation expectations remain well anchored, it can be appropriate for central banks to look through a temporary rise in inflation.[7]

The good ship Transitory was a crowded one, with most mainstream analysts and advanced-economy central bankers on board.[8]

The common expectation was that supply conditions would improve reasonably quickly, that the rapid recovery in demand would run its course, and that demand would rotate back from goods to services, bringing inflation down.

For a time, the data were consistent with the transitory hypothesis. Monthly readings for core inflation declined every month from April to September 2021, although progress came slower than expected (Figure 5). The case began to weaken around midyear, as was reflected in our communications. Beginning in October, the data turned hard against the transitory hypothesis.[9] Inflation rose and broadened out from goods into services. It became clear that the high inflation was not transitory, and that it would require a strong policy response if inflation expectations were to remain well anchored. We recognized that and pivoted beginning in November. Financial conditions began to tighten. After phasing out our asset purchases, we lifted off in March 2022.

By early 2022, headline inflation exceeded 6 percent, with core inflation above 5 percent. New supply shocks appeared. Russia's invasion of Ukraine led to a sharp increase in energy and commodity prices. The improvements in supply conditions and rotation in demand from goods to services were taking much longer than expected, in part due to further COVID waves in the United States.[10] And COVID continued to disrupt production globally, including through new and extended lockdowns in China.[11]

High rates of inflation were a global phenomenon, reflecting common experiences: rapid increases in the demand for goods, strained supply chains, tight labor markets, and sharp hikes in commodity prices.[12] The global nature of inflation was unlike any period since the 1970s. Back then, high inflation became entrenched — an outcome we were utterly committed to avoiding.

By mid-2022, the labor market was extremely tight, with employment increasing by over 6½ million from the middle of 2021. This increase in labor demand was met, in part, by workers rejoining the labor force as health concerns began to fade. But labor supply remained constrained, and, in the summer of 2022, labor force participation remained well below pre-pandemic levels. There were nearly twice as many job openings as unemployed persons from March 2022 through the end of the year, signaling a severe labor shortage (Figure 6).[13] Inflation peaked at 7.1 percent in June 2022.

At this podium two years ago, I discussed the possibility that addressing inflation could bring some pain in the form of higher unemployment and slower growth. Some argued that getting inflation under control would require a recession and a lengthy period of high unemployment.[14] I expressed our unconditional commitment to fully restoring price stability and to keeping at it until the job is done.

The FOMC did not flinch from carrying out our responsibilities, and our actions forcefully demonstrated our commitment to restoring price stability. We raised our policy rate by 425 basis points in 2022 and another 100 basis points in 2023. We have held our policy rate at its current restrictive level since July 2023 (Figure 7).

The summer of 2022 proved to be the peak of inflation. The 4½ percentage point decline in inflation from its peak two years ago has occurred in a context of low unemployment — a welcome and historically unusual result.

How did inflation fall without a sharp rise in unemployment above its estimated natural rate?

Pandemic-related distortions to supply and demand, as well as severe shocks to energy and commodity markets, were important drivers of high inflation, and their reversal has been a key part of the story of its decline. The unwinding of these factors took much longer than expected but ultimately played a large role in the subsequent disinflation. Our restrictive monetary policy contributed to a moderation in aggregate demand, which combined with improvements in aggregate supply to reduce inflationary pressures while allowing growth to continue at a healthy pace. As labor demand also moderated, the historically high level of vacancies relative to unemployment has normalized primarily through a decline in vacancies, without sizable and disruptive layoffs, bringing the labor market to a state where it is no longer a source of inflationary pressures.

A word on the critical importance of inflation expectations. Standard economic models have long reflected the view that inflation will return to its objective when product and labor markets are balanced — without the need for economic slack — so long as inflation expectations are anchored at our objective. That's what the models said, but the stability of longer-run inflation expectations since the 2000s had not been tested by a persistent burst of high inflation. It was far from assured that the inflation anchor would hold. Concerns over de-anchoring contributed to the view that disinflation would require slack in the economy and specifically in the labor market. An important takeaway from recent experience is that anchored inflation expectations, reinforced by vigorous central bank actions, can facilitate disinflation without the need for slack.

This narrative attributes much of the increase in inflation to an extraordinary collision between overheated and temporarily distorted demand and constrained supply. While researchers differ in their approaches and, to some extent, in their conclusions, a consensus seems to be emerging, which I see as attributing most of the rise in inflation to this collision.[15] All told, the healing from pandemic distortions, our efforts to moderate aggregate demand, and the anchoring of expectations have worked together to put inflation on what increasingly appears to be a sustainable path to our 2 percent objective.

Disinflation while preserving labor market strength is only possible with anchored inflation expectations, which reflect the public's confidence that the central bank will bring about 2 percent inflation over time. That confidence has been built over decades and reinforced by our actions.

That is my assessment of events. Your mileage may vary.

3. Conclusion

Let me wrap up by emphasizing that the pandemic economy has proved to be unlike any other, and that there remains much to be learned from this extraordinary period. Our Statement on Longer-Run Goals and Monetary Policy Strategy emphasizes our commitment to reviewing our principles and making appropriate adjustments through a thorough public review every five years. As we begin this process later this year, we will be open to criticism and new ideas, while preserving the strengths of our framework. The limits of our knowledge — so clearly evident during the pandemic — demand humility and a questioning spirit focused on learning lessons from the past and applying them flexibly to our current challenges.

Endnotes

[1]Shiller (1997) and Stantcheva (2024) study why people dislike inflation. Pfafjar and Winkler (2024) study households' attitudes toward inflation and unemployment. Binetti, Nuzzi, and Stantcheva (2024) investigate households' attitudes toward, and understanding of, inflation. Kaplan and Schulhofer-Wohl (2017) and Jaravel (2021) document heterogeneity in the inflation rate experienced by households across the income distribution.

[2]The data for the personal consumption expenditures (PCE) price index is available for June 2024. Over the 12 months to June 2024, the PCE price index increased 2.5 percent. Data for the consumer price index and producer price index are available through July 2024 and can be used to estimate the level of the PCE price index through July. While such an estimate is subject to uncertainty, it suggests that inflation remained near 2.5 percent through July.

[3]Research documenting such benefits include Aaronson and others (2019), who discuss the experience in the 2010s and review related historical evidence.

[4]Payroll employment grew by an average of 170,000 per month over the three months ending in July. On August 21, the Bureau of Labor Statistics released the preliminary estimate of the upcoming annual benchmark revision to the establishment survey data, which will be issued in February 2025. The preliminary estimate indicates a downward adjustment to March 2024 total nonfarm employment of 818,000.

[5]Early examples include Ball, Leigh, and Mishra (2022) and di Giovanni and others (2022). More recent work includes Benigno and Eggertsson (2023, 2024), Blanchard and Bernanke (2023, 2024), Crump and others (2024), Bai and others (2024), and Dao and others (forthcoming).

[6]The Federal Reserve Board staff's estimate of the labor force makes two adjustments to the Bureau of Labor Statistics' published estimates: (i) reweighing Current Population Survey respondents such that the labor force estimates in all years reflect the Census Bureau's latest vintage of population estimates; and (ii) accounting for net immigration that is likely not fully reflected in the Census Bureau's latest population estimates, as detailed in the CBO's 2024 Demographic Outlook (see https://www.cbo.gov/publication/59899). The pre-pandemic trend described here is calculated by appending the CBO's January 2020 projected labor force growth from the start of the pandemic through 2024:Q2 onto the level of the labor force just before the start of the pandemic. (See Congressional Budget Office (2020), The Budget and Economic Outlook: 2020 to 2030; https://www.cbo.gov/publication/56073.)

[7]For example, former Chair Ben Bernanke and Olivier Blanchard summarize the standard approach in their work on inflation the following way: "Standard central banking doctrine holds that, so long as inflation expectations are reasonably well anchored, there is a case for 'looking through' temporary supply shocks rather

than responding to the short-run increase in inflation" (Blanchard and Bernanke, 2024, p. 2). Clarida (forthcoming) notes how central banks around the world faced a sharp rise in the relative price of goods and chose, at least initially, to accommodate the price pressures with an expected transitory increase in inflation.

[8]In the September 2021 Summary of Economic Projections (SEP), the median projection for headline inflation in 2022 was 2.2 percent. In the August 2021 Survey of Professional Forecasters (the closest survey to the September SEP), the median projection for headline inflation in 2022 was also 2.2 percent. Projections from the Blue Chip survey were similar around this time.

[9]Beginning with the data for October, readings for monthly core PCE jumped to 0.4 percent or higher and inflationary pressures broadened out across goods and services categories. And monthly job gains, already strong, were consistently revised higher over the second half of 2021. Measures of wage inflation also accelerated.

[10]For example, labor supply continued to be materially affected by COVID even after vaccines became broadly available in the U.S. By late 2021, anticipated increases in labor force participation had not yet materialized, likely owing, in part, to the rise of the Delta and Omicron COVID variants.

[11]For example, in March 2022, lockdowns were imposed in the Jilin province, the largest center for auto production. Authorities also ramped up or extended restrictions in manufacturing hubs in the southeast and in Shanghai, where lockdowns had initially been scheduled to end in April 2022.

[12]The global nature of this inflationary episode is emphasized in Cascaldi-Garcia and others (2024) and Clarida (forthcoming), among others.

[13]It has been argued that the natural rate of unemployment had risen, and that the unemployment rate was less informative about tightness in labor market than other measures such as those involving vacancies. For example, see Crump and others (2024). More generally, research has emphasized that the unemployment rate and the ratio of vacancies to unemployment often provide similar signals, but the signals differed in the pandemic period, and the ratio of vacancies to unemployment is a better overall indicator. For example, see Ball, Leigh, and Mishra (2022) and Benigno and Eggertsson (2023, 2024).

[14]For example, Ball, Leigh, and Mishra (2022) and Cecchetti and others (2023) present analyses emphasizing that disinflation would require economic slack.

[15]Blanchard and Bernanke (2023) use a traditional (flexible) Phillips curve approach to reach this conclusion for the U.S. Blanchard and Bernanke (2024) and Dao and others (forthcoming) examine a broader set of countries using similar approaches. Di Giovanni and others (2022) and Bai and others (2024) use different techniques and emphasize supply constraints and shocks in the increase in inflation over 2021 and 2022.

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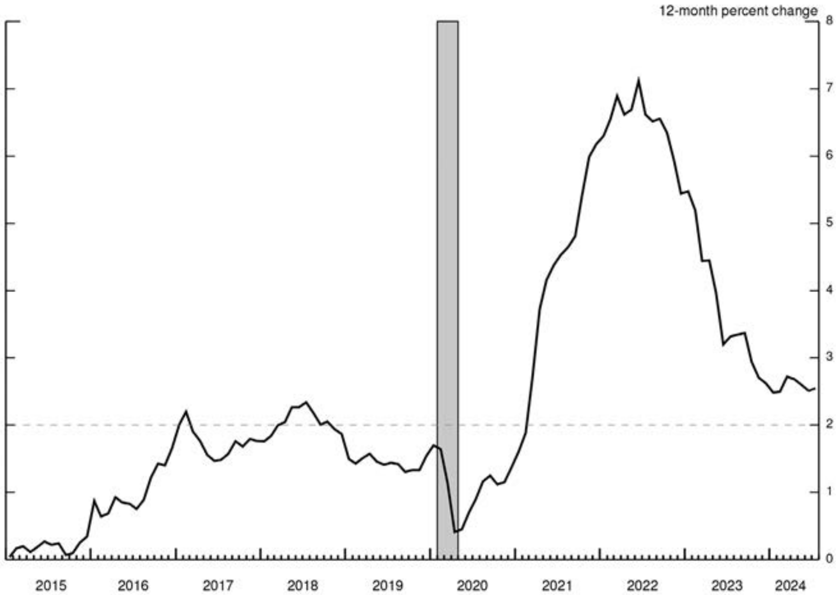
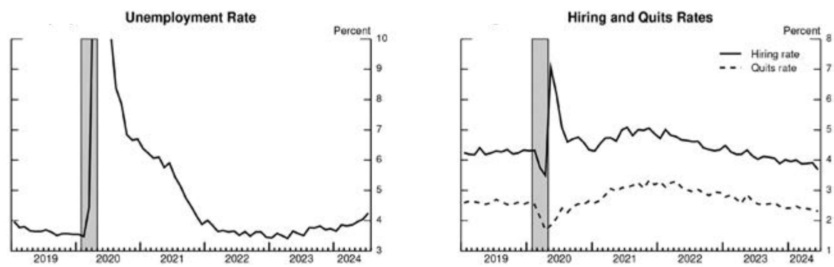
Figure 1
Personal Consumption Expenditures Price Index



Note: The data are monthly and extend through July 2024. The data for July 2024 are estimates based on consumer price index and producer price index data. The outlined shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020. PCE is personal consumption expenditures. The dashed line is at the 2 percent longer-run inflation target.
Source: Bureau of Economic Analysis, PCE, via Haver Analytics.

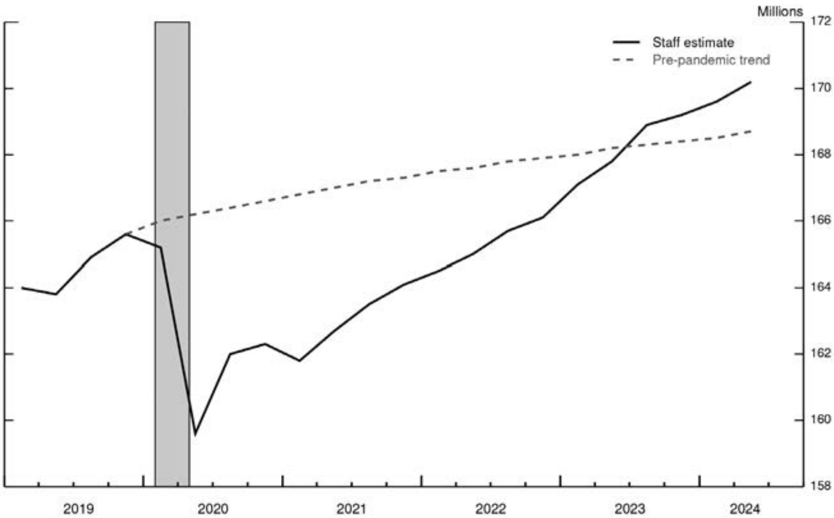
Figure 2



Note: The data are monthly and extend through July 2024. The outlined shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020. The unemployment rate peaked at 14.8 percent in April 2020. Unemployment rates for April-July 2020 are omitted for readability.
Source: Bureau of Labor Statistics via Haver Analytics.

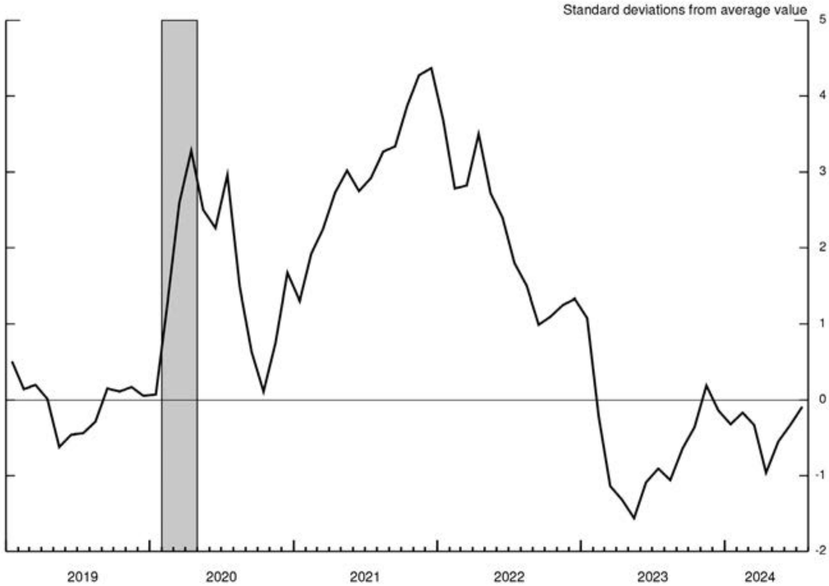
Note: The data are monthly and extend through June 2024. Rates are measured as percent of private employment. The outlined shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Bureau of Labor Statistics via Haver Analytics.

Figure 3
Civilian Labor Force



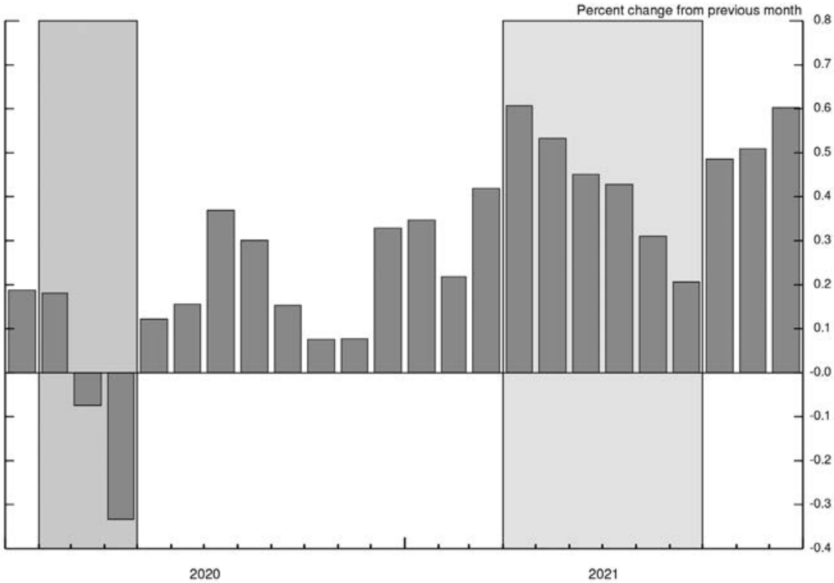
Note: Quarterly and seasonally adjusted data extending through 2024:Q2. The black line is a Federal Reserve Board staff estimate of the labor force, making two adjustments to the Bureau of Labor Statistics' published estimates: (i) reweighing Current Population Survey respondents such that the labor force estimates in all years reflect the Census Bureau's latest population estimates; and (ii) accounting for net immigration that is likely not fully reflected in the Census Bureau's latest population estimates, as detailed in the Congressional Budget Office's (CBO) *The Demographic Outlook: 2024 to 2054,* https://www.cbo.gov/publication/59899. The pre-pandemic trend is calculated by appending the CBO's January 2020 projected labor force growth from the start of the pandemic through 2024:Q2 onto the level of the labor force just before the start of the pandemic. The outlined shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Bureau of Labor Statistics via Haver Analytics; CBO; Federal Reserve Board staff calculations.

Figure 4
Global Supply Chain Pressure Index



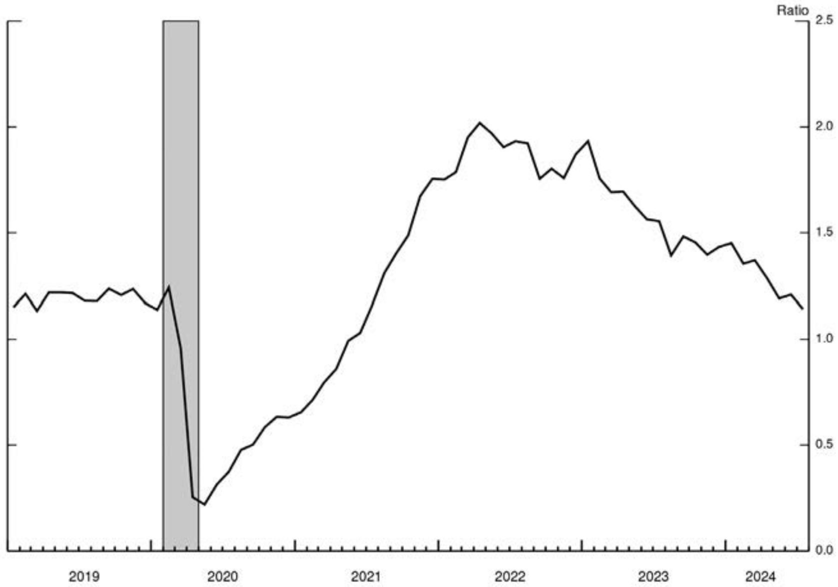
Note: The data are monthly and extend through July 2024. The index is presented as the number of standard deviations from its average value. The outlined shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Federal Reserve Bank of New York.

Figure 5
Core PCE Prices



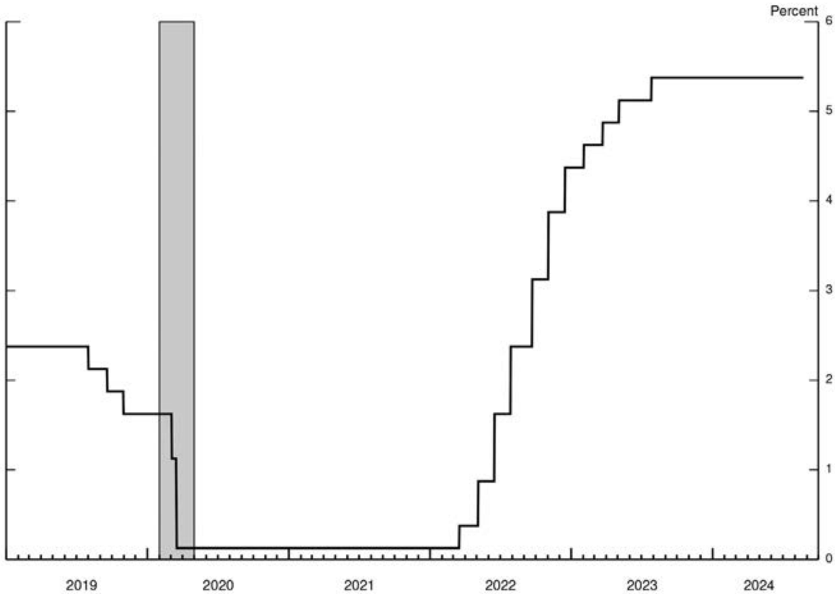
Note: The data are monthly and extend through December 2021. PCE is personal consumption expenditures. The gray outlined shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020 – April 2020. The light-gray outlined shaded region highlights the period from April 2021 to September 2021.
Source: Bureau of Economic Analysis, PCE, via Haver Analytics.

Figure 6
Job Openings to Unemployment



Note: The data are monthly and extend through July 2024. The ratio is calculated as the JOLTS (Job Openings and Labor Turnover Survey) job openings at the end of the previous month divided by current-month unemployed. The outlined shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Bureau of Labor Statistics via Haver Analytics.

Figure 7
Midpoint of the Target Range for the Federal Funds Rate



Note: The data are daily and extend through August 22, 2024. The outlined shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Federal Reserve Board.

Revisiting the Phillips and Beveridge Curves: Insights from the 2020s Inflation Surge

Pierpaolo Benigno and Gauti B. Eggertsson

Abstract

This paper reexamines the Phillips and Beveridge curves to explain the inflation surge in the U.S. during the 2020s. We argue that the pre-surge consensus regarding both curves requires substantial revision. We propose the Inverse-L (INV-L) New Keynesian Phillips Curve as a replacement for the standard New Keynesian Phillips Curve. The INV-L curve is piecewise-linear and more sensitive to labor market conditions when it crosses the *Beveridge threshold* — a point at which the labor market becomes excessively tight and enters a "labor shortage" regime. We introduce a modified Beveridge curve that features a near-vertical slope once the *Beveridge threshold* is passed, suggesting that in this region, adjustment in labor market tightness occur almost exclusively through a drop in vacancies rather than an increase in unemployment. This feature matches the U.S. experience since the Federal Reserve's tightening cycle began in

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March 2022. We also observe a similar pattern in the data during five other inflation surges over the past 111 years where the Beveridge threshold was breached. We define a Beveridge threshold unemployment rate. Once unemployment falls below this rate, policymakers need to be alert to sharp inflationary pressures arising from demand or supply shocks. We explore several policy implications.

1. Introduction

The inflation surge of the 2020s peaked at 6.2% for the core Consumer Price Index (CPI), while the overall CPI was almost double digits. The peak of the core CPI coincided with the start of the Federal Reserve's tightening cycle of Federal Funds Rates in Q1 2022. The rise in overall CPI continued into the following quarter, partly influenced by the Ukraine-Russia War, which began on February 24, 2022.

When the Federal Reserve began tightening policy in March 2022, the central policy question was: How costly would it be to bring inflation back to its 2% target? At the core of this debate are two fundamental macroeconomic relationships: the slope of the Phillips curve and the shape of the Beveridge curve.

The Phillips curve relates inflation to a measure of economic activity.[1] At that time, empirical evidence suggested that the Phillips curve was very flat. A leading example is the work by Hazzell, Herreno, Nakamura, and Steinsson (2022), which found that a 2.9-percentage-point increase in unemployment resulted in only a one-percentage-point decrease in inflation. This led pessimists to argue that, to achieve its inflation target, the Federal Reserve would need to accept a substantial increase in unemployment.

The Beveridge curve describes the relationship between the intensity with which firms are looking for workers (job vacancies or *v*) and how many workers are looking for a job (the unemployed or *u*). The Beveridge curve is typically plotted as shown in Figure 2. A common metric of labor market tightness is the ratio *v/u,* a concept that dates back to Beveridge's work in 1944.

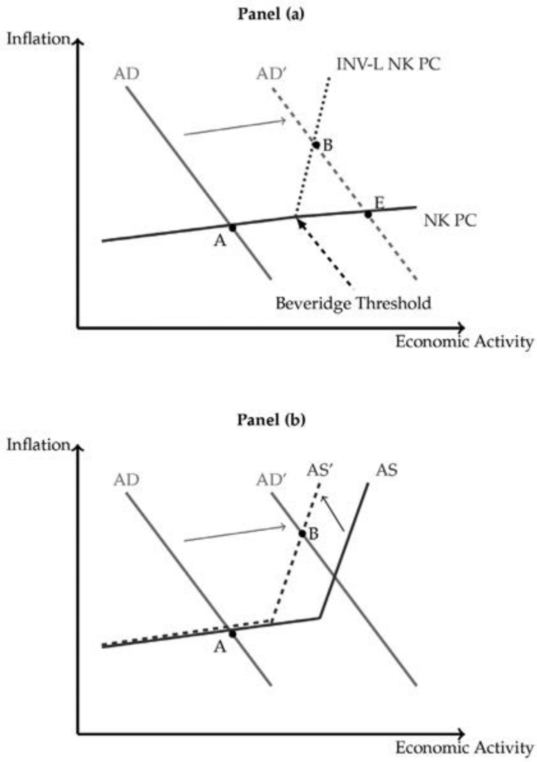
If the Beveridge curve is flat, it indicates that cooling the labor market (reducing v/u) will inevitably result in significant unemployment. Drawing from several past episodes, authors such as Blanchard, Domash, and Summers (2022) adopted a pessimistic view in 2022, arguing that a substantial increase in unemployment would be necessary to cool the labor market and bring inflation back to target.

Others were more optimistic. Several economists, including the authors of this paper and most notably Federal Reserve Chairman Jerome Powell, argued for the possibility of a "soft landing" — reducing inflation without a substantial increase in unemployment. Benigno and Eggertsson (2023, hereafter BE) formalized this prediction, which current data increasingly supports. One contribution of this paper is to reconcile why prominent economists reached divergent conclusions despite using similar methodological approaches. Central to the resolution is that, unlike in our framework, existing models of the Beveridge curve are highly sensitive to a single parameter, the elasticity of the matching function with respect to unemployment, the value of which there is no consensus in the literature.[2]

This paper revisits the soft landing prediction and clarifies how our modeling and empirical framework differ from existing approaches. Central to our analysis is a substantially modified Phillips curve, which we refer to as the Inverse-L (INV-L) New Keynesian Phillips Curve. This curve resembles the letter "L" turned backward, with each leg slanted, as shown in Figure 1. While our modification of the Beveridge curve is more modest, it carries significant implications. The most notable is that once a certain threshold is crossed, the Beveridge curve becomes nearly vertical.

We introduce a new term: the Beveridge threshold. This value marks a critical point in the labor market, measured by the ratio v/u, that triggers fundamental changes in both the Phillips curve and the Beveridge curve. Once the Beveridge threshold is crossed, the Phillips curve becomes steeper and more prone to generating inflation, while the Beveridge curve becomes nearly vertical, with most labor market adjustments occurring through changes in vacancies.

Figure 1



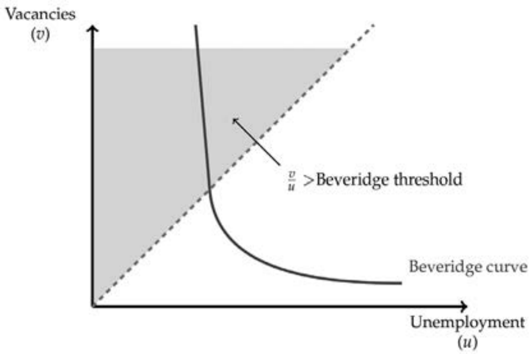
Note: Panel (a): Demand shock impacting non-linear Phillips curve. Panel (b): Supply shock supercharged under a non-linear Phillips curve.

The Beveridge threshold can also be used to calculate an indicator of the unemployment rate that triggers stronger inflationary pressures, which we call the Beveridge threshold unemployment rate. This rate marks the point below which the Phillips curve steepens significantly.

The exact value of the Beveridge threshold is uncertain. Beveridge originally conjectured it to be 1, and this approximation works surprisingly well for U.S. data. However, the uncertainty around this threshold poses a significant challenge for policymakers.

The past 111 years of U.S. economic history include six major inflation surges: World War I, World War II, the Korean War, the Vietnam War, the Great Inflation of the 1970s, and the inflation surge of the 2020s. In all but one of these episodes (the Great Inflation of the 1970s), the labor market was extraordinarily tight, as

Figure 2



Note: Beveridge curve during the 2020s inflationary surge. Gray area: region where $v/u > 1$.

indicated by *v/u* crossing the Beveridge threshold. One contribution of this paper is demonstrating that in these five episodes, the data suggest normalization primarily occurred through falling vacancies rather than rising unemployment.

Figure 1 illustrates three central lessons of the INV-L New Keynesian Phillips curve.

First, it explains why the inflation surge was unexpected by both markets and policymakers at the time (see panel (a)). In response to a substantial increase in demand, a flat Phillips curve, widely taken for granted prior to the inflation surge, would result in equilibrium at point E, with only a trivial inflationary effect.[3] The INV-L Phillips curve explains the unpleasant surprise: beyond the Beveridge threshold, there is an unexpected burst of inflation for those who placed their faith in a flat Phillips curve.

Second, it illustrates how the costs of reducing inflation differ between the standard conventional flat New Keynesian (NK) Phillips curve and the INV-L Phillips curve. Consider, for example, the estimate by Hazell et al. (2022). Their analysis suggests that reducing inflation by 4.2 percent would require a 12.2 percentage-point increase in the unemployment rate. In contrast, the INV-L curve implies a much smaller loss. In the extreme case, if the curve were completely vertical beyond the Beveridge threshold, there would be no cost at all.

Third, panel (b) shows how supply shocks have out-sized inflationary impacts when demand intersects the Phillips curve beyond the Beveridge threshold. We present both theoretical and empirical evidence to support this, suggesting that supply shocks played a significant role in the surge.[4]

A more subtle implication of this point is that the debate over whether demand or supply drove the inflation surge is somewhat misleading in our framework. Panel (b) suggests that demand must push the economy beyond the Beveridge threshold for supply shocks to have a meaningful effect. In the text, we provide a simple decomposition based on BE, attributing roughly two-thirds of the surge to demand forces and one-third to supply. However, our empirical analysis indicates that supply shocks would not have had a statistically significant impact if the economy had not crossed the Beveridge threshold.

Figure 2 highlights our key insight about the Beveridge curve: once the economy crosses the Beveridge threshold (denoted by the dashed line and shaded region), the curve becomes nearly vertical, with adjustments occurring mainly through changes in vacancies rather than unemployment. This feature, central to our paper, aligns with recent data, as we will demonstrate. While some search-and-matching models can replicate this behavior, their results are typically highly sensitive to specific parameter, for which empirical value there is little agreement. In contrast, this is a relatively robust feature of our model.

A key challenge in our framework is the uncertainty surrounding the value of the Beveridge threshold. While Beveridge's conjecture of 1 proves to be a surprisingly good approximation, there is nothing inherently special about this value; it can vary over time and with economic shocks. This uncertainty presents significant challenges for policymakers, especially given the lags in policy implementation. As of June 2024, the latest v/u was 1.2. Consequently, policymakers face two significant risks: if they are too slow to ease policy, they risk causing a "hard landing," characterized by high unemployment due to flatter Phillips and Beveridge curves. On the other hand, if they cut rates prematurely, they leave the economy vulnerable to inflationary supply shocks, which could be exacerbated above the Beveridge threshold, or to unexpected demand shocks, which the analysis suggests have a much larger impact on inflation once the equilibrium surpasses the Beveridge threshold. Our current assessment suggests that the former risk outweighs the latter.

A useful property of the Beveridge curve we propose is that it allows us to construct a Beveridge threshold unemployment rate, below which the Phillips curve steepens. The gap between the actual unemployment rate and the Beveridge threshold rate widened post-COVID, exceeding –1% at the peak of the inflation surge. As of this writing, the gap is narrowing and approaching zero, suggesting that further policy tightening may be unnecessary. The Beveridge threshold unemployment rate could become a useful metric for the Fed in evaluating its maximum employment mandate.[5]

2. The Labor Shortage, Supply Bottlenecks and the 2020s Inflation Surge

Two words dominated the economic discussion leading up to the inflation surge: "labor shortage" and "supply chain shortage." In this section, we focus on both terms. Of the two, we argue that the labor shortage is of primary importance, partly because it is a necessary condition for supply disruptions to have a significant impact on core inflation. We show that out of the six inflation surges in the U.S. during the last 111 years, five were associated with labor shortages.

2.1 Evidence of Labor Shortage

In this section we start by reviewing anecdotal evidence of labor shortage in the U.S. leading up to the inflation surge and review more formal measures we rely on later in the paper.

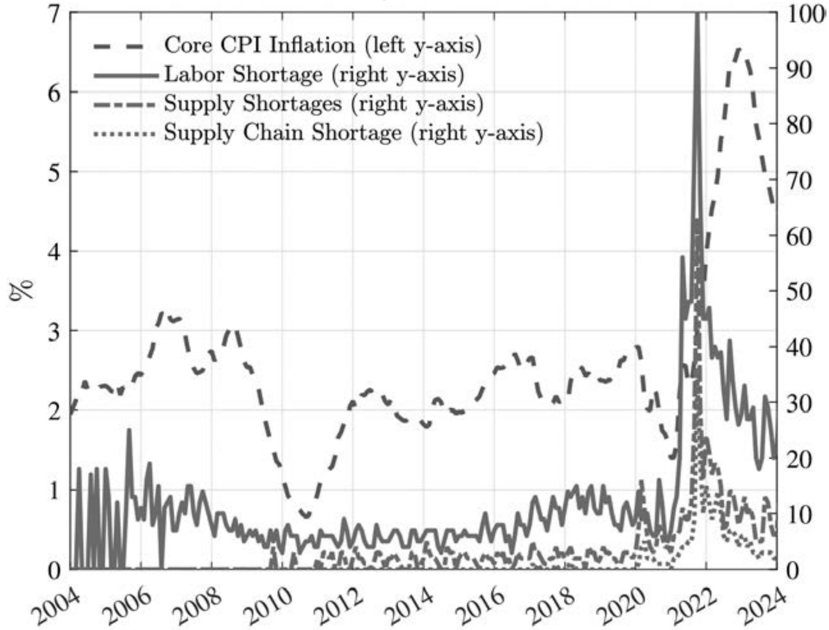
Casual anecdotal evidence abounds of labor shortages during the inflationary surge of the 2020s. A family of five enters a restaurant in Providence in 2021 which is at 1/3 capacity. They are turned away on account of the restaurant being full. When the bewildered customers point out that 2/3 of the restaurant is empty, the answer is: that part is closed due to "labor shortage." Figure 3 in the online version of this paper illustrates anecdotal evidence of this kind, stories that were widespread throughout the U.S. during the inflation surge: Panel (a) shows a scene from Ohio where an establishment announced it is closed "due to no staff." Panel (b) shows that McDonald's in Pennsylvania began offering new employees a signing bonus of 500 dollars. Meanwhile, other McDonald's establishments tried to attract new employees by giving them the opportunity to "eat as much as they want" while working. Panel (c) shows a strategy employed in Virginia: It closed during certain days. An alternative common strategy was to close during specific hours of the day.[6] Panel (d) shows a similar sign in Florida to the one in Ohio, announcing the establishment is closed due to a "labor shortage." To the right, a former worker puts an alternative announcement suggesting there is no such thing as a "labor shortage." According to the worker, all the company needs is to improve employment conditions.

The entry of "labor shortage" into public discussion is a relatively recent phenomenon. One way of seeing this is shown in Figure 4, which displays a Google trend index for "labor shortage" in the U.S., normalized to 100 when it peaked in October 2021, as the inflation surge was gaining momentum.[7] The Google trend reached its maximum five months before core CPI peaked, in March 2022, and when the Federal Reserve tightened policy. Prior to the inflation surge, "labor shortage" barely registered in Google trends.

A more formal metric of labor market tightness is originally proposed by Beveridge (1944), the founding father of labor economics. He suggested that the tightness of the market should be considering the number of vacancies firms are seeking to fill *(v)* (demand for labor) relative to the number of unemployed workers looking for jobs *(u)* (supply of labor). Beveridge suggested that the labor market is tight when there are more firms looking to fill jobs than unemployed people seeking them, i.e., $\frac{v_t}{u_t} \equiv \theta_t > 1$. We call $v/u = 1$ the **Beveridge threshold** and define the region when it is crossed as a **labor shortage.** Michaillat and Saez (2022) provide theoretical rationale that the economy is efficient at the Beveridge threshold.

The bottom panels of Figures 5 and 6 show the CPI inflation rate since 1913. They illustrate the six major inflation surges in U.S. economic history over the past 111 years: World War I, World War II,

Figure 4



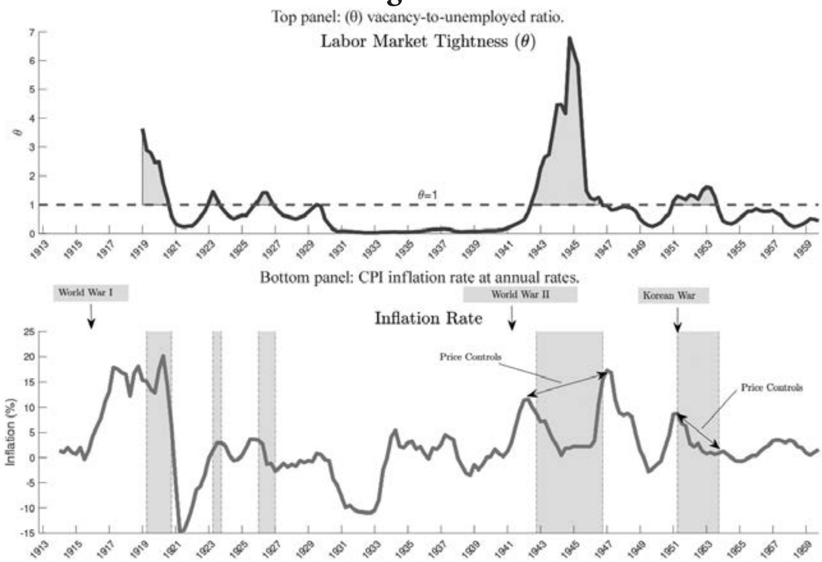
Note: Core CPI inflation rate at annual rates (left y-axis), Google trend indexes on "labor shortage," "supply shortage," "supply chain shortage," (right y-axis).
Source: BLS and Google.

the Korean War, the Vietnam War, the Great Inflation of the 1970s, and the COVID-19 inflation surge. The upper panel plots the *v/u* ratio marking the Beveridge threshold with a dashed line.[8]

We see a striking pattern when comparing the two panels in each figure. In the six major inflation surges observed in U.S. data since World War I, *v/u* surpasses the Beveridge threshold in all but one case: the Great Inflation of the 1970s. We analyze the correlation embedded in these relationships in next section.

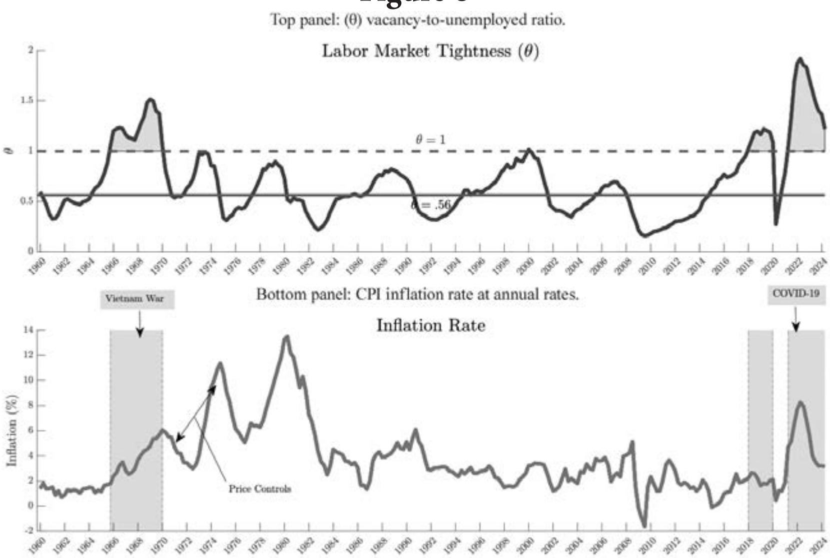
In recent years, researchers have increasingly begun using the ratio of vacancies to unemployment (*v/u*) as an alternative to unemployment alone, which is the more conventional measure of labor market slack.[9] Does *v/u* convey any relevant information beyond *u* alone? As we will discuss in Section 4, in the absence of shocks, the ratio *v/u* conveys the same information as *u* alone via the Beveridge curve. However, as we will see, COVID-19 caused measurable and significant

Figure 5



Note: Period 1913 Q1 – 1959 Q4.
Source: Petrosky-Nadeau and Zhang (2021) and BLS.

Figure 6



Note: Period 1960 Q1 – 2024 Q2.
Source: Petrosky-Nadeau and Zhang (2021), Barnichon (2010) and BLS.

shifts to the curve, among which is the fact that more vacancies are needed to create a match for a given level of unemployment.

Figure 7 shows that while *u* alone reasonably captures movements in *v/u* in the decade leading up to the inflation surge, this relationship breaks down after the COVID-19 pandemic and during the inflationary surge.[10] Figure 31 in the Appendix shows other episodes where *u* deviates from *v/u*. This explains the finding in Furman and Powell (2022): *v/u* performs better than *u* alone even if one restricts oneself to predicting inflation using only data *prior* to the pandemic.

To see how the relationship broke down, consider the period when inflation breached the inflation target in the spring of 2021 (e.g., year-on-year core inflation was 2.96% in April 2021, the highest in 25 years). In May 2021, unemployment was at 5.75%, suggesting a slack labor market to many observers, since it was at 3.9% leading up to the pandemic. Meanwhile, several other measures, such as the prime-age employment-to-population ratio frequently cited by Fed officials at the time, also pointed to a weak labor market.[11] At the same time, the vacancy-to-unemployed ratio surpassed the Beveridge threshold, signaling the beginning of a tight labor market.

Using the unemployment rate alone fails to capture both the demand and supply sides of the labor market, as emphasized by Beveridge, who argued that both sides were better proxied by *v/u*, with *v* representing demand and *u* supply. The Beveridge metric during the inflation surge of 2020s suggested a significant imbalance between the demand and supply of labor. Despite a large number of workers looking for jobs, there was an even larger number of firms trying to fill them, as suggested by our anecdotal evidence at the beginning of this section. Indeed, *v/u* reached its highest level since World War II during this episode, as shown in Figures 5 and 6.

2.2 Evidence of Supply Shortages

Aside from the popular discussion of labor shortage, the topics of "supply-side bottlenecks" and "supply chain disruptions" also dominated the discussion leading up to the inflation surge.

Figure 7

Note: Vacancy-to-unemployed ratio and its fitted value using a regression proposed by Kalantzis (2023): $\ln \theta_t = a + b \ln(u_t/(1-u_t)) + \varepsilon_t$ on the sample 2001 Q1 – 2024 Q2. The Figure shows the time-series for the sample 2009 Q1 – 2024 Q2.
Source: JOLTS and BLS.

As in the case of the labor shortage, there is a considerable amount of anecdotal evidence in this vein. Figure 8 in the online version of this paper illustrates a notable event from the spring of 2021, when a single freight vessel blocked the Suez Canal, causing delays for up to 369 vessels. Similarly, U.S. ports experienced severe congestion as the economy recovered, with a peak of 150 vessels idling while awaiting their turn to offload cargo. A well-known instance involved about 100 ships drifting idle off the coast of Los Angeles, a critical hub where approximately 40 percent of containerized U.S. imports are processed through the ports of Los Angeles and Long Beach. Part of the reason for these supply disruptions, aside from pure accidents like the Suez incident, was that the recovery from COVID-19 was uneven. Demand for goods outpaced the demand for services, a topic we return to later.

Again it is useful to consider Google Trends to formalize these anecdotal evidences. We see in Figure 4 that different measures of supply shortages spiked prior to the 2020s inflation surge.

A major challenge in measuring supply shortages in the literature following the inflation surge is the lack of a uniform method. Myriad measures have been proposed, see among others the Global Supply Chain Pressure Index of the Federal Reserve Bank of New York discussed in Benigno et al. (2022). These metrics are sensitive to post hoc pattern identification. While there is undoubtedly much to be learned from these measures, particularly as more data becomes available, our preferred approach takes a different direction. While not perfect, we prefer to use exactly the same measures that were commonly used to capture supply disturbances in the literature on the Phillips curve *prior* to the inflation surge of the 2020s, thus avoiding any concerns of ex post fitting.

The three most common measures are shown in Figure 9: headline shocks to overall CPI or PCE, and the difference between the growth of the import price deflator and the GDP deflator (see discussion in Ball et al. (2022)).

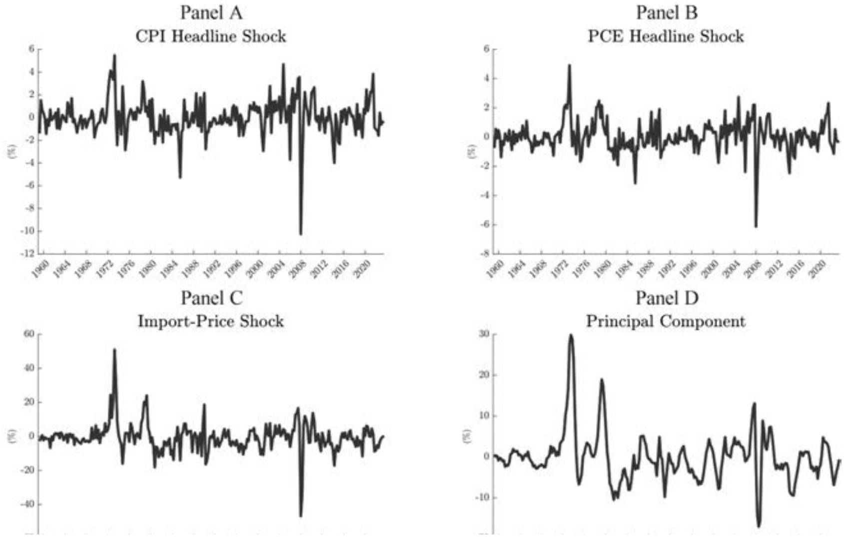
The most striking feature of these measures, relative to the prominence of supply disruptions in public discussion, is that they do not seem particularly volatile during the inflation surge. As we will see in the next section, however, once combined with labor shortage, they can have a substantial effect.

We view it as quite plausible that this measure of supply shocks leaves out some important components specific to COVID-19. In the empirical analysis we report, there is a substantial unexplained spike in inflation in Q2 of 2021 (see Figure 12 in the next section). A natural explanation for this is that our measure of supply shocks does not fully capture the special nature of supply-side bottlenecks during that quarter. For example, it was at the very end of Q1 2021 that the Suez Canal was clogged.[12]

3. The Return of the Non-linear Phillips Curve and the Role of Super-Charged Supply Shocks

The last section suggested a relationship between inflation and labor market tightness, showing that in five out of six inflation surges in the U.S. during the past 111 years, the labor market was extraordinarily tight. Here, we show that once the economy crosses the Beveridge threshold and enters a period of labor shortage, i.e., $v/u > 1$, there is strong evidence of the Phillips curve becoming substantially steeper.

Figure 9
Measures of Supply Shock and Their Principal Component



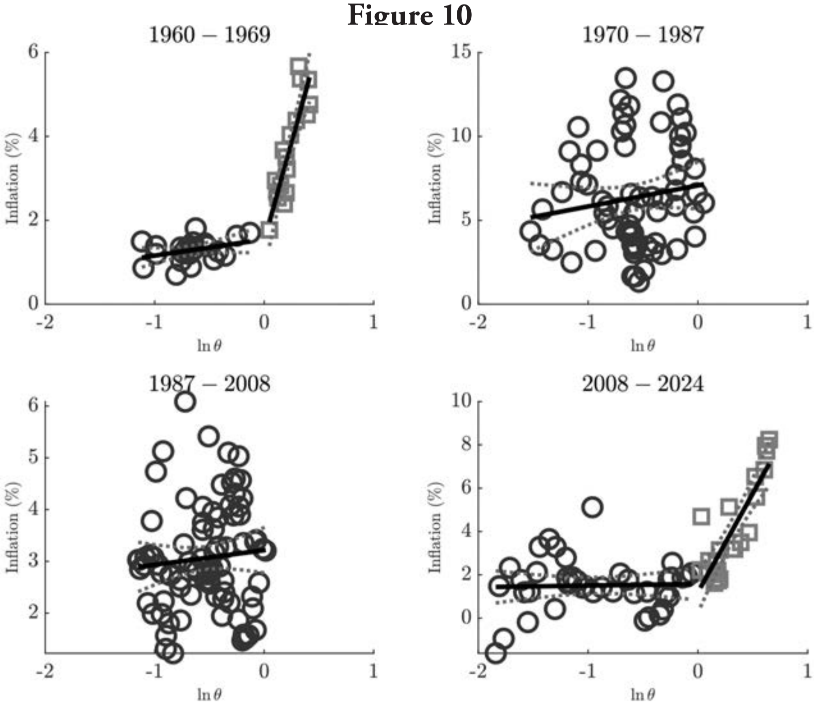
Note: Panel a: CPI Headline Shock. Panel b: PCE Headline Shock. Panel c: Import-Price Shock. d: Principal Component of the three shocks.
Source: BLS, Authors' computation.

This has two major implications. First, demand shocks will exert a substantially larger impact on inflation. Second, negative supply shocks have a larger impact on inflation.

3.1 Basic Correlations

Sometimes, a picture says more than a thousand words. Figure 10, reproduced from BE, shows a scatter plot of aggregate quarterly data with inflation on the y-axis and the logarithm of θ on the x-axis. Labor shortage is characterized by crossing the Beveridge threshold so that $\theta > 1$, or equivalently $\log(\theta) > 0$. We split the period into four sub-periods, with panels (a) and (d) both showing instances where $\theta > 1$, corresponding, respectively, to the late 1960s and the 2020s. The periods of labor shortage are shown with squares, while what we define as the "regular labor market" is shown by circles. As the Beveridge threshold is crossed, just looking at the raw data seems to hint at a substantial difference in the relationship between *v/u* and inflation.

Figure 10



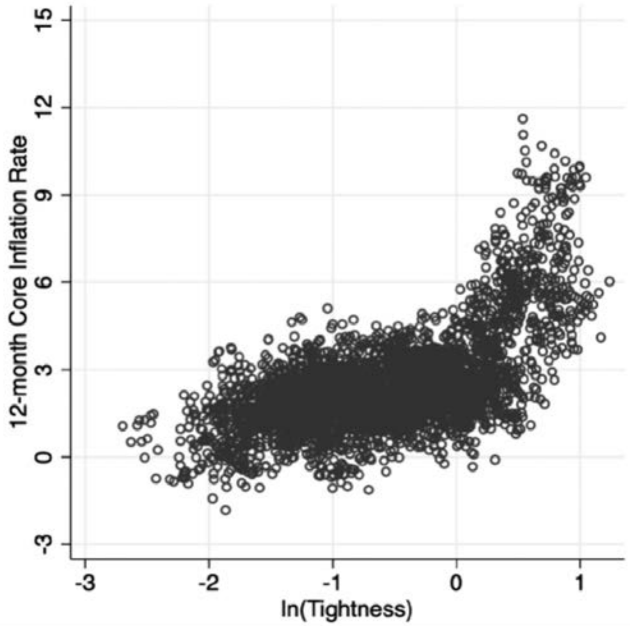
Note: Inflation: CPI inflation rate at annual rates. ln θ: log of the vacancy-to-unemployed ratio. Sample 1960 Q1 – 2024Q2.
Source: BLS and Barnichon (2010).

An obvious limitation of time series data is that there is a limited number of episodes of labor shortages. Gitti (2023) considers data on inflation in 21 Metropolitan Statistical Areas (MSAs) in the United States from December 2000 to April 2023 and constructs a new time series for *v/u* corresponding to each region. The raw data that her overall findings are based on are shown in Figure 11. The same pattern emerges as in the aggregate time series: there appears to be a clear break as one crosses the Beveridge threshold around log (θ) = 0.

3.2 Traditional Statistical Analysis of Phillips Curves Allowing for Non-linearity

Theoretically, a scatter plot represents equilibrium points where aggregate demand and supply intersect. One cannot claim that it provides any reliable information about either demand or supply, such as a Phillips curve.

Figure 11



Note: Inflation: CPI inflation rate at annual rates. ln θ: log of the vacancy-to-unemployed ratio for 21 Metropolitan Statistical Areas in the U.S. from 2000–2023.
Source: Gitti (2023).

And yet, it is hard to look at these figures without suspecting that during periods of labor shortage, there are strong hints of higher inflation pressures. Here, we report results from BE that show this suspicion can be supported with conventional regression analysis, controlling for confounding influences, particularly supply shocks, as suggested by McLeay and Tenreyro (2019) as one way of solving the inherent identification problem when estimating Phillips curves.

BE replicate conventional regressions common in the literature, where core inflation is regressed on ln θ and a number of control variables, including proxies for supply shocks and inflation expectations. Their innovation relative to the existing literature is simple. Existing literature, such as Ball et al. (2022), considers empirical specifications for non-linearities at all times by including second-order terms. Instead, BE introduce a dummy variable for the periods when $\theta > \theta^*$, where θ^* is an estimate of the break point in the slope of a piece-wise linear Phillips curve. The dummy variable is introduced for both the

θ variable and the supply shock, and they find that it is statistically and economically significant in both cases. Moreover, by examining the likelihood function of their empirical specification, they find that $\theta^* \approx 1$ provides a reasonably good fit, thus supporting the Beveridge hypothesis that crossing the unitary threshold leads to an excessively tight labor market. Yet, it is worth emphasizing that this threshold is not precisely estimated. As discussed in the introduction, this presents significant challenges for policymakers.

The motivation for the specification, shown in Appendix A along with baseline results, is both empirical and theoretical. Inspection of Figures 10 and 11 suggests that a piece-wise linear function may provide a reasonable approximation of the data. Moreover, BE show theoretically that a characterization of this kind arises quite naturally, if one adapts a model of wage setting in the spirit of Phillips (1958) as we will discuss in Section 3.4.

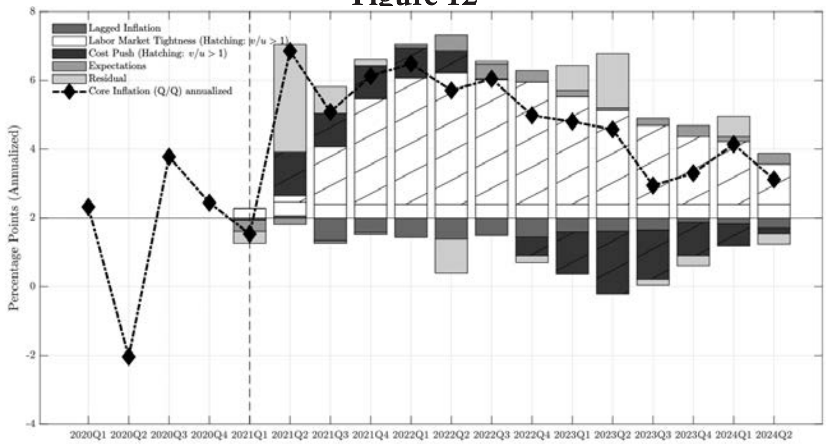
The main conclusions of the benchmark empirical result in BE are summarized below. We refer the reader to the original paper for precise definitions of variables and a number of robustness checks.

The first main conclusion is that the slope of the Phillips curve, defined in terms of the relation between core inflation and θ, increases by a factor of ten once the Beveridge threshold is crossed. It is very flat in the absence of a labor shortage (0.52) compared to when there is a labor shortage (5.35), using the last part of the sample from 2009 onwards.[13] The second major conclusion is that labor shortages supercharge supply shocks. While supply shocks do not have a statistically significant effect on core inflation under normal circumstances according to the benchmark estimates, they do so during a labor shortage, as we will show below.

Figure 12 shows the evolution of core CPI inflation accounted for by the various right-hand side variables of the regression in BE.[14]

The first major point is that the majority of the run-up is explained through the combination of the hatched white bars (the contribution of θ interacted with the dummy variable for labor shortage) and the hatched dark bars (the contribution of the supply shocks interacted with the dummy variable for labor shortage). At the beginning

Figure 12



Note: Decomposition of the baseline regression in BE between the contributions of the various regressors: lag inflation, ln θ, supply shocks, inflation expectations. For the variable ln θ, hatching corresponds to the contribution of the variable for the portion of θ that exceeds the unitary value. For the supply shock, hatching corresponds to the contributions of the variable when $\theta > 1$. Core inflation and all the components are plotted at annualized quarterly rates.
Source: Benigno and Eggertsson, 2023.

of the surge, in the second quarter of 2021, supply shocks explain a larger component. However, starting from the following quarter, labor tightness becomes predominant in explaining the run-up, even though supply shocks still play a non-trivial role.

A second observation is that a significant part of the initial decline in inflation is due to supply shocks exerting downward pressure on inflation, playing an even bigger role than they did in the run-up. However, the component capturing labor market tightness remains an important headwind and explains why inflation has not fallen promptly to the two-percent target. In the second quarter of 2024, when the estimation period ends, the *v/u* was at 1.2 as of June 2024, down from its peak of 2 in March 2022 once the Federal Reserve started raising rates. Thus, the U.S. economy has yet to return to the Beveridge threshold, and accordingly, inflation remains more sensitive to both supply shocks and labor market tightness.

The light gray bars in Figure 12 represent the residual that the econometric specification is unable to account for. Interestingly, it plays the largest role in the first quarter of the run-up in inflation, i.e., Q2 of 2021. A plausible explanation for this, as we have already discussed, is that our measure of supply shock is based on traditional frameworks developed by the literature prior to the inflation surge. As a result, it may not capture the unique features that characterized the inflation of the 2020s, such as supply chain disruptions, which were likely of particular importance early in the period.[15]

3.3 The Fed Credibility and the Inflation Surges of 1960s vs 2020s

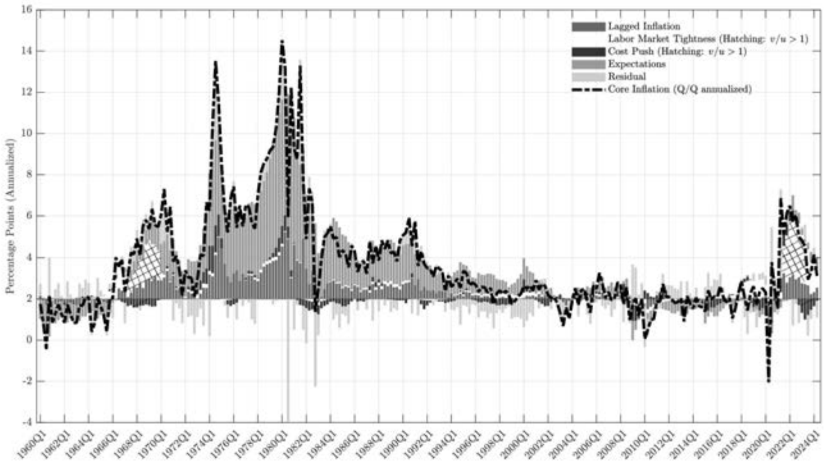
A notable feature of Figure 12 is that inflation expectations play virtually no role in the inflation dynamic. This is consistent with the observation that long-term inflation expectations were stable during this period.

Conventional wisdom, however, attributes the unanchoring of inflation expectations as an important factor in explaining the Great Inflation of the 1970s. Of the six major inflation surges of the past 111 years discussed in the last section, this is the only one where v/u remained below the Beveridge threshold. Figure 13 performs the same type of decomposition but for the entire period 1960 Q1 – 2024 Q2.

A central result is that inflation expectations play a large role in explaining the Great Inflation of the 1970s, consistent with conventional wisdom. Their contribution also remained persistently high as the Federal Reserve brought down inflation in the 1980s. This is one of the fundamental insight of the literature explaining the depth and duration of the Volcker recession which brought inflation back under control (see Erceg and Levin (2003) and Goodfriend and King (2005) for two classic references).

For our purposes, it's crucial to distinguish between the inflation surges of the 1960s and the 2020s. While both were triggered by labor market tightening beyond the Beveridge threshold ($v/u = 1$), there is an important difference. As shown in Figure 13, inflation expectations in the 1960s *began to become unanchored* towards the end of the surge, which did not happen in the 2020s. This unanchoring in the 1960s may have contributed to the Great Inflation of the 1970s, an episode often overlooked by economists. The 1960s surge likely made inflation expectations more vulnerable to rapid increases following the oil price shocks of the 1970s.

Figure 13

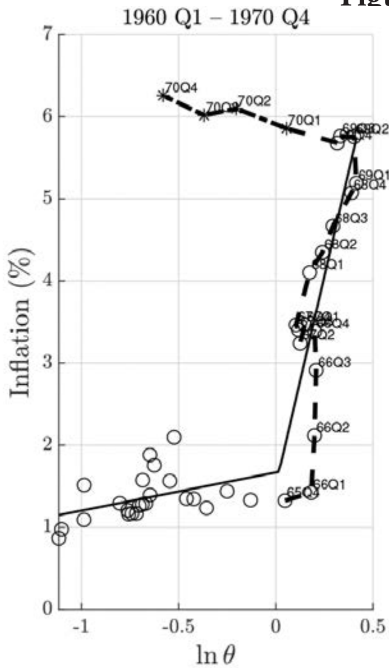


Note: Decomposition of the baseline regression in BE between the contributions of the various regressors: lag inflation, ln θ, supply shocks, inflation expectations. For the variable ln θ, hatching corresponds to the contribution of the variable for the portion of θ that exceeds the unitary value. For the supply shock, hatching corresponds to the contributions of the variable when $\theta > 1$. Core inflation and all the components are plotted at annualized quarterly rates.
Source: Benigno and Eggertsson, 2023.

To develop this argument further, consider the scatter plots from Q1 1960 to Q4 1970 and from Q3 2008 to Q2 2024 as shown in Figure 14. First, examine the run-up in inflation during both episodes. We see that inflation travels along the steep part of the Phillips curve once $log(\theta) > 0$. That is where the similarities end, however. Once θ starts dropping during the inflation surge of the 2020s, inflation *travels down the same curve.* In sharp contrast, during the 1960s surge, as θ started dropping in the early 1970s, *inflation kept increasing.*

This is explained by a rise in inflation expectations, as a careful examination of Figure 13 reveals. To develop this argument in a more transparent way, Figure 15 shows inflation expectations on the x-axis and actual inflation on the y-axis. If expectations move one-to-one with realized inflation, we should expect the data to align along the 45-degree line, which is shown as a dashed line. If expectations are insensitive to realized inflation, however, the data should cluster around the vertical dashed line, representing the 2 percent inflation target. In both figures, circle markers denote the data before the Beveridge threshold is crossed. The continuous line in both graphs

Figure 14

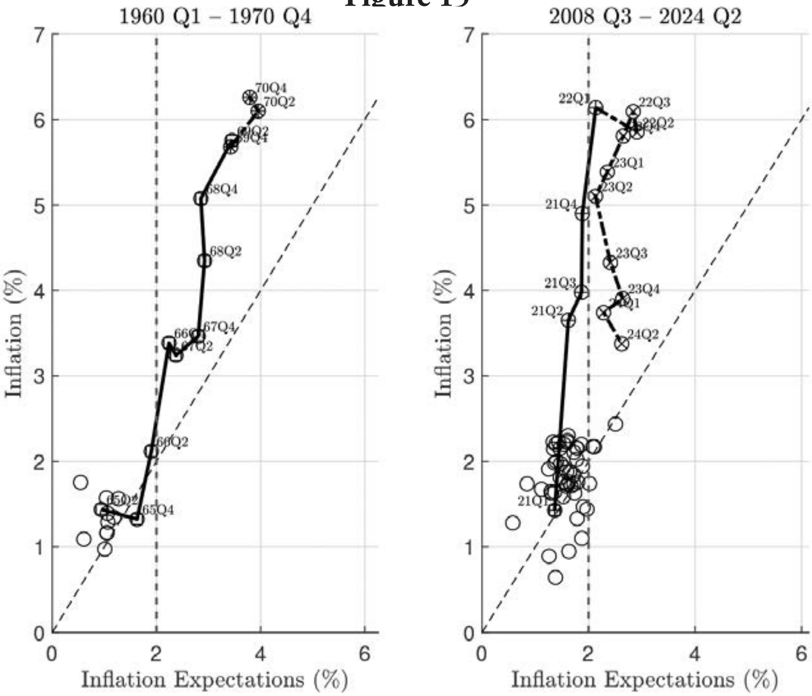


Note: Scatter plots of core CPI inflation, quarterly rates (annualized), (y-axis), and vacancy-to-unemployed ratio, ln *v/u*, (x-axis). Left panel: period 1960 Q1 – 1970 Q4. Right panel: period 2008 Q3 – 2024 Q2.
Source: BLS and Barnichon (2010), Authors' computation.

illustrates the rise in inflation associated with increased labor market tightness as *v/u* crosses 1.

A first observation is that the continuous line in the 1960s is much closer to the 45-degree line than in the 2020s, where it deviates more significantly. Of even greater interest is what happens once the labor market starts weakening again. This is indicated by asterisk markers in the 1960s: as labor market tightness eases, inflation continues to increase in tandem with inflation expectations. In sharp contrast, consider the recent episode shown in the right panel of Figure 15. The cross markers denote the period after March 2022, when the Federal Reserve began tightening interest rates, and labor market tightness started to ease. In response to this, actual inflation declines, in sharp contrast to the end of the inflation surge in the 1960s. Moreover, inflation expectations remain much closer to the 2 percent target throughout the 2020s inflation surge, compared to the 1960s.

Figure 15



Note: Scatter plots of core inflation, quarterly rates (annualized), (y-axis), and inflation expectations, (x-axis). Left panel: period 1960 Q1 – 1970 Q4, bi-annual frequency; Livingston survey inflation expectations. Right panel: period 2008 Q3 – 2024 Q2, quarterly frequency; 2-year Cleveland Fed inflation expectations.
Source: BLS, Federal Reserve Bank of Cleveland, Federal Reserve Bank of Philadelphia, Authors' computation.

3.4 The Relationships Between Inflation and v/u, and the INV-L New Keynesian Phillips Curve

So far, we have limited ourselves to describing the data without explaining the theoretical reasoning that motivates our thinking. Here, we describe how one can, on the basis of our previous work in BE, arrive at a straightforward theoretical relationship that rationalizes a piece-wise linear relationship, grounded in the empirical evidence we have already presented. The resulting relationship is what we term the Inverse-L New Keynesian Phillips curve. Relative to the standard New Keynesian Phillips curve, there are two major differences. The first is that we replace traditional measures of slack, such as the output gap, with $\theta = v/u$. The second is that the model can be approximated as being piece-wise linear; once a certain threshold is breached and $\theta > \theta^*$, the slope of the Phillips curve changes.

We arrive at this relationship in two steps, which are described in detail in BE. In the first step, a New Keynesian (NK) Phillips curve is derived where inflation depends on marginal costs, but our interpretation of how this marginal cost is computed differs from the standard approach, namely by emphasizing the wages of new hires rather than the average wage rate. In the second step, we postulate a wage-setting behavior as in Phillips (1958), which is non-linear. It is thus the labor market that is the fundamental source of the non-linearity of the Phillips curve. In the second step, wages of new hires can be expressed in terms of labor market tightness, i.e., θ.

Following the aforementioned ordering, in the first step, BE obtains:

$$\pi_t = \kappa_w \underbrace{\hat{w}_t^{new}}_{\text{Marginal Cost of Labor}} + \kappa_v \underbrace{\hat{v}_t}_{\text{Cost Push Shocks}} + \beta E_t \pi_{t+1} \tag{1}$$

Where w_t^{new} represents the real wages of new hires, $\hat{v}_t$ are supply/cost push shocks, π_t is inflation, E_t is an expectation operator, and $K_v > 0$, $K_q > 0$, and $0 < \beta < 1$ are coefficients. The key difference, relative to the standard Phillips curve, is that marginal costs are proxied by newly negotiated wages compared to some measure of average wages. This innovation also clarifies the difference between our results and an influential paper by Bernanke and Blanchard (2023). They attribute a more trivial role to labor market tightness (especially toward the beginning of the surge). Bernanke and Blanchard (2023) follow the New Keynesian tradition and measure marginal cost with unit labor cost, proxied by average hourly labor cost.[16]

Here, instead, we distinguish between the salaries of *existing* workers and *new* workers. We argue that it is the wages of new workers that are relevant to marginal cost if a firm needs to increase production. The wages of new and existing workers may be very close under normal circumstances. BE, for example, assume for simplicity that they are exactly the same in the absence of labor shortage. When there is a labor market shortage, however, they may become very different, a difference that can be exaggerated by inflation to the extent that existing workers have negotiated their salaries in nominal terms.

The difference between the salaries of new workers relative to existing workers became particularly stark during the inflation surge. One way of seeing this is to compare the wage growth of those workers accepting new jobs to the wages of existing workers.

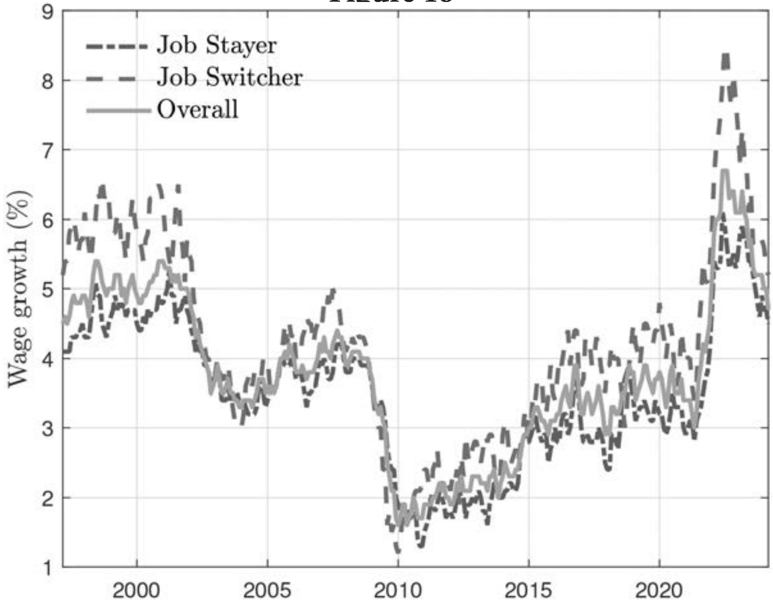
Figure 16 shows that workers switching from one job to another, who correspond to approximately 40 percent of all new hires,[17] saw a much more substantial increase in their nominal wage growth than existing workers. One aspect of the data on job-to-job switchers is that there may be compositional effects; perhaps one reason for the wage hike of a person switching jobs is that they found a more productive way of exploiting their talents. For this reason, some researchers have focused on wage growth for particular vacancies, which do not pose the same challenge. A recent estimate of wage growth taking this approach is shown by Crump et al. (2023) using Burning Glass Data and the methodology developed by Cattaneo et al. (2024).

Figure 17 compares the two-year growth rate of nominal wages for particular vacancies in the period 2017–2019 relative to 2020–2022 and 2021–2023. As shown in this figure, the wage growth in 2017–2019 is far below that of the latter two-year periods, which is especially true at the lower end of the distribution. In sum, the evidence in Figures 16 and 17 suggests that it makes a quantitatively important difference if the wages of newly hired workers represent the true marginal costs for firms during a labor shortage, rather than average wages.

Starting from equation (1), BE show in a second step that the non-linear INV-L NK Phillips curve arises due to the way in which wages are set, bringing us back to the original Phillips curve. It is often overlooked that Phillips' (1958) article differs in two fundamental ways from existing formulations that carry his name. First, the y-axis represents nominal wage growth. Second, and this was one of his central point, it is highly non-linear.

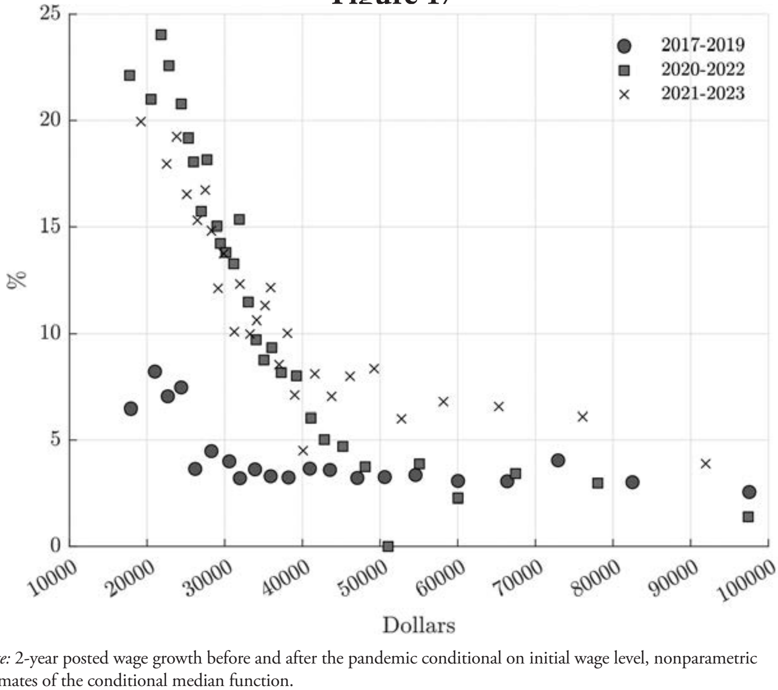
Figure 18 shows the original Phillips curve, which is very flat at high unemployment rates and becomes very steep once the labor market is tight. The reason Phillips gives for the shape of his curve is that workers are very reluctant to accept wages below the *prevailing wage,* so wages fall only slowly even if unemployment is high. The converse is not true, however. Workers are happy to accept *new wages*

Figure 16



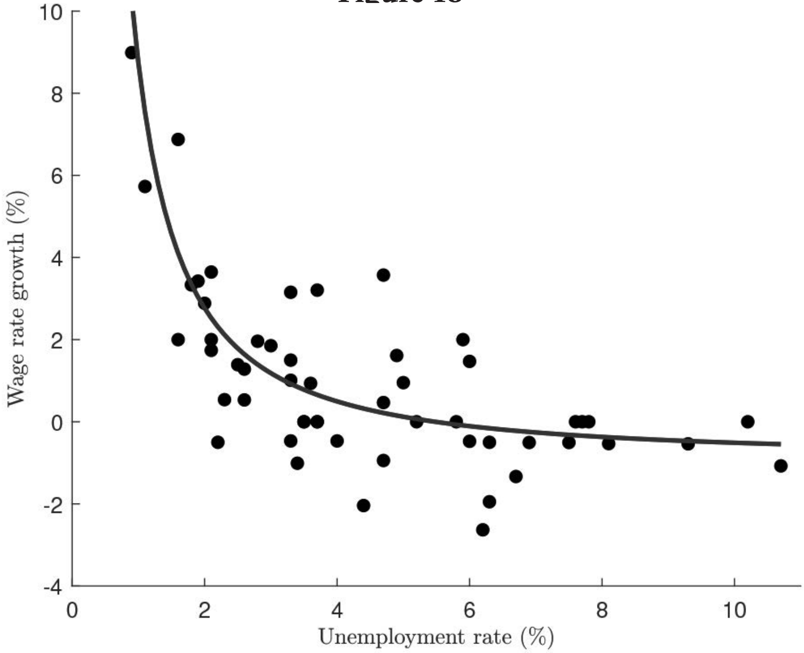
Note: Wage growth (%), overall, and decomposition between job switchers and job stayers. *Wage Growth Tracker, Federal Reserve Bank of Atlanta.*

Figure 17



Note: 2-year posted wage growth before and after the pandemic conditional on initial wage level, nonparametric estimates of the conditional median function.
Source: Crump et al. (2024).

Figure 18



Note: Phillips curve (1861 – 1913, United Kingdom, Phillips, 1958): Wage rate growth *(Source:* Brown and Hopkins, 1950) vs. unemployment rate.
Source: Feinstein, 1972, adjusted by Board of Trade.

that are higher than the prevailing ones, so in a tight labor market "we should expect employers to bid wage rates up quite rapidly." BE embed this idea into the Phillips curve in Figure 1.[18] Importantly, BE's theoretical framework allows them to express new wages in terms of *v/u*. This is significant since data on vacancies and unemployment are readily available, while good and representative data on new wages is not as easy to come by.[19] Below, we present a simplified version relative to BE:

$$\pi_t = \begin{cases} \tilde{\kappa}^{tight}\hat{\theta}_t + \tilde{\kappa}_v^{tight}\hat{v}_t + \beta E_t\pi_{t+1} & \hat{\theta}_t > \hat{\theta}_t^* \\ \\ \tilde{\kappa}\hat{\theta}_t + \tilde{\kappa}_v\hat{v}_t + \tilde{\kappa}_\beta E_t\pi_{t+1} & \hat{\theta}_t \leq \hat{\theta}_t^* \end{cases} \qquad (2)$$

in which $\tilde{\kappa}^{tight} > \tilde{\kappa} > 0$, $\tilde{\kappa}_v^{tight} > \tilde{\kappa}_v > 0$, whereas the relationship between $\tilde{\kappa}_\beta$ and β is ambiguous depending on the specifics of the calibration.

It is worth highlighting one aspect of the result we mentioned above, even if we do not develop it further in this analysis. We have taken for granted that the Beveridge threshold is fixed at 1, as suggested by Beveridge himself. BE analysis suggests, however, that it can take on values different from 1, depending on institutional details, and moreover, it may vary over time. The exact region of labor market tightness when it becomes more and more inflationary is a topic that is largely unexplored.

3.5 Using the INV-L Phillips Curve to Understand the Inflation Surge of 2020s

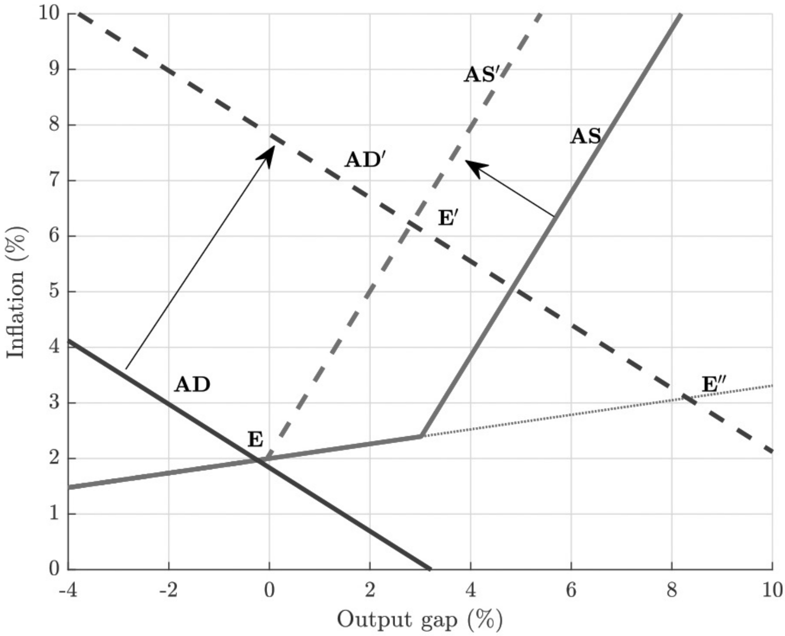
We can use the simple framework we developed to gain insights into the inflation surge of the 2020s and give the reader a quantitative feel for the illustrative figures in the introduction. The Phillips curve derived in the last subsection maps directly onto our empirical estimates. Figure 19 casts the analysis in an Aggregate Demand (AD) and Aggregate Supply (AS) framework, rewriting the Phillips curve in terms of output instead of v/u — a more familiar exposition for most readers. The numerical example uses the empirical estimates of the regression we have discussed (see further details in BE and Table 1 in the Appendix, column 4).

Consider first the increase in demand alone. If the slope of the Phillips curve is unchanged, then the demand would only have increased inflation to about 3 percent. In the numerical example, the increase in demand and negative supply shocks are chosen to match the relative contribution of labor market tightness and supply shocks as shown in Figure 12 for the second quarter of 2022. When the labor market is slack, on the flatter part of the curve, the supply shocks do not have a statistically significant effect according to our estimate.

Consider now the consequence of a nonlinear Phillips curve. Not only does it amplify the effect of the demand shock, but it also amplifies the supply shocks' effect so that about three-quarters of the rise in core CPI from 2 to 6.2 percent is accounted for by the shift in AD, while one-quarter is explained by supply shocks.

An interesting property of the numerical example is that if the supply shocks revert back to pre-surge levels, then inflation can be

Figure 19



Note: The 2020s Inflationary Surge: Inflation and output determination using an AS – AD framework in response to an increase in demand and a supply shock.
Source: Benigno and Eggertsson (2023).

brought down to about 2.5 percent without any drop in output with suitable monetary tightening: a soft landing. We think this provides a reasonable description of the current policy environment, a claim buttressed by the regression decomposition in Figure 12.

A word of caution is appropriate. As of writing, the labor market is still in the labor shortage region with *v/u* = 1.2 as of June 2024. This implies that if the deflationary supply pressures observed from Q1 2022 to the present reverse themselves, the Fed might be more cautious about cutting rates before crossing the Beveridge threshold. Yet, given the uncertainty surrounding the Beveridge threshold, as will become clearer in the next section, policymakers also risk over-tightening and entering a zone with far less favorable inflation-output trade-offs, where further reductions in inflation would come at the cost of substantial output contraction and higher unemployment.

One of the key arguments against the possibility of a soft landing, which now seems within reach, was based on the Beveridge curve, suggesting that cooling the economy would inevitably lead to a significant rise in unemployment. However, as with output, this concern has proven overly pessimistic, provided the Fed's contractionary policies have not been pushed too far. The reasons for this will be discussed in the following sections.

4. Revisiting the Beveridge Curve

In the last section, we linked inflation to economic slack in a non-linear way, suggesting that the ratio of job vacancies to unemployed workers, v/u, is a useful measure of slack. A key takeaway from this is that inflation can be reduced without a significant drop in output. Instead, it is labor market tightness, v/u, that decreases. But how does this adjustment occur? Through a reduction in vacancies or an increase in unemployment?

The empirical relationship between v and u is known as the Beveridge curve. If this relationship is stable, then either v or u can serve as a sufficient statistic for the other. In this section, we show that during a labor shortage, a reduction in v/u not only leads to a small drop in output but also occurs primarily through a decrease in vacancies, with little change in unemployment. We first establish this empirically by analyzing data from the 2020s inflation surge, followed by data from the four other inflation surges over the past 111 years when v/u crossed the Beveridge threshold of 1.

We then provide a theoretical rationale for this result and compare it with prominent theoretical frameworks used to predict the likelihood of a hard or soft landing when the Federal Reserve began tightening in March 2022.

Unlike the Phillips curve, which is named after Phillips and was first drawn by him, the Beveridge curve was not drawn by its namesake. As in the case of the Phillips curve, the first study plotting the Beveridge curve was based on data from the United Kingdom, using a subsample of Phillips' analysis, and published in the same year by Dow and Dicks-Mireaux (1958).

Dow and Dicks-Mireaux (1958) begin their work with the premise that unemployment and unfilled vacancies are frequently used to characterize labor demand. They state that "an increase in the pressure of demand will then always increase the level of unfilled vacancies reported and reduce unemployment" (Dow and Dicks-Mireaux, 1958, p. 4). This suggests an inverse relationship between vacancies and unemployment, which is the Beveridge curve. Interestingly, they further argue that "if employers give a correct statement of their vacancies, the line dividing areas of high and low demand would be at exactly 45 degrees through the origin" (Dow and Dicks-Mireaux, 1958, p. 4). This is identical to what we have termed the Beveridge threshold.

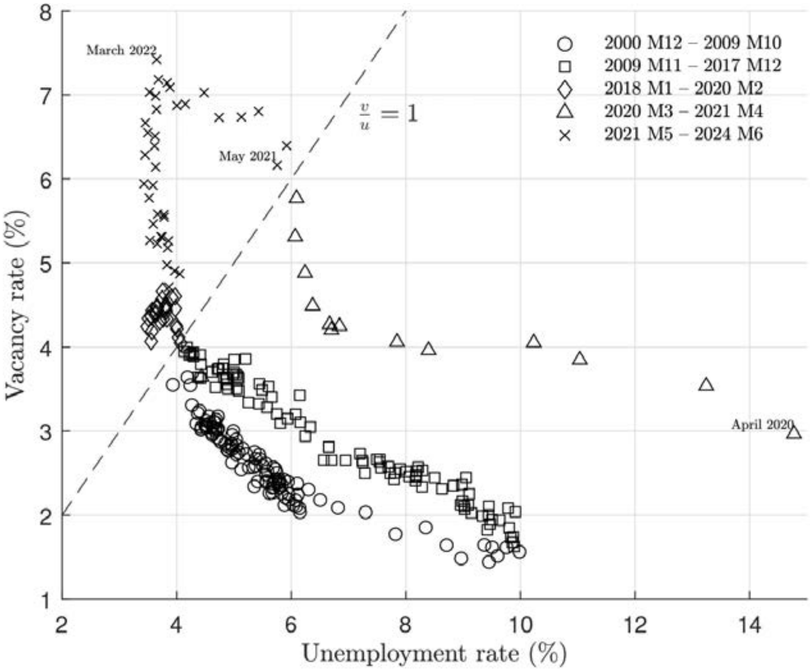
4.1 The U.S. Beveridge Curve in the 21st Century

Figure 20 plots the job vacancy rate, calculated as the number of vacancies as a fraction of the labor force, and the unemployment rate, calculated as the number of unemployed individuals as a fraction of the labor force. The Beveridge threshold, $v/u = 1$, is shown with a dashed line. The data are monthly, sourced from the Job Openings and Labor Turnover Survey (JOLTS) of the U.S. Bureau of Labor Statistics (BLS), and cover the period from the survey's start in December 2000 to the most recent observation.

We can identify five distinct periods, or "regimes," each exhibiting unique dynamics. The first period, identified with circle markers, extends from the start of the sample to the peak of unemployment during the financial crisis in October 2009. This period shows a stable pattern, resembling a curve that negatively correlates the vacancy rate with the unemployment rate.

Following the trough in October 2009, there was a continuous improvement in labor market conditions up to February 2020. This period also displayed a stable pattern but on a curve that was outwardly shifted compared to the previous period. Within this time frame, we have identified the data from January 2018 to February 2020 with diamond markers, where the vacancy rate exceeded the unemployment rate and crossed the Beveridge threshold, just before COVID-19 and well before the inflation surge.[20]

Figure 20



Note: United States: scatter plots of job vacancy rate *(v)* and unemployment rate *(u)*, monthly frequency, sample December 2000 – June 2024.
Source: BLS, JOLTS.

The diamond-markers period is followed by an abrupt shift due to the eruption of the COVID-19 pandemic, captured by the triangle markers on the far right of the graph, where the unemployment rate reached 15%. This fourth period is characterized by an irregular recovery in the labor market.

As emphasized in the last section, the final part of this recovery is marked by a tight labor market, with the job vacancy rate rising above the unemployment rate. This period is depicted with x-markers, starting from May 2021. During this time, there is a steady decline in the unemployment rate and an increase in vacancies until the Federal Reserve begins raising rates in March 2022. Notably, the most recent points of decline align closely with the pre-COVID observations shown with diamond markers.

Should the sharp reduction in vacancies with little or no change in unemployment be surprising? One way to address this question is from a purely theoretical perspective, which we will explore shortly. However, it seems natural first to consider what can be learned from the other four inflationary surges of the past 111 years when the Beveridge threshold was crossed. Once the Beveridge threshold was breached, did the labor market adjust through an increase in unemployment or a reduction in vacancies? As we will see, a drop in labor market tightness driven by a reduction in vacancies, with little change in unemployment, is a pattern shared across these episodes, with the possible exception of the aftermath of World War I.

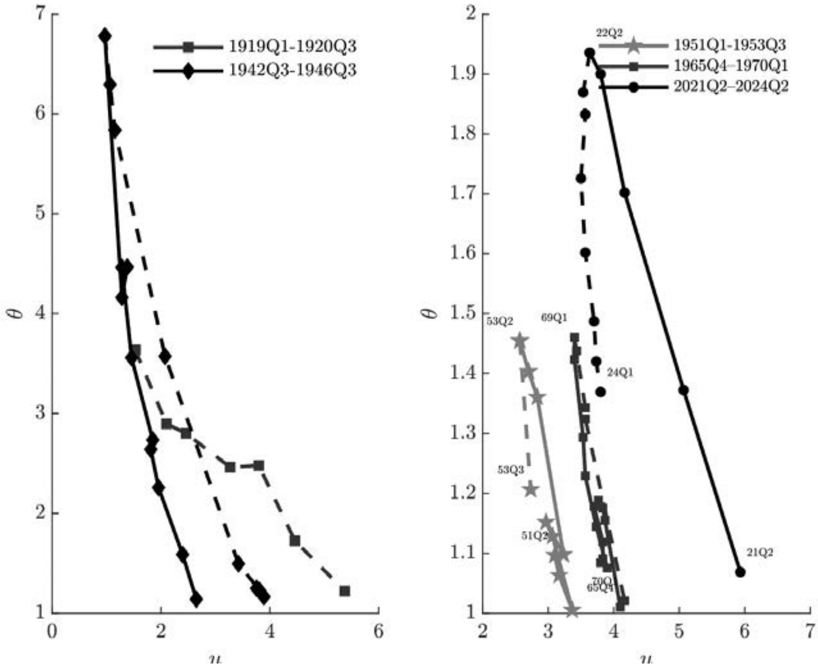
4.2 Four Inflation Surges of the 20th Century and the Adjustment of v/u

There are four major inflation surges in the 20th century associated with labor shortages ($v/u > 1$): World War I, World War II, the Korean War, and the Vietnam War. Our question is: Is it possible to cool down the labor market, $\theta = v/u$, without increasing unemployment? To answer this, it makes sense to temporarily set aside the traditional representation of the Beveridge curve and instead plot unemployment on the x-axis and θ on the y-axis in place of v. We focus on periods when $\theta > 1$ and seek to understand whether bringing it back to 1 requires a significant increase in unemployment. Our general finding is that throughout these episodes, the adjustment largely occurs via a fall in vacancies.

Figure 21 plots the data on a diagram with θ on the y-axis and the unemployment rate on the x-axis.[21] The figure uses solid lines to represent periods when θ is rising and a dashed line to indicate periods when it is declining.

The left panel documents the two most extreme episodes: World War I and World War II. The increase in θ was sharpest during World War II, reaching a peak of 7. Moving from 7 back to 1 increased unemployment from 1.2% to 4%. Meanwhile, the vacancy rate dropped from 8.4% at its peak to 4%, aligning with the Beveridge threshold of 1. This suggests that about 60 percent of the adjustment occurred through a reduction in vacancies. However, this adjustment

Figure 21



Note: United States: scatter plots of vacancy-to-unemployed ratio, θ, and unemployment rate, *u,* at quarterly frequency. Periods in which θ is above the unitary value. Left panel: 1919 Q1 – 1920 Q3, 1942 Q3 – 1946 Q3. Right panel: Periods 1951 Q1 – 1953 Q3, 1965 Q4 – 1970 Q1, and 2021 Q2 – 2024 Q2.
Source: BLS, Barnichon (2010), Petrosky-Nadeau and Zhang (2021).

was clearly influenced by the fact that unemployment started at very low levels, presumably well below its natural rate.

The inflationary surge in the 2020s, shown in the right-side panel, began with a relatively higher unemployment rate, close to 6%. As the labor market cooled, nearly all of the adjustment occurred through a reduction in vacancies, likely because the economy was near the natural rate of employment. The same general pattern holds for the Korean War and the Vietnam War: θ dropped back to the Beveridge threshold with relatively modest changes in unemployment.[22]

We do not have data on the run-up in vacancies during World War I, as our analysis is based on a series constructed by Petrosky-Nadeau and Zhang (2021), which only goes back to 1919. Generally, the drop in labor market tightness after World War I led to a greater increase in unemployment than in other episodes. This was largely driven by extremely contractionary monetary policy, which briefly resulted in a deflation rate of –15% — a record in U.S. history, even surpassing that of the Great Depression. The sharply contractionary monetary policy at the time is largely attributed to the constraints imposed by the gold standard (see, e.g., the discussion in Friedman and Schwartz (1963)).

What emerges from these figures is that at low unemployment rates, unemployment becomes relatively insensitive to variations in labor demand, as originally suggested by Dows and Dicks-Mireaux (1958). This observation seems to capture the concept of a minimum unemployment rate or maximum employment.

4.3 A Minimalistic Model of a Beveridge Curve

The analysis presented so far in this section has been purely descriptive, based on data. Here, we summarize a parsimonious search and matching model that underlies the analysis of BE. This model effectively describes the dynamics of labor tightness during periods of labor shortages. In Section 5, we generalize the model to better capture periods of slack in the labor market. We then contrast this model with two influential analyses that were hotly debated as the Federal Reserve began tightening policy in 2022: the work of Blanchard, Domash, and Summers (2022, hereafter BDS) and Figura and Waller (2022, hereafter FW).

The labor market literature is rich in theories of the Beveridge curve. A comprehensive survey of this literature is beyond the scope of this paper.[23] We propose an alternative view of the Beveridge curve based on BE. Our objective is to link inflation determination to measures of slack, specifically v/u, in the most parsimonious way possible. Accordingly, we make several stark simplifying assumptions.

The model has three key aspects. First, at the beginning of each period, the household makes a labor force decision, F_t. Second, at the same time, an exogenous fraction of the labor force participants $(1 - z_t)$ are "attached" to existing firms, while a fraction z_t are "unattached" and search for employment (for now, this fraction is exogenous; see Section 5 for an extension). Third, the level of employment/unemployment is determined at the end of the period via a standard matching function from the search and matching literature, after which production takes place.

An important aspect of our interpretation of the model is that the unattached workers, z_t, include previously unemployed individuals, those laid off, people entering the labor force, and those transitioning from one job to another. Only about 20 percent of new jobs are filled by unemployed workers, while about 40 percent are filled by people moving from one job to another, with the remainder primarily consisting of those who were previously categorized as non-participants in the labor force.

At the end of each period, unattached workers are either employed or unemployed. Therefore, we have:

$$z_t F_t = H_t + U_t, \tag{3}$$

where H_t is the number of hires in the period and U_t is the number of unemployed people at the end of the period. Following the labor-market search literature, we assume that the number of hires is a Cobb-Douglas function of unemployed workers and job vacancies:[24]

$$H_t = m_t \left(U_t^{\eta} V_t^{1-\eta} \right), \tag{4}$$

where m_t represents matching efficiency and η is a parameter satisfying $0 < \eta < 1$. Using lowercase letters to denote unemployment and vacancy rates, i.e., $u_t \equiv \frac{U_t}{F_t}$ and $v_t \equiv \frac{V_t}{F_t}$, we can combine equations (3) and (4) by substituting for $\frac{H_t}{F_t}$ to obtain the following Beveridge curve:

$$z_t - u_t = m_t v_t^{1-\eta} u_t^{\eta}, \tag{5}$$

which will turn out to be a useful expression when contrasting with other works and can be more neatly expressed as:

$$v_t = \left(\frac{z_t - u_t}{m_t u_t^{\eta}} \right)^{\frac{1}{1-\eta}}. \tag{6}$$

This Beveridge curve holds at any time *t,* unlike in many labor market models where the Beveridge curve represents a steady-state relationship. The key to deriving a Beveridge curve that applies at all times, without any transition dynamics, is the assumption that the fraction of workers attached to existing firms, $(1 - z_t)$, is chosen at random and independently of the workers' history. A similar modeling approach is used in the familiar Calvo model of price setting.

The Beveridge curve describes a negative relationship between the vacancy rate and the unemployment rate and is plotted in Figure 22. The figure shows data ranging from January 2020, before the COVID-19 pandemic, to the present day. We plot a family of curves because they can be shifted by z_t and m_t. Both can be computed from the data and are shown in Figure 23. The value of z_t can be backed out directly,[25] while we need to make an assumption about η to extract the time series for m_t.[26]

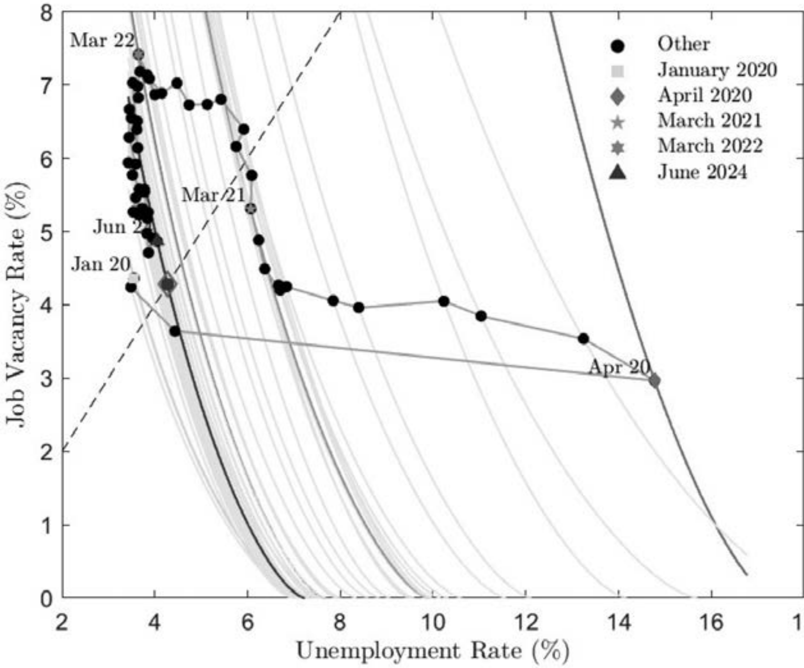
By construction, each curve passes through every data point. The largest shift in the curve occurs in April 2020, when z_t spikes and matching efficiency m_t drops, with unemployment reaching its peak and the vacancy-to-unemployment ratio hitting its minimum.

As the labor market began to recover after the initial COVID-19 shock, the Beveridge curve shifted back to the left. Around November 2020, it stabilized for some time, as seen from the points climbing up the curve crossing the March 2021 marker, with unemployment decreasing and vacancies surging significantly. During this period, θ rose from 0.6 to 1.1 by May 2021. Afterward, labor market conditions continued to improve, with matching efficiency increasing and the fraction of unattached workers decreasing.

Notably, both matching efficiency and the fraction of unattached workers stabilized at the end of 2022, just before the Federal Reserve began raising rates. This suggests that the Beveridge curve has largely remained stable since then, with only a minor drift to the left.

The dark grey Beveridge curve in Figure 22 is defined as the curve that passes through the most recent data point, from June 2024. As is evident from this curve, the cooling of the labor market has closely followed this curve since shortly after the Federal Reserve began tightening policy. The BE Beveridge curve thus predicted that the labor market would stabilize largely through a reduction in vacancies, at the cost of a relatively modest increase in unemployment, as observed in the data.

Figure 22

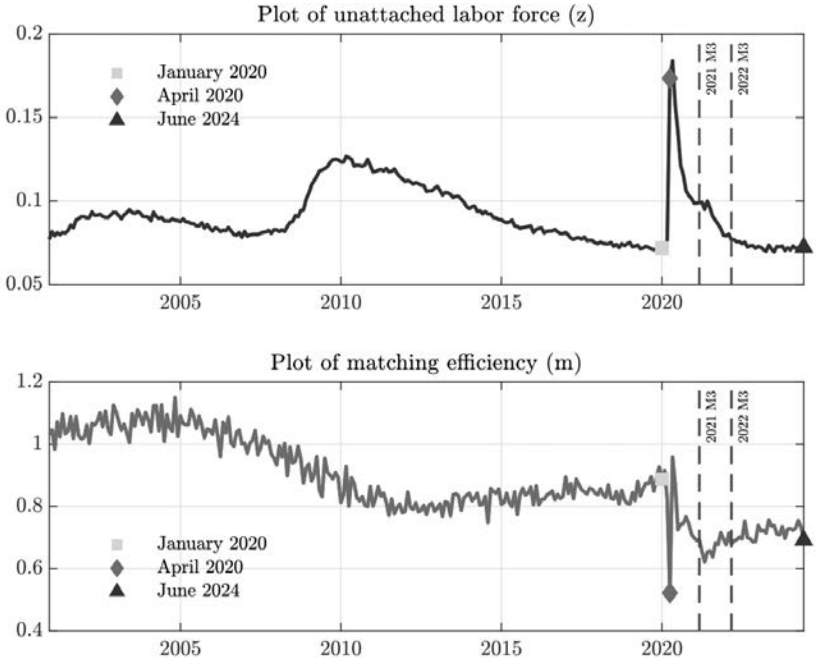


Note: Scatter plot of job vacancy rate versus unemployment rate, sample January 2020 – June 2024, and Benigno-Eggertsson Beveridge curve (6).
Source: JOLTS, BLS. Authors' computation.

While the exogenous series z_t has largely returned to pre-pandemic levels, matching efficiency remains notably below its pre-COVID level (see Figure 23). On the eve of COVID-19 in January 2020, matching efficiency stood at 0.88. It dropped significantly at the start of the pandemic, as filling vacancies became more difficult, then briefly recovered, only to decline again. Although it began to modestly improve during the inflation surge, matching efficiency still remains below pre-COVID levels, ending our sample at 0.75.

One explanation for the decline in matching efficiency, which suggests that more vacancies are needed to generate a successful hire at any given level of unemployment, is a structural change in aggregate spending. It likely takes longer for a worker to find a good job match when moving across sectors than when switching jobs within the same sector. Eggertsson and Kohn (2023) show that the COVID-19

Figure 23



Note: Unattached workers (*z*), matching efficiency (*m*), sample December 2000 – June 2024.
Source: JOLTS, BLS. Authors' computation.

recovery was highly uneven, with spending in the goods market greatly outpacing the recovery in services. The spending mix has still not returned to its pre-COVID levels. The possibility that the COVID-19 crisis could trigger a persistent or permanent sectoral shift was anticipated by Guerrieri et al. (2021), who study optimal monetary policy in the context of structural reallocation.[27]

One of the central lessons of this episode is that viewing unemployment in isolation provides limited information about the tightness of the labor market. Recall that before the COVID-19 crisis, unemployment was 3.9%. This created the perception that any unemployment above that level indicated a slack labor market. However, Equation (6) clarifies that a tight labor market, such as when $\theta > 1$, can be consistent with a relatively high unemployment rate of 5.75%, as observed during the run-up of inflation in 2021. The reason for this is that there were so many firms urgently looking to hire, resulting in a high vacancy rate.[28]

Looking ahead, if the Beveridge curve remains stable as indicated by the dark grey line, then the unemployment rate will be 4.28%, as shown by the diamond, once the labor market reaches balance at the Beveridge threshold.[29]

A careful reader will observe that while the Beveridge curve we have outlined here does a reasonable job of describing the data in a tight labor market, a look at Figure 20 reveals that its success is limited by its inability to replicate the two relatively stable regimes shown by the circle and square markers. We extend the model in Section 5 to address this by making z_t endogenous. Before we get there, however, it is useful to put the empirical success of this simple Beveridge curve in context by comparing it with more standard ones. To focus the discussion, we consider two papers aimed at predicting the effect of the Federal Reserve's tightening of policy in 2022 on unemployment.

4.4 The Beveridge Curve and the Policy Debate When the Fed Tightened Policy in 2022

There was a lively debate after the Federal Reserve began tightening policy in March 2022 about how costly it would be in terms of rising unemployment, often framed as whether there would be a "soft" or "hard" landing following the inflation surge. We first consider the analysis by Blanchard, Domash, Summers (BDS) who predicted a hard landing in July 2022 based on April 2022 data, and then turn to the analysis by Figura and Waller (FW). Our general finding is that their analyses are not as different as they might initially appear. The key difference lies in their assumptions about the elasticity of the matching function. There's little consensus on this elasticity, and both use values well within the typical range found in the literature. As we will see, the BE model we reviewed in the last section is not as sensitive to different assumptions about this elasticity.

The basis of the BDS curve is the standard matching function (4) that we also assumed in our analysis, which can be written in rates as:

$$h_t = m_t v_t^{1-\eta} u_t^{\eta} \tag{7}$$

or more neatly as:

$$v_t = \left(\frac{h_t}{m_t u_t^{\eta}} \right)^{\frac{1}{1-\eta}}. \tag{8}$$

This represents a negative relationship between the vacancy rate and the unemployment rate. The key assumption is that $h_t \equiv H_t/F_t$, the gross number of hires with respect to the labor force, which they label reallocation intensity, is an exogenous variable, shown in the top panel of Figure 34 in the Appendix.[30]

Comparing the BDS Beveridge curve in (7) and the BE curve in (5), we see that the *only* difference is that in BE, h_t is endogenous with $h_t = z_t - u_t$.

Figure 24 depicts our replication of their results, plotting the BDS Beveridge curve for a given h. As shown by the line drawn through the March 2022 marker, when the Federal Reserve began raising rates, the BDS Beveridge curve implies a substantial increase in unemployment to 5.8% to reach the Beveridge threshold of $v/u = 1$. In contrast, the BE Beveridge curve implies a value of 4.5%, which is closer to the rate at which the U.S. economy is currently landing.

Comparing the Beveridge curves in Figure 22 and Figure 24, we see that BDS requires a continuous shift in the exogenous variable h since March 2022 to rationalize the data. In contrast, the data in the BE Beveridge curve moves along the same curve.

FW consider a textbook dynamic of the unemployment rate in labor-market search models, as presented in Pissarides (2000). Abstracting from variations in the labor force, which is normalized to 1, the unemployment rate at time $t + 1$ is

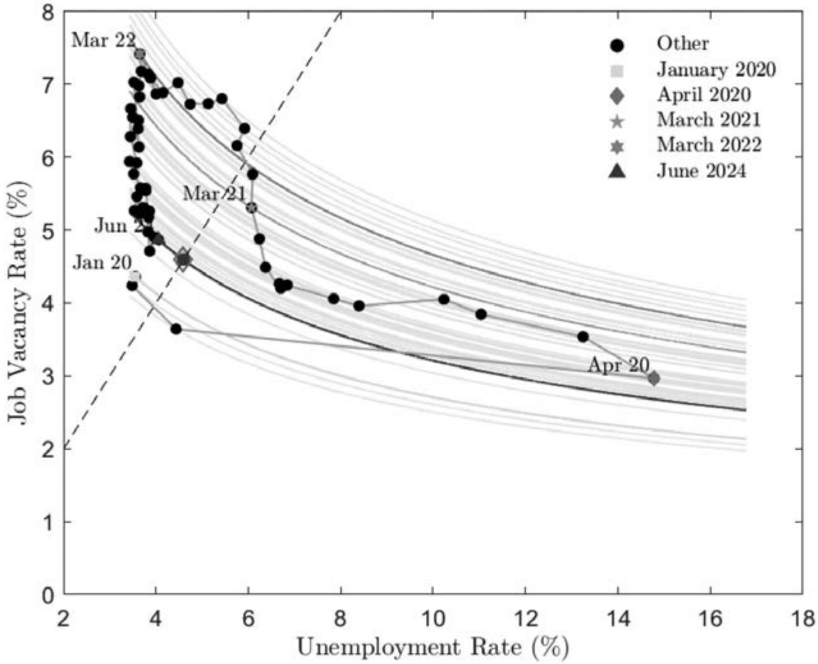
$$u_{t+1} = u_t + s_t(1 - u_t) - f_t u_t. \tag{9}$$

Variations in the unemployment rate are driven by workers separating from job relationships, represented by the term $s_t(1 - u_t)$, where the separation rate is defined as $s_t \equiv S_t/N_t$, with S_t as the number of separations and N_t as the number of employed workers. The number of unemployed workers entering into job relationships, given by $f_t u_t$, depends on the job-finding rate, defined as $f_t \equiv H_t/U_t$.

The job-finding rate can be related to the vacancy-to-unemployment ratio through the same matching function (4) as:

$$f_t = \frac{H_t}{U_t} = m_t \left(\frac{v_t}{u_t}\right)^{1-\eta}. \tag{10}$$

Figure 24



Note: Scatter plot of job vacancy rate versus unemployment rate, sample January 2020 – June 2024, and Blanchard-Domash-Summers Beveridge curve (8).
Source: JOLTS, BLS. Authors' computation.

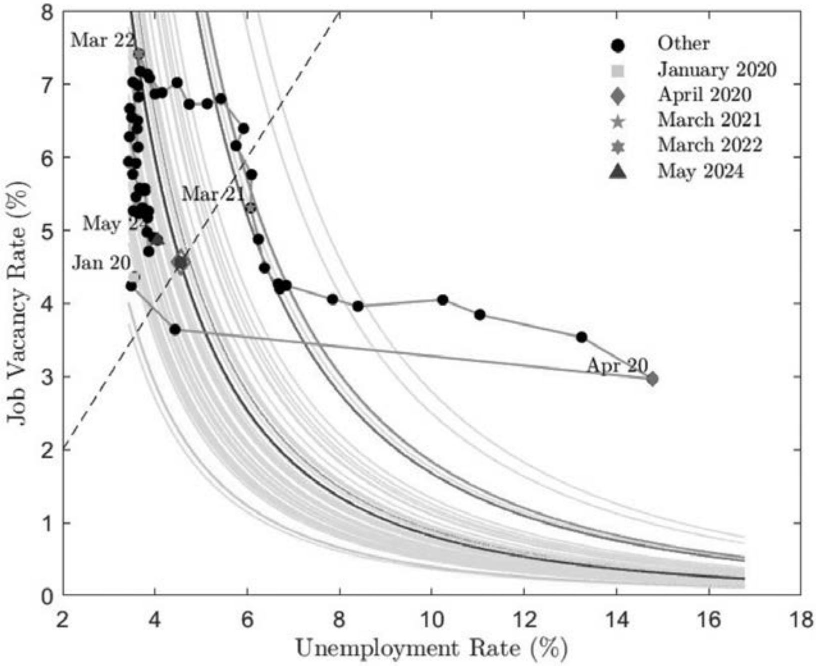
Using equation (10) to substitute for f_t in equation (9), and assuming that unemployment is at steady state, so that u_t+1 = u_t, we obtain the benchmark Beveridge curve commonly found in the literature:

$$v_t = \left(\frac{(1-u_t)s_t}{m_t u_t^{\eta}} \right)^{\frac{1}{1-\eta}}, \tag{11}$$

where m_t and s_t are allowed to vary over time, and we assume that the steady-state relationship holds period by period, as is common in the literature.

Figure 25 is our replication of the FW results. Their main input in the calculation is the value of the coefficient η, which we estimate to be 0.663 using their model, close to their assumed value of 0.7.[31] Unlike BE and BDS, the curves do not pass directly through the data points; for example, the dark grey curve for the last observation in May 2024 is well to the right of the data point.[32]

Figure 25



Note: Scatter plot of job vacancy rate versus unemployment rate, sample January 2020 – June 2024, and a standard Beveridge curve (11) as in Figura and Waller (2022).
Source: JOLTS, BLS. Authors' computation.

As the figure indicates, FW perform considerably better than BDS in tracking the drop in vacancies. However, their Beveridge curve does not align as cleanly with the actual observations as in BE, with the data points slightly to the left of the dark grey curve.[33] Yet, the overall fit conveys the same message: the adjustment is taking place almost exclusively through a drop in vacancies.

What accounts for the different findings? To address this question, it is useful to first summarize the differences in the three approaches, which are mainly: (i) FW assume s_t is exogenous, while BDS assume h_t is exogenous, and BE assume z_t is exogenous; (ii) the steady-state analysis of FW implies that their Beveridge curve does not necessarily pass through the data points, unlike BDS and BE; (iii) FW estimate m_t and s_t differently and use a different dataset, while BE and BDS use JOLTS data.

A key input in all these exercises is the elasticity of the matching function with respect to unemployment, η. Most importantly, the different methods used to estimate matching elasticities significantly impact the results. We assume the same value for η in both BE and our replication of BDS, with $\eta = 0.3155$, while for the replication of FW, we use $\eta = 0.663$.[34]

Both of these estimates, however, fall well within the range established by various authors. Sahin et al. (2014), for example, cite various studies that provide estimates ranging from 0.28 to 0.72 and, after reviewing several studies, settle on a value of 0.5. Petrongolo and Pissarides (2001) report a similar range in their survey of the literature, highlighting the dependence on estimation methods. Therefore, before proceeding further, it is worth considering the results of BE, FW, and BDS using the same elasticity value, which is common in the literature.

Figure 26 shows the Beveridge curve implied by the three approaches, assuming a common value of $\eta = 0.5$.[35] As the figure reveals, the results from FW and BDS are essentially the same, suggesting a landing somewhere between the hard and soft predictions of the two.

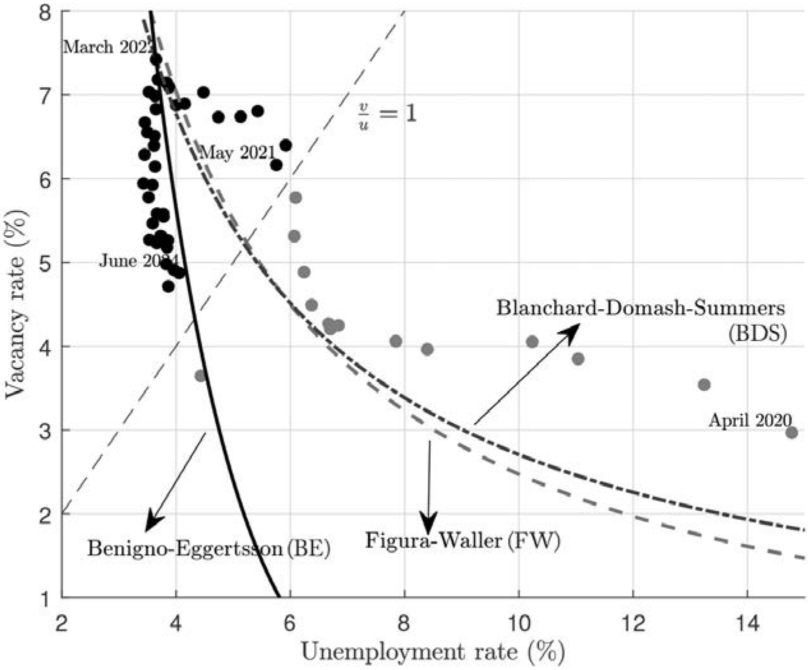
Furthermore, as shown in Figure 36 in the Appendix, if we swap the initially assumed elasticities of the two models, assigning $\eta = 0.3155$ to FW and $\eta = 0.663$ to BE and BDS, the results reverse: BDS predicts a soft landing, while FW predicts a hard landing. Interestingly, however, the BE model is relatively insensitive to this parameter and consistently predicts a soft landing.

Yet, this insensitivity may also be considered a weakness, as we have already noted. While the BE Beveridge curve is well-suited to describing a tight labor market under conditions of full employment, it is unable to account for the Beveridge curve when the labor market is loose. This is what we now turn to.

5. A Generalized Beveridge Curve and the Beveridge Threshold Unemployment Rate

The appeal of the Beveridge curve we proposed in equation (6) lies in its ability to accurately predict behavior in a tight labor market.

Figure 26



Note: Comparisons between Beveridge curves of Benigno and Eggertsson (2023), Figura and Waller (2022) and Blanchard, Domash and Summers (2022). Scatter plot of job vacancy rate versus unemployment rate, sample January 2020 – June 2024.
Source: JOLTS, BLS. Authors' computation.

The curve captures the fact that when *v/u* crosses the Beveridge threshold, most of the adjustment occurs through a reduction in vacancies. However, when explaining periods in which the labor market is below the Beveridge threshold, equation (6) performs less well and requires constant adjustments to the exogenous variables to match the data. Our interpretation of this result is that while our assumption of an 'exogenous' fraction of 'unattached workers' is a reasonable approximation in a tight labor market, it is less effective when *v/u* < 1. Below, we outline a simple approach to address this issue.

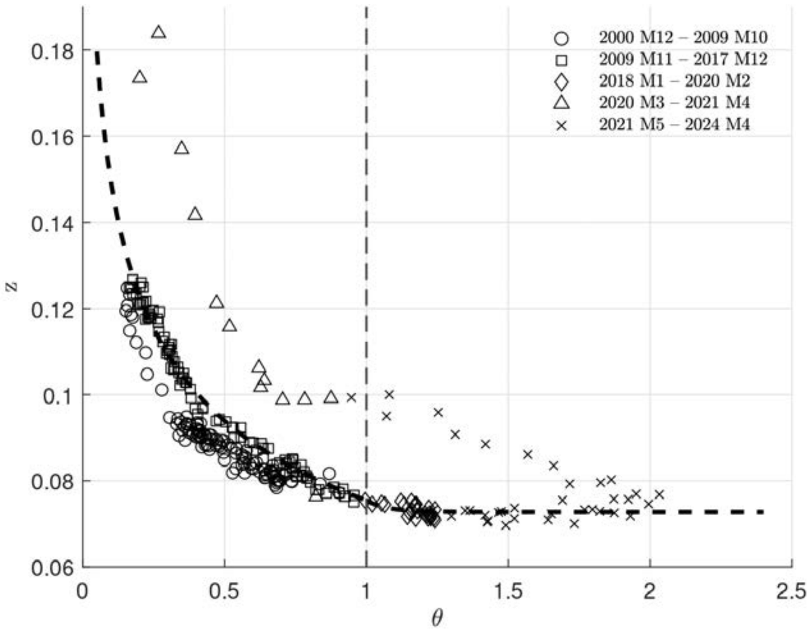
In Figure 27, we present a scatter plot of θ, the vacancy-to-unemployed ratio, and the variable *z*, whose time series is shown in Figure 23. We use different markers to distinguish five periods in the sample. The circle markers, representing the pre-financial crisis period (December 2000 – September 2009), and the square markers, representing the post-financial crisis period up to the end of 2017, are aligned on a curve specific to each period.[36] In contrast, the data where θ is greater than unity align well on a nearly horizontal line for the post-COVID period, particularly when the sample is further restricted starting from March 2022. This suggests a relationship where the number of unattached workers, or conversely, the number of attached workers, is insensitive to labor market conditions captured by θ when it is well above unity. However, in a loose labor market, a lower θ is associated with a higher fraction of unattached workers, likely due to higher unemployment. Based on this insight, we hypothesize a relationship of the following form:

$$z(\theta_t) = \begin{cases} (\bar{z}_t - a_h) + a_h\theta_t^{-b_h} & \theta_t \geq 1 \\ \\ (\bar{z}_t - a_l) + a_l\theta_t^{-b_l} & \theta_t < 1 \end{cases} \tag{12}$$

for some non-negative parameters a_h, a_l, b_h and b_l and a variable $\bar{z}_t$ that might shift over time. The function is continuous at $\theta_t = 1$; moreover $b_h > b_l$ and $a_h < a_l$ capture the features of the data underlined in Figure 27. We estimate the parameters of the functional form (12) on the sample from September 2009 to January 2020, including the square and diamond markers, and that from March 2022 to June 2024, which looks more vertically aligned. We fix $\bar{z}_t$ at the value that our original variable z_t had in April 2018, i.e., at 0.0754, when θ was close to the unitary value at 0.9956. The fit of the estimation is shown in Figure 27, demonstrating how well the proposed dashed curve aligns with the square and diamond markers, as well as some of the x-markers, which represent data since March 2022. The curve also becomes asymptotic already at values of θ greater than 1.15.[37] We can then use the estimates of a_h, b_h, a_l and b_t, and the time series for z_t and θ_t to back up the primitive disturbance $\bar{z}_t$. This is plotted in the top panel of Figure 28. It is interesting to note the stability of $\bar{z}_t$ before COVID-19, with an upward shift after the 2007–2009 financial crisis. Then, the extraordinary effect of the COVID-19 pandemic on the U.S. labor market is evident, with a sudden and unprecedented spike in $\bar{z}_t$ and its return to pre-COVID values during the last couple of years.

We can now use this analysis to improve the Beveridge curve by substituting the function $z(\theta_t)$ for z_t in equation (6), obtaining it implicitly defined in:

Figure 27



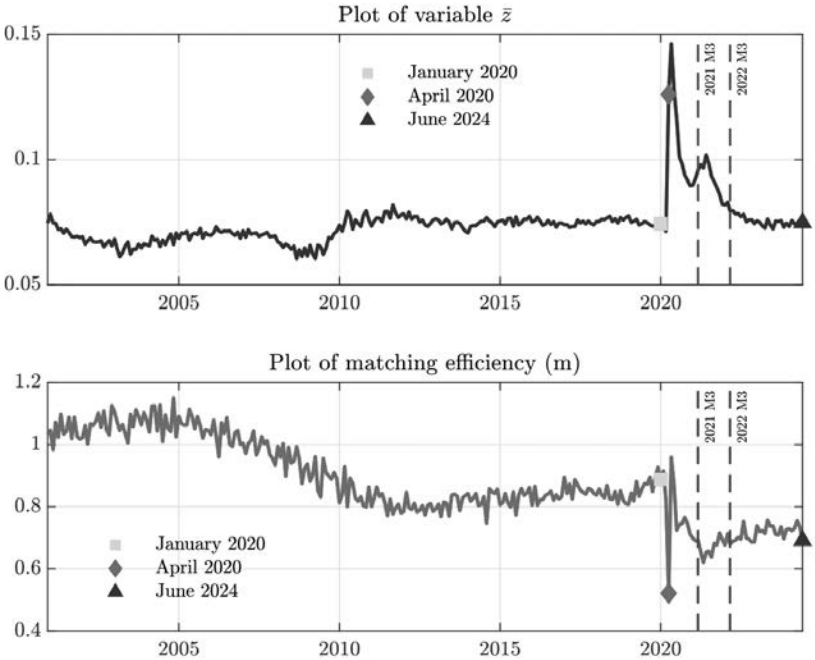
Note: Scatter plot of fraction of unattached workers, z, as in Figure 23, and θ, job vacancy-to-unemployed ratio.
Sample: December 2020 – June 2024.
Source: JOLTS, BLS. Authors' computation.

$$0 = \begin{cases} m_t u_t^{\eta} v_t^{1-\eta} - z_t - a_h(u_t^{b_h} v_t^{-b_h} - 1) + u_t & \theta_t \geq 1 \\ \\ m_t u_t^{\eta} v_t^{1-\eta} - z_t - a_l(u_t^{b_l} v_t^{-b_l} - 1) + u_t & \theta_t < 1 \end{cases} . \tag{13}$$

Figure 29 shows the resulting Beveridge curve. By allowing for an endogenous evolution of z_t, we see that it can match both the steepness of the curve during labor shortages and its slope below the Beveridge threshold.

Key to this derivation is the introduction of the function in equation (12). The interpretation of this function is straightforward. It appears to approximate the data relatively well by assuming that the number of unattached workers searching for jobs was exogenous under conditions of extreme labor tightness. As labor market conditions worsen (i.e., as θ decreases), the first-order effect would be an increase in z_t due to a larger number of unemployed individuals. With job prospects uncertain, it is also plausible that workers

Figure 28



Note: Plot of $\bar{z}$, as in equation (12), and of matching efficiency *m.* Sample: December 2020 – June 2024.
Source: JOLTS, BLS. Authors' computation.

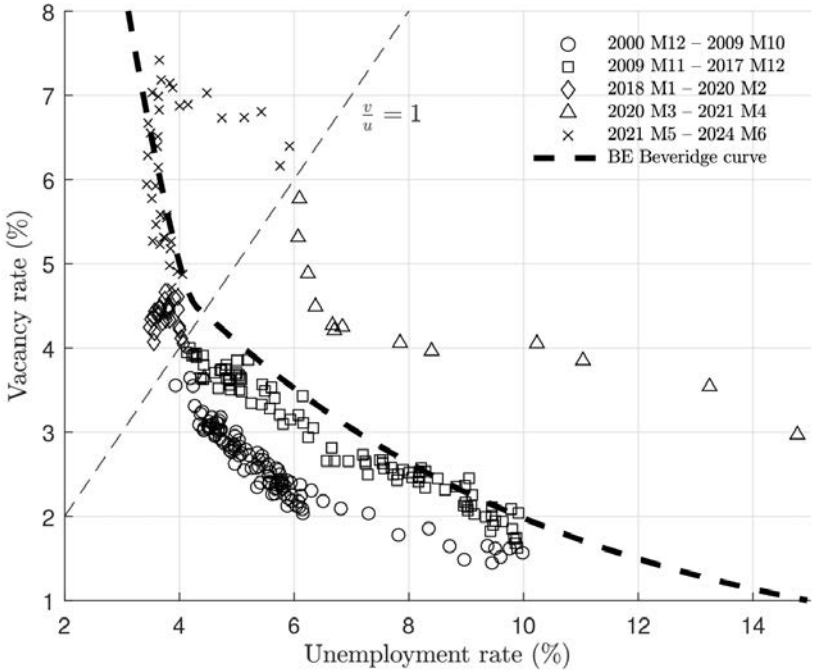
become more insecure about their current jobs and begin looking for alternatives, and that members of households who did not work before might try to re-enter the job market if a household member becomes unemployed. These are all mechanisms that are ripe for future research.[38]

5.1 Beveridge Threshold Unemployment Rate

In this section, we derive an index that we believe could be of practical interest to policymakers. It answers the following question: At what level of unemployment should the policymaker be concerned that inflation becomes excessively sensitive to demand and supply shocks?

By construction, the generalized Beveridge curve is continuous at the point $\theta_t = 1$, but it has a kink at that point. At the kink, the vacancy and unemployment rate are given by:

Figure 29



Note: United States: scatter plot of job vacancy rate v and unemployment rate u; plot of the Beveridge curve in equations (13). Sample: December 2020 – June 2024.
Source: JOLTS, BLS. Authors' computation.

$$v(\theta_t = 1) = u(\theta_t = 1) = \frac{\bar{z}_t}{1 + m_t}. \tag{14}$$

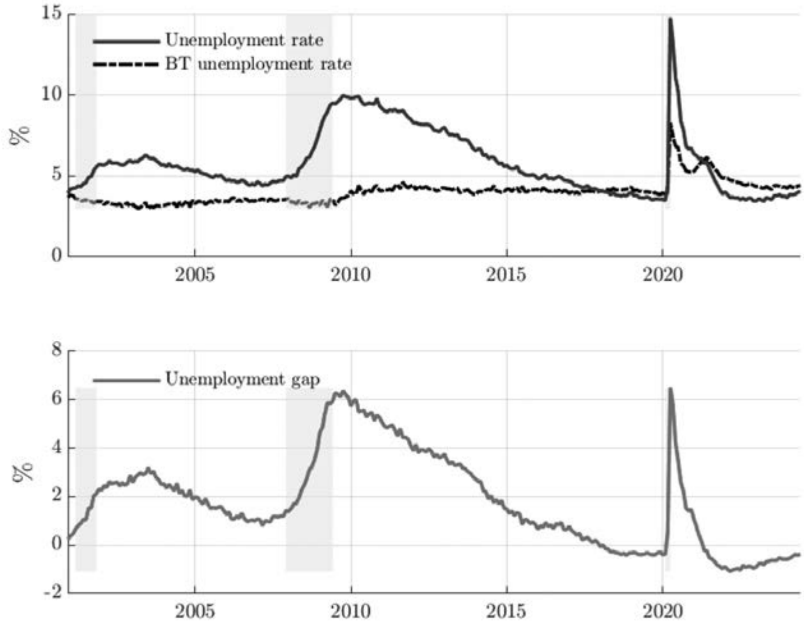
The curve now has as primitive shifters the matching efficiency m_t and the variable $\bar{z}_t$, both plotted in Figure 28. An increase in $\bar{z}_t$ or a fall in m_t both lead to an increase in the unemployment rate at which the economy lands when θ reaches unity. Given the latest values of $\bar{z}_t$ and m_t in June 2024, the prediction is that unemployment will land at 4.42%. With the higher value of matching efficiency pre-COVID, it would have been at 3.96%. Understanding the shifters for the kink point is also important for our Phillips curve analysis, indicating the unemployment rate at which the curve becomes steep and when inflationary pressure from movements in demand or supply shocks could become more significant. We label this unemployment rate, the Beveridge threshold unemployment rate, which can be backed up using the sequences $\bar{z}_t$ and m_t.

Figure 30 plots in the top panel the unemployment rate in comparison with the Beveridge threshold counterpart, while the bottom panel plots the unemployment gap given by their difference. It is interesting to observe that the Beveridge threshold unemployment rate was consistently below 4% before the Great Financial Crisis, even reaching 3%. With the financial crisis, it increased above 4%, never crossing above 4.5%, and returned just below 4% before the COVID-19 pandemic. It is with the pandemic that this concept of the unemployment rate reached 8%, then gradually decreased to 4.42% at its latest June 2024 observation.

There are only two episodes during the sample in which the unemployment rate went below the Beveridge threshold, and they correspond to the periods in which the ratio *v/u* went higher than the unitary value. However, during the first episode in 2018 lasting until the pandemic, the gap did not go lower than –0.5%. Instead, the post-pandemic episode started in May 2021, with the gap suddenly widening to a maximum of –1.08% exactly in March 2022 at the peak of the inflationary surge. At that time, the unemployment rate was at 3.65%, while the Beveridge threshold rate lagged behind at 4.73%. This gap is another way to read the pressure coming from the labor market to inflation, combined with the steep part of the Phillips curve. In contrast, the positive unemployment gap experienced for all the other parts of the sample, and evidently during the financial crisis and COVID pandemic, did not substantiate into deflation or very low inflation because of the flatness of the Phillips curve.

More work is surely needed to appropriately interpret the Beveridge threshold unemployment rate we have been proposing here. However, it is tempting to relate it to the concept of the natural unemployment rate, capturing either maximum or potential employment levels.[39] The fact that it is derived in a more independent way from the unemployment rate makes it attractive and less prone to underestimation of the unemployment gap that affects most measures based on filtering the unemployment rate itself. The fact that it is rarely touched by the U.S. economy also aligns with other analyses, such as Gagnon and Sarsenbayev (2022), who have emphasized that advanced economies have mostly been running at an excessive

Figure 30



Note: Top panel: unemployment rate, *u*, and Beveridge threshold unemployment rate, equation (14). Bottom panel: unemployment gap, defined as the difference between the unemployment rate and the Beveridge threshold unemployment rate. Sample: December 2000 – June 2024.
Source: JOLTS, BLS. Authors' computation.

unemployment rate, based on a conceptual framework with downward nominal wage rigidities, a key feature of our theoretical apparatus as well.[40]

However, regardless of whether it is close to the natural rate of unemployment, it may still represent a useful instrument to advise policymakers on where inflationary pressures could start to become a significant concern. As of our latest data from June 2024, the gap is just 0.37% and is likely to have shrunk further in July after the latest unemployment rate reading of 4.3%. This is good news regarding the tightening actions undertaken by the Federal Reserve since the start of the hiking cycle.

Conversely, a positive gap is not necessarily a signal of an impending recession, although its sudden increase has been related to recessions in the U.S. economy, as evidenced by the grey areas.

This brings us to ask importantly what will happen on the other side of the gap to evaluate the risk of overshooting too much the Beveridge-unemployment threshold. To answer this issue, we come back to the Beveridge curve (13).

5.2 Landing Beyond the Beveridge Threshold

Using the latest values of $\bar{z}_t$ and m_t, we can plot the Beveridge curve shown in Figure 29, along with scatter plots of the vacancy and unemployment rates since the start of the JOLTS data in December 2000. The figure illustrates the flatter portion of the curve when the labor market is loose, i.e., $\theta < 1$, highlighting the potential costs in terms of higher unemployment in a weak labor market. The most recent reading of θ in June 2024 is 1.20, corresponding to an unemployment rate of 4.06% and a vacancy rate of 4.87%. Reducing the vacancy rate to 4.42%, thereby bringing θ to 1, would increase unemployment by only 0.36%. However, if the vacancy rate were to drop further, say to 4.04%, unemployment would rise to 5.05%, with θ falling to 0.8, as shown in Table 1.

This highlights the different slope of the Beveridge curve at the kink point and underscores the potential costs in terms of the unemployment rate if monetary policy contraction goes beyond what is necessary to bring the labor market to 'neutral' conditions. As of July 2024, the most recent unemployment rate is 4.3%, although vacancy data are not yet available. Assuming the stability of the latest Beveridge curve shown in Figure 29, we can infer that the vacancy rate should settle around 4.5%, resulting in $\theta = 1.046$, which is very close to the Beveridge threshold. Any further reduction in θ would come with higher unemployment costs: 4.42% at $\theta = 1$, 4.56% at $\theta = 0.95$, and 4.71% at $\theta = 0.90$.

As shown in Figure 29, the dashed curve plotted with the latest data on $\bar{z}$ and m aligns well with the x-markers since mid-2022 and a few of the square markers, mostly following the 2007–2009 financial crisis. However, the curve also shifts with changes in $\bar{z}$ and m. To shift the curve downward and better fit the square and diamond markers, matching efficiency would need to improve to pre-COVID levels. Achieving a good fit with all the circle markers would require

Table 1
Corresponding u and v Values for Different θ Values

θ	u (%)	v (%)
1.20	4.06	4.87
1.10	4.19	4.61
1.00	4.42	4.42
0.95	4.56	4.33
0.90	4.71	4.24
0.80	5.05	4.04

Note: Top panel: unemployment rate, *u*, and Beveridge threshold unemployment rate, equation (14). Bottom panel: unemployment gap, defined as the difference between the unemployment rate and the Beveridge threshold unemployment rate. Sample: December 2000 – June 2024.
Source: JOLTS, BLS. Authors' computation.

matching efficiency similar to pre-financial crisis levels, while the triangle markers are largely explained by the unprecedented increase in $\bar{z}$ during COVID.

6. Conclusion: Policy Implications

The bad news for policymakers emerging from our analysis of the Phillips curve is that at very low unemployment rates, they may encounter a steeper Phillips curve, which has the added disadvantage of amplifying the impact of supply shocks. The good news, however, is that as long as inflation expectations remain stable, the cost of reducing inflation in terms of increased unemployment is relatively low. The contrast between the inflation surge of the 1960s, which triggered a persistent change in inflation expectations, and the Federal Reserve's success today in maintaining stable inflation expectations is striking.

We conclude with two warnings. The first is that once the labor market crosses back over the Beveridge threshold so that $v/u < 1$, further reductions in inflation are likely to be more costly due to the flatness of the Phillips curve and the less steep Beveridge curve (and if the actual Beveridge threshold is higher, these costs will emerge even sooner). The second warning is that the Beveridge threshold may not yet have been reached. Much of the current reduction in inflation is in part due to the easing of supply shocks. With v/u still greater than 1, this suggests that adverse supply shocks could have significant effects on inflation. Our current assessment suggests that the former risk outweighs the latter suggesting policy should ease going forward.

Appendix A

Here we reproduce benchmark regression from BE. It is a ordinary least squares regression:

$$\pi_t = \beta_c + \beta_\pi \pi_{t-1} + (\beta_\theta + \beta_{\theta_d} D_t)\ln\theta_t + (\beta_v + \beta_{v_d} D_t)v_t + \beta_{\pi^e}\pi_t^e + \varepsilon_t, \tag{A.15}$$

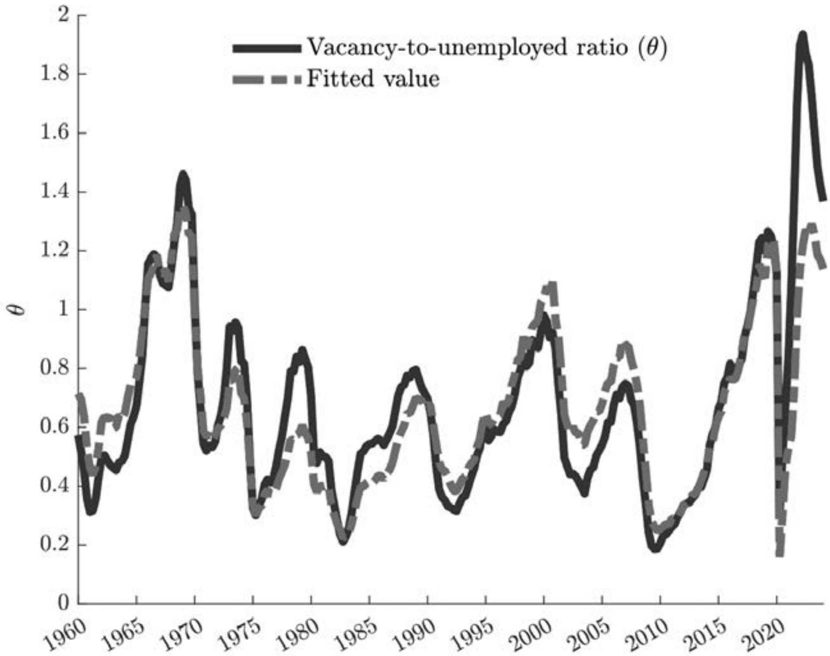
where βc, $\beta\pi$, $\beta\theta$, $\beta\theta_d$, β_v, βv_d , $\beta\pi_e$ are parameters, and ϵ_t *is a zero-mean normally-distributed error.* D_t is a dummy variable that takes value one if $\theta_t \geq 1$. $\pi_t \equiv \ln P_t / \ln P_{t-1}$ is inflation, π_{t-1} is its one-quarter lag, $\ln \theta_t$ is the logarithm of the vacancy-to-unemployed ratio, v_t is a supply shock, and π^e_t is inflation expectations.

Table A.1
Phillips Curve Estimates

	(1) **1960–2024**	(2) **2008–2024**	(3) **1960–2024**	(4) **2008–2024**
Inflation lag	0.3707***	0.2668	0.2572***	0.1377
	(0.0949)	(0.2503)	(0.0933)	(0.1951)
ln 0	0.6748***	0.7267*	0.2367	0.5227
	(0.1779)	(0.3708)	(0.1993)	(0.3188)
0 ≥ 1			3.7165***	5.3565***
			(0.8248)	(0.8936)
v shock	0.0377**	0.0177	0.0446**	0.0093
	(0.0192)	(0.0393)	(0.0204)	(0.023)
0 ≥ 1			0.1015	0.275**
			(0.0993)	(0.1212)
Inflation expectations	0.6596***	0.8263	0.8072***	0.5091
	(0.1064)	(0.6225)	(0.1016)	(0.5048)
Constant	0.5559***	0.9406**	0.1977	0.3954
	(0.1538)	(0.4176)	(0.1662)	(0.3822)
R^2 adjusted	0.8139	0.5137	0.8264	0.6603
Observations	258	64	258	64

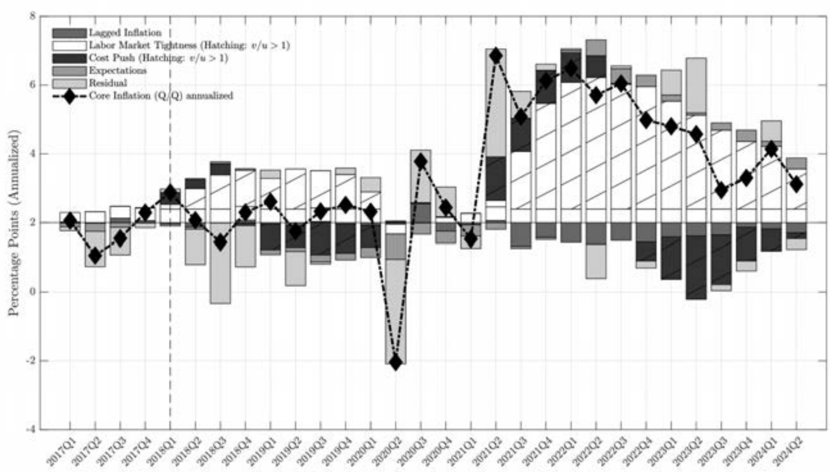
***,**,* denote statistical significance at the 1,5, and 10 percent level, respectively.
Newey-West standard errors.
(1) and (3): sample 1960 Q1 – 2024 Q2
(2) and (4): sample 2008 Q3 – 2024 Q2

Figure 31



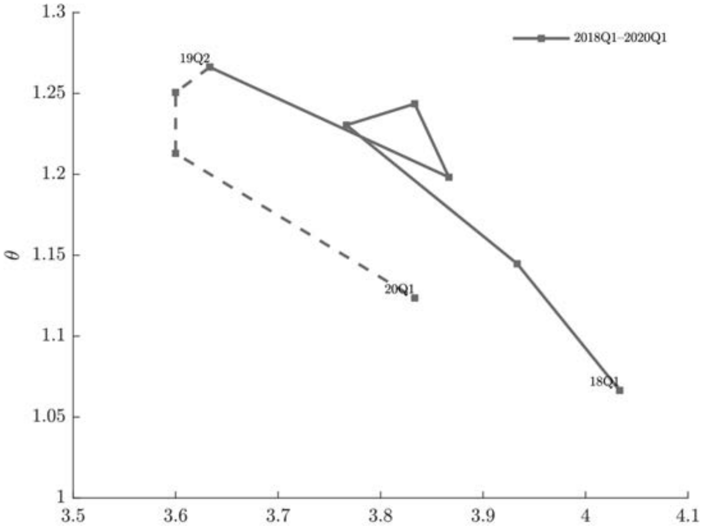
Note: v/u relative to fitted value based upon the regression reported in Figure 7.

Figure 32



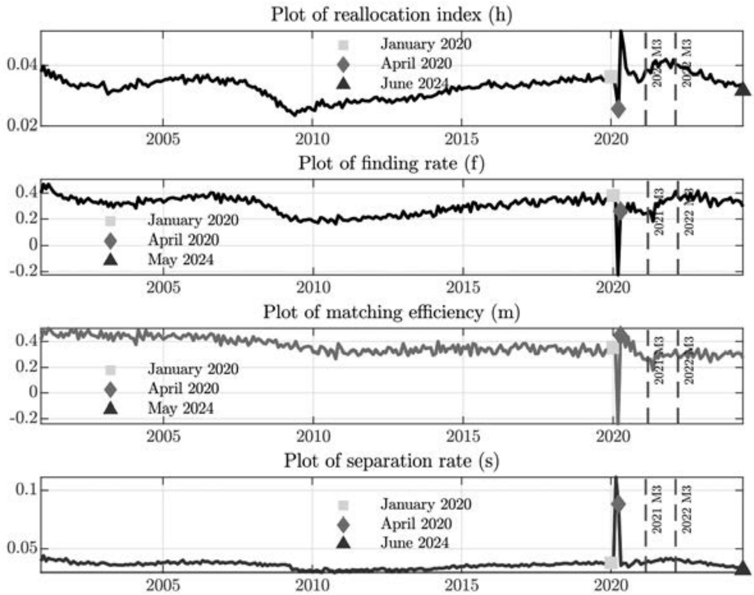
Note: Decomposition of the baseline regression in BE between the contributions of the various regressors: lag inflation, ln θ, supply shocks, inflation expectations. For the variable ln θ, hatching corresponds to the contribution of the variable for the portion of θ that exceeds the unitary value. For the supply shock, hatching corresponds to the contributions of the variable when $\theta > 1$. Core inflation and all the components are plotted at annualized quarterly rates.
Source: Benigno and Eggertsson, 2023.

Figure 33



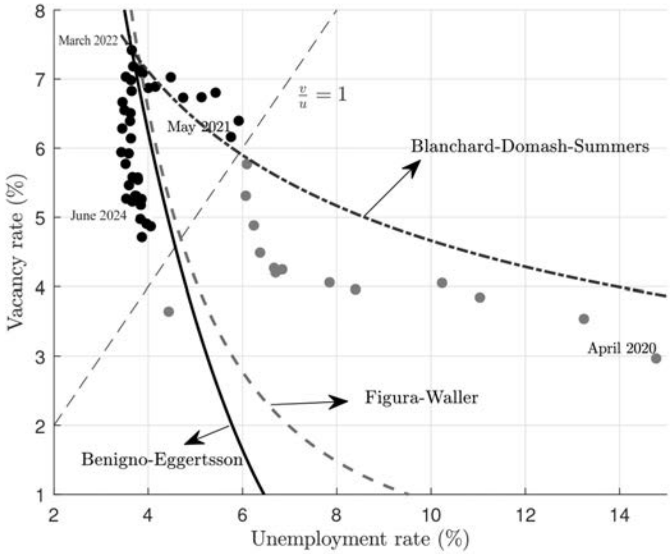
Note: United States: scatter plots of vacancy-to-unemployed ratio, θ, and unemployment rate, u, at quarterly frequency. Period 2018 Q1 – 2020 Q1.
Source: BLS.

Figure 34



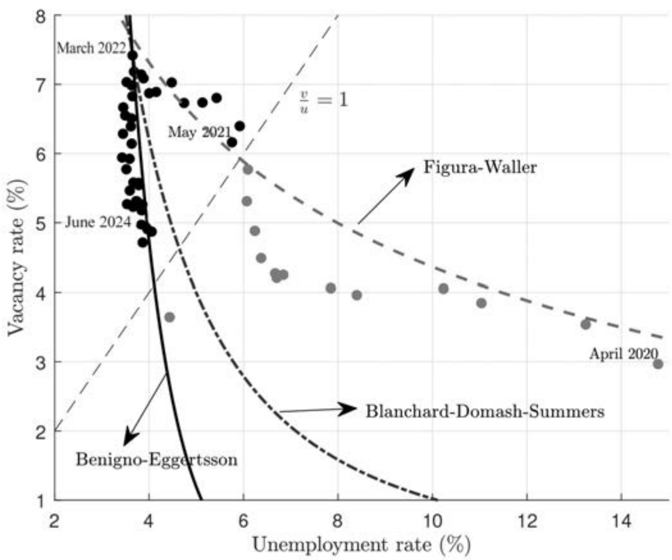
Note: Blanchard, Domash and Summers (2022): reallocation index *(h)*. Figura and Waller (2022): Job finding rate *(f)*, matching efficiency *(m)*, separation rate *(s)*, sample December 2000 – June 2024.
Source: JOLTS, BLS. Authors' computation.

Figure 35



Note: Comparisons between Beveridge curves. Scatter plot of job vacancy rate versus unemployment rate, sample January 2020 – June 2024.
Source: JOLTS, BLS. Authors' computation.

Figure 36



Note: Swapping elasticities: comparisons between Beveridge curves. Scatter plot of job vacancy rate versus unemployment rate, sample January 2020 – June 2024.
Source: JOLTS, BLS. Authors' computation.

Endnotes

[1]An important aspect of the Phillips curve is expectations about future inflation. Long-term inflation expectations remained stable throughout the 2020s episode, as discussed in detail by Benigno and Eggertsson (2023).

[2]We discuss the debate between Blanchard, Domash, and Summers (2022) and Figura and Waller (2022) in Section 4. See also Crump et al. (2024) for discussion of the role of labor market and supply shock in shaping inflation dynamics during the inflation surge.

[3]This was a significant element in the formulation of the Federal Reserve's new policy framework announced in 2020, which emphasized the need to focus more on the employment part of the dual mandate, partly due to the judgment that the risk of inflation was low given the small slope of the Phillips curve. The idea was that there was little harm in letting the labor market run hot due to the low risk of inflation. In her presentation of the framework, for example, Governor Brainard argued that a key benefit of the 2020 policy framework was that it eliminated the 'longstanding presumption that accommodation should be reduced preemptively' as the labor market tightens 'in anticipation of high inflation that is unlikely to materialize.' See further discussion in Eggertsson and Kohn (2023)

[4]In panel b) the interpretation of the x-axis, which we simply denote economic activity is output, as in Figure 19. In panel (a) the curves take the same shape regardless of if the x-axis refer to output or v/u.

[5]Michaillat and Saez (2022) introduce the notion of an efficient unemployment rate, also identified by the Beveridge threshold and equivalent to the geometric average of the unemployment and vacancy rates. Our Beveridge threshold unemployment rate has a different foundation and quantitative implications as detailed in Section 5.

[6]This strategy was adopted, for example, by the pharmacy CVS, which closed from 1–2 PM in many of its locations for a "lunch break."

[7]The numbers represent search interest relative to the highest point on the chart for the U.S. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular.

[8]These figures are adapted from Michaillat and Saez (2022), one of the original motivation of this analysis, even if they do not focus on inflation but instead emphasize the efficiency property of the Beveridge threshold.

[9]See for example Barnichon et al. (2021), Furman and Powell (2021), Ball et al. (2022), Domash and Summers (2022) and more recently Barnichon and Shapiro (2024).

[10]Our observation is built on a regression proposed by Kalantzis (2023) and is described in the subtitle of Figure 7. We have found that the Kalantzis regression is the best fitting one relative to various alternatives we have explored.

[11]See Eggertsson and Kohn (2023) for a discussion.

[12]The incident occurred on March 23, 2021, and the canal was cleared for traffic on March 29, 2021.

[13]See column 4 in Table A.1 in the Appendix.

[14]Figure 32 in the Appendix show the decomposition starting from 2017.

[15]The most common traditional measure is the difference between headline and core inflation. Yet it does not account for the highly unusual supply bottlenecks that were especially prominent at the onset of the inflation surge, as indicated by the Global Supply Chain Pressure Index of the Federal Reserve Bank of New York. See Benigno et al. (2022).

[16]Moreover, Bernanke and Blanchard (2023) assume flexible prices and constant returns to labor, which implies that price inflation is equal to wage inflation and variations in supply shocks. This tends to put a large weight on supply shocks by necessity, since average wage inflation was low towards the beginning of the surge.

[17]See Sedlacek (2016).

[18]See also Forbes, Gagnon, and Collins (2021) for a discussion of how downward nominal rigidities can bend the Phillips curve and for providing worldwide empirical evidence.

[19]Moreover, allowing for decreasing returns in labor, equation (1) would also show a term referring to the employment rate, which is a direct function of v/u.

[20]Figure 32 in the Appendix shows that, during this period, negative supply shocks mitigated the inflationary impact of labor market tightness.

[21]Data are presented on a quarterly basis, i.e., as averages of the monthly rates.

[22]The 2018–2020 episode of labor market tightness is shown in Figure 33 in the Appendix displaying similar characteristics.

[23]For surveys covering the literature on Beveridge curves, see, for example, Petrongolo and Pissarides (2001), Elsby et al. (2015), and Barlevy et al. (2023).

[24]Since H_t represents gross hires, one could argue that the matching function is misspecified if the composition of gross hires changes over time due to variations in flows from different segments of the hiring pool. See, e.g., BDS for a discussion, where they argue that in 2022 the proportions of the different flows were similar to what they were before the pandemic, suggesting that U_t is a reasonable proxy for the flows of other groups into new jobs.

[25]We can back out the time series for z_t using equation (3), as both H_t and U_t can be empirically measured using JOLTS data, and F_t is also measured by the BLS.

[26]We can rewrite (4) as

$$\frac{H_t}{U_t} = m_t \theta^{1-\eta},$$

and regress the log of the left-hand side on $\log(\theta)$ to obtain the estimate $\eta = 0.3155$ in the sample from January 2009 to December 2019, which is close to the value assumed by BDS of 0.4. Using this value, we obtain a time series for m_t using as input the time series for H_t, U_t, and V_t, i.e.,

$$m_t = \frac{H_t}{U_t^{\eta} V_t^{1-\eta}}.$$

[27]Their main finding is that structural reallocation can, in principle, justify inflation being above or below its target level for some time.

[28]In Section 5.1, we refine the conditions under which the labor market is considered tight with respect to the unemployment rate by introducing the concept of the Beveridge threshold unemployment rate, which indicates the value below which the labor market is tight.

[29]Section 5.1 improves this prediction, suggesting a landing at 4.42%.

[30]They further assume that gross separations and gross hires are equalized at each point in time in their model.

[31]The job finding rate f in equation (10) is approximated following Shimer (2005) as:

$$f_t = 1 - \frac{U_{t+1} - U_{t+1}^s}{U_t},$$

where U_t is the number of unemployed individuals and U^s_{t+1} is the number of short-term unemployed, i.e., workers unemployed for less than five weeks in month $t + 1$, as measured by the BLS. Thus, f_t is the probability that a worker unemployed in month t finds a job by $t + 1$. Figure 34 shows the job finding rate for the sample from December 2020 to June 2024. To obtain an estimate of η, we regress $\ln f_t$ on a constant and $\ln(v_t/u_t)$ in the sample from January 2009 to December 2019, obtaining a point estimate for η equal to 0.663. Note that this differs substantially from our estimate of 0.315. We then retrieve m_t using (10), which is shown in Figure 34 in the Appendix and differs from the one used in our analysis, as shown in Figure 23. To obtain the separation rate, following Ahn and Crane (2020), we use equation (9) to retrieve the sequence s_t, given the sequences of the unemployment rate and finding rate. This is shown in the bottom panel of Figure 34, with numbers in line with the literature.

[32]Due to the construction of the finding rate, one observation is lost, so the last curve is plotted for May 2024 instead of June 2024.

[33]Figure 35 in the Appendix neatly compares the three models using the same graph.

[34]The reason for the different estimates is as follows: BDS, like us, consider gross hires, which include job-to-job transitions, whereas FW consider net hires, focusing only on transitions from the unemployment pool to employment. The latter approach is more suitable for using the matching function (4), while our approach would require more careful consideration of different matching functions for unemployed workers versus those transitioning from job-to-job. However, FW focus on new hires coming from the pool of unemployed, which constitutes only 20 percent of new hires, with the remainder approximately evenly divided between those joining the labor force and those making job-to-job transitions.

[35]The time series for m_t is appropriately recomputed when considering a different value for the matching elasticity in the three models.

[36]The diamond markers, denoting the periods from January 2018 to February 2020, also align well with the square markers.

[37]The estimates are the following: $a_h = 0.0027$, $b_h = 14.2464$, $a_l = 0.1140$, $b_l = 0.2168$.

[38]For simplicity, we assumed that the $z(\theta_t)$ functional form had different parameters below and above the Beveridge threshold. However, this is not necessary. We have also considered more general invariant functional forms. One example that matches the data relatively well is a generalized Sigmoid function. We leave further exploration of this issue, as well as detailed microfoundations, to future research.

[39]Our concept of the Beveridge threshold unemployment rate is closer to the efficient unemployment rate proposed by Michaillat and Saez (2022) because both are identified by the Beveridge threshold, but it has a different theoretical foundation and quantitative implications.

[40]Our Beveridge threshold unemployment rate is therefore different from the secular trend unemployment rate estimated by Crump et al. (2024), which is more symmetric with respect to the actual rate.

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Commentary: Revisiting the Phillips and Beveridge Curves: Insights from the 2020s Inflation Surge

Guido Lorenzoni and Iván Werning

It is wonderful to have the opportunity to discuss this paper. Gauti Eggertsson and Pierpaolo Benigno do a fantastic job of pointing our attention to non-linearities and supply constraints as crucial to understand the inflation experience of the last four years and it is great how they combine data and theory to support their view. Let us say from the start that the paper is a pleasure to read and we broadly agree with its perspective and many of its elements. In particular, we agree that a Phillips curve is the central tool to approach the study of inflation, both in general and to understand the latest episode. We also agree that this relation has at times been oversimplified and that nonlinearities are important.

Our job as discussants is to focus on points of disagreement, so we will do that. The main thrust of our comments is that their approach is very aggregate in nature, while we think we need a more disaggregate or sectoral perspective, building up to the aggregate. This is especially true for the post-Covid dislocations we just experienced.

The Phillips curve was born in economics not as a theory but as an empirical regularity, summarized as a reduced-form equation. Over time it morphed into a theory, summarized as a structural equation. The theoretical Phillips curve posits that when in the economy there is some form of scarcity—with aggregate demand too high relative to supply conditions—then we get inflation. In the simplest aggregate macro models, this scarcity is captured in a single metric, such as a positive output gap or some measure of overheating in the labor market. However, in more disaggregated models, scarcity can be initially localized in specific markets, and then gradually propagate.

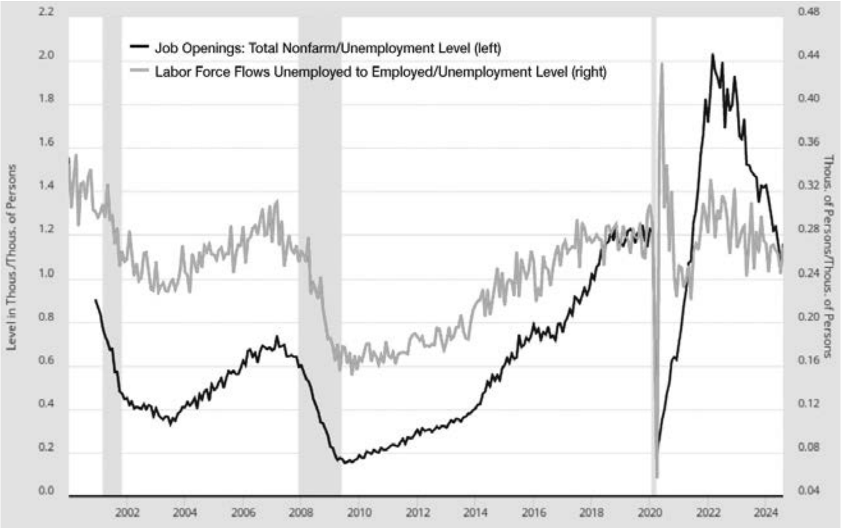
In the recent 2020s inflation surge, was scarcity purely an aggregate phenomenon or was it concentrated in some parts of the economy and then spread? Was it primarily labor scarcity or did the scarcity of non-labor inputs play an important role? Does the timing of events matter and help us reveal the nature of the surge? These are hard questions, and they matter for policy. So let us focus on these.

Let us begin with two broad observations on why there is room for different interpretations of the recent episode.

First, aggregate time series rarely give conclusive answers about causation. It is great that Gauti and Pierpaolo have gone back and reconstructed the connection between labor market tightness and inflation for over a century. However, there are not a lot of episodes in which the economy visits what they interpret as the nonlinear portion of the Phillips curve and, instead of invoking non-linearities, the same data can be interpreted assuming a linear Phillips curve that shifts upward because of other forces, like a generic cost-push shock. Bottom line, as it typically happens with aggregate data, it is hard to reach a definitive conclusion.

A second simple reason for why there is room for alternative interpretations is that labor market tightness can be measured in different ways and this is an area where there has been considerable uncertainty and debate. A simple observation is that labor market tightness can be measured directly looking at the ratio of vacancies to unemployment, but it can also be measured indirectly by looking at how easy it is for a worker to find employment. If we look at the job finding rate measured from flow rates from unemployment to employment, it shows a much more modest increase in the recent experience, relative to the vacancy-to-unemployment ratio. The two measures are plotted in Figure 1, that clearly shows the divergent behavior of vacancy-based measure (in black) and of the flow-based measure (in gray) in the 2021–2024 period.

Figure 1
Alternative Measures of Labor Market Tightness



Source: U.S. Bureau of Labor Statistics.

This is tightly connected to the observation that the Beveridge curve appears to have shifted, and that a high ratio of vacancy to unemployment has not translated to a reduction in the unemployment rate. A possible explanation of this shift is that the ratio of vacancy to unemployment may appear artificially higher because the denominator may understate the number of workers searching for jobs, since it does not include the workers who are looking to transition from job to job. And there is evidence that quits and job-to-job search went up in the period we are considering. Including these extra searchers paints a more balanced picture of the two sides of the search labor market, or of relative tightness. In this view, the labor market was tight in 2021–2023 but not as tight as many believe.[1]

Given that there is open room for disagreement on Gauti and Pierpaolo's hypothesis, let us discuss an alternative interpretation of the recent inflation surge.

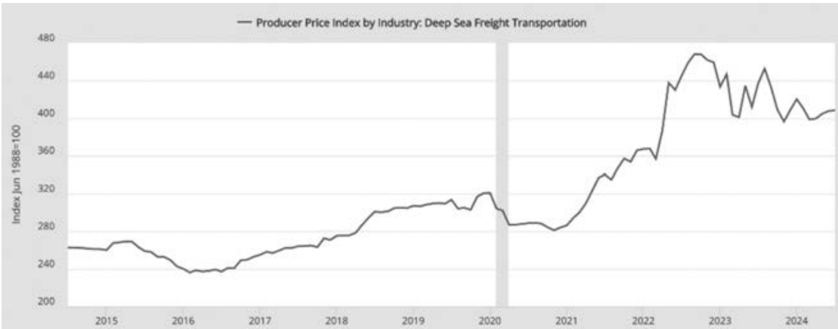
Our favorite alternative story is that the initial shock was not aggregate and broad-based, but asymmetric and concentrated, and that it lead to scarcity not just in labor markets, but also in markets for other inputs—including intermediate goods, materials, commodities, and energy.

There is abundant evidence of large increases in the price of many inputs, and of various forms of rationing and disruptions in the supply of others. As an example of price increases, Figure 2 shows an index of the price of container shipping. For evidence of rationing and disruptions, Figure 3 shows the Global Supply Chain Pressure Index put together by the New York Fed. There is also survey evidence corroborating this story from the point of view of the businesses buying these inputs. For example, Figure 4 shows how manufacturing firms answered the question "why you are not operating your plants at full capacity?" in the Quarterly Survey of Plant Capacity. Labor scarcity is visible here, but we also see scarcity of materials and concerns with transportations playing an important part.

What graphs like these suggest is that at some point, shortly after economies reopened after Covid closures, a number of supply constraints started popping up in various places. Sometimes prices increased fast, sometimes the constraints took more the form of delays or rationing, i.e., an increase in the shadow price of these resources. But for businesses utilizing these inputs the outcome was similar: increasing output became more costly at the margin.

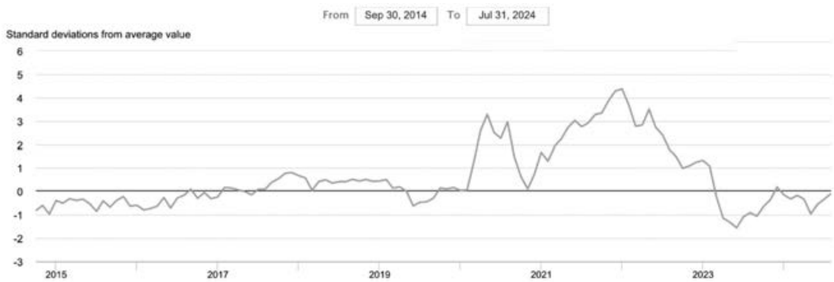
Pointing to the importance of these forms of scarcity is not inconsistent with a broad Phillips curve logic: the increase in the price or shadow price of scarce inputs is ultimately driven by demand being too strong relative to the existing supply capacity. Even energy shocks depend on both demand and supply forces. Sectoral Phillips curves can be used to understand how these initial shocks, caused by excess demand in some market, transmit through the economy. Shortages in sectors where prices adjust relatively fast, or instantly, like in commodity markets, give an initial boost to "non-core" inflation. The shock then transmits to other sectors that use the output of the first hit sectors as inputs, increasing their nominal marginal costs and producing inflation throughout the economy. At the aggregate level, what we observe is an upward shift in the aggregate Phillips curve, as we will discuss in more detail below. Non-linearities still matter, because they determine a situation in which excess demand causes

Figure 2
Shipping Costs



Source: FRED/BLS

Figure 3
Global Supply Chain Pressure Index



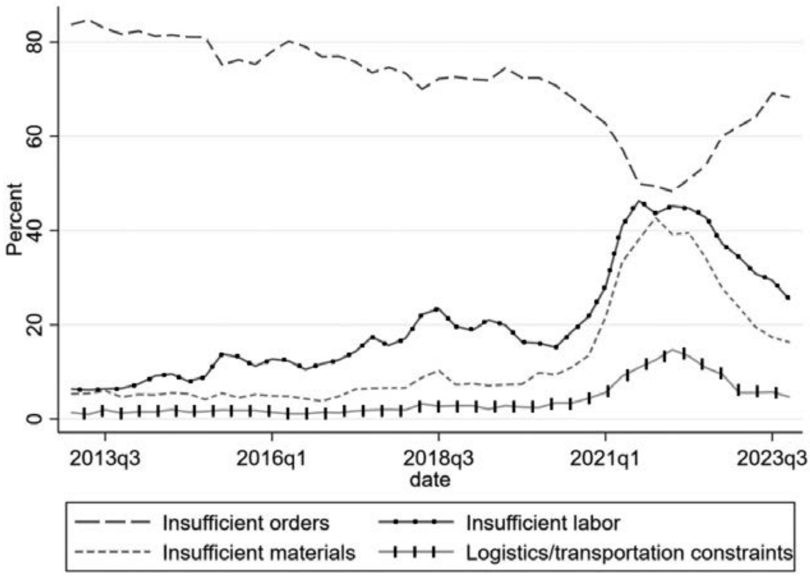
Source: Federal Reserve Bank of New York.

some sector to hit a constraint. But the transmission of the shock across sectors, or, in a different language, the transmission from non-core inflation to core inflation, is also central to the overall transmission mechanism.

There are two reasons why we find this asymmetric, sectoral story more appealing.

First, in broad terms, the experience of inflation has been remarkably similar across countries. If we look across the globe, not just at the U.S. and Europe, the pattern of inflation surge was similar in countries with different degrees of fiscal stimulus, different monetary responses, and different labor market experiences. There are many ways to see this. In Figure 5, we make the point by plotting a measure

Figure 4
Shortages of Labor and Other Inputs

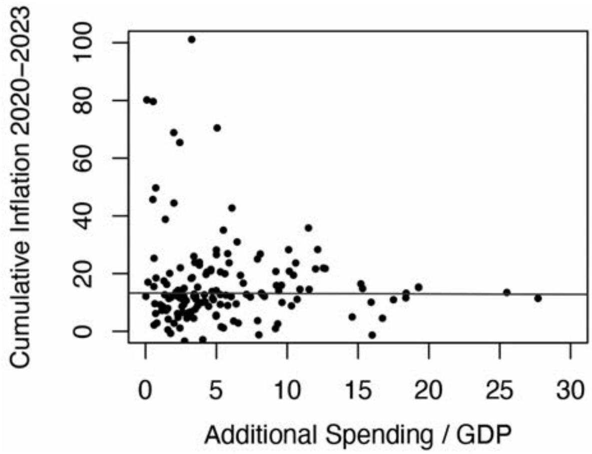


Source: Answers to question of why capacity is not fully used, from the Quarterly Survey of Plant Capacity.

of fiscal expansion against inflation: we see essentially no systematic relationship. The fact that countries shared a similar inflation experience irrespective of the local degree of stimulus, suggests that shocks affecting the cost of *tradable* inputs is a more likely underlying force. For example, a world-wide shortage of microchips or a surge in shipping costs transmit easily across borders and tend to lift inflation everywhere. A story centered on domestic labor markets pressures seems insufficient, given that labor is essentially a non-tradable input and labor scarcity alone would tend to have more localized effects.

A second reason why we find the alternative interpretation more appealing is that if we disaggregate inflation at the sectoral level, the surge of inflation tends to be initially concentrated in sectors with relatively low labor intensity, mostly sectors producing goods, and only gradually we see a pick-up in inflation in the service sector and in nominal wages. In a labor-market centered story you would tend to see the opposite pattern.

Figure 5
Cumulative Inflation and Stimulus
Cumulative Inflation in Excess of 2016–2019 vs Stimulus

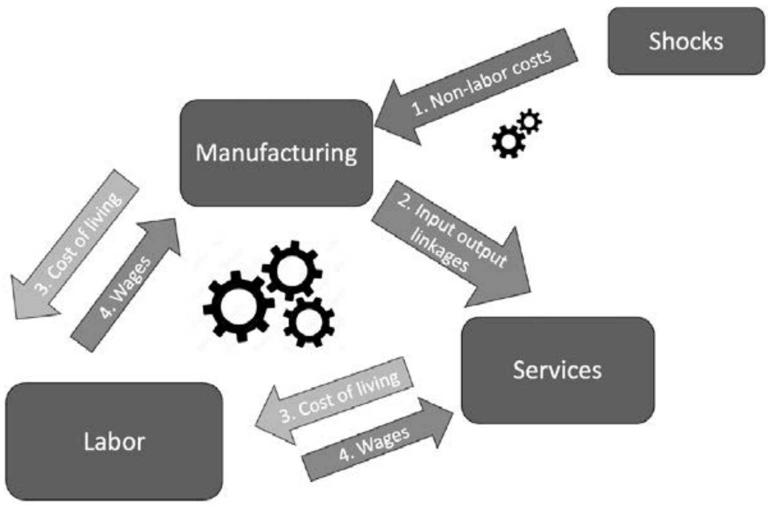


Source: Inflation is CPI inflation from IMF World Economic Outlook. Additional spending is from IMF Fiscal Monitor Database of post-Covid spending. The line is from OLS regression.

In Figure 6, we offer a schematic representation of a simple model to think about the transmission of inflation across sectors. The model has three sectors, manufacturing, services, and labor, which is considered an additional sector that uses consumption goods to produce labor services. In the appendix, we present a three equation model based on this structure. The only source of exogenous shocks in the model are energy shocks and shocks to supply chain pressures, captured, respectively, by the WTI crude oil price and by the index in Figure 4. These exogenous shocks only affect directly one sector, manufacturing.

The model is extremely stylized, some parameters are calibrated, and some are estimated naively by OLS using the entire sample. So our exercise here should really be taken just as a proof-of-concept exercise. The result we want to emphasize is that the model can produce a prolonged period of high inflation, purely due to slow propagation across sectors. In Figure 7 we plot actual inflation (black lines) and model simulated inflation (gray line) for the three sectors. The simulated path starts in June 2022, under the assumption that after that date all exogenous shocks are set to zero and that propagation

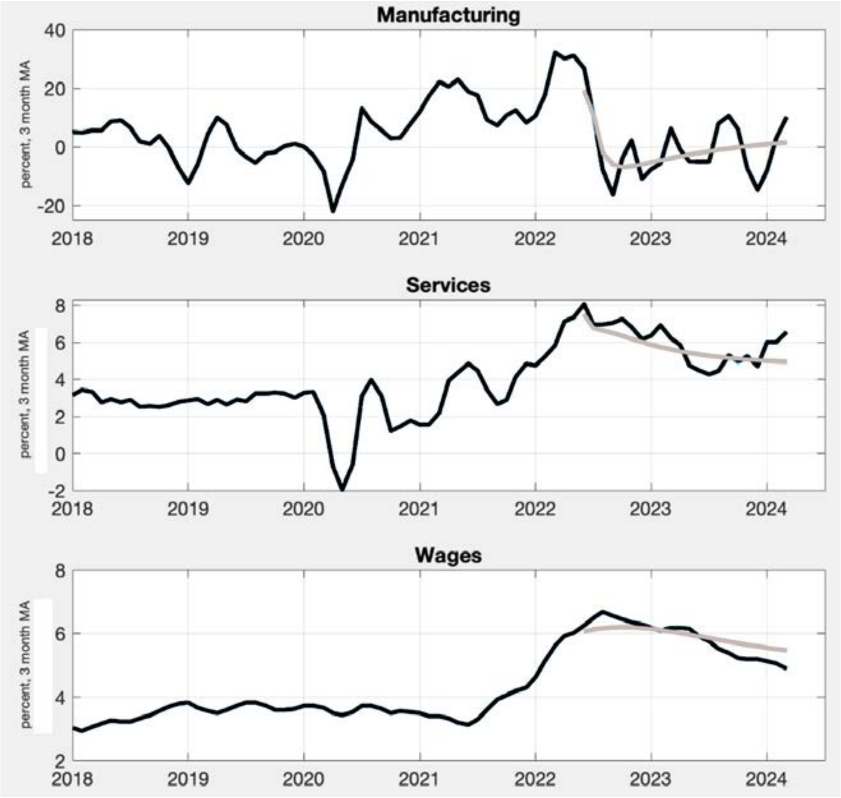
Figure 6
Schematic Representation of Multi-sector Model



only happens because the service sector and the labor sector react to cumulated past price increases. The service sector responds because manufacturing goods are inputs for the service sector, the labor sector responds because when higher prices of goods and services increase the cost of living, and workers respond trying to restore their real wage. The surprising thing is that in Figure 7 the last two years of inflation can be interpreted as a long aftershock of the early phase of the episode.

We are not the only ones who have pursued a sectoral interpretation of recent events.[2] A non-exhaustive list of papers that take a sectoral approach includes Comin, Johnson, and Jones (2023), Ferrante, Graves, and Iacoviello (2023), di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2023), Guerrieri, Marcussen, Reichlin, and Tenreyro (2023), Rubbo (2024). An emphasis on supply shocks coming from energy prices and other sources is also a core component of the model and empirical decomposition proposed in Blanchard and Bernanke (2023) and of the model and simulations in Gertler and Gagliardone (2023). The view discussed here is also consistent with the findings of papers emphasizing the unusually high pass-through from non-core

Figure 7
Sectoral Inflation: Actual and Simulated After June 2022



Source: Own calculations. Black line: actual series. Gray line: simulated series with all exogenous shocks set to zero after June 2022. Details in the appendix.

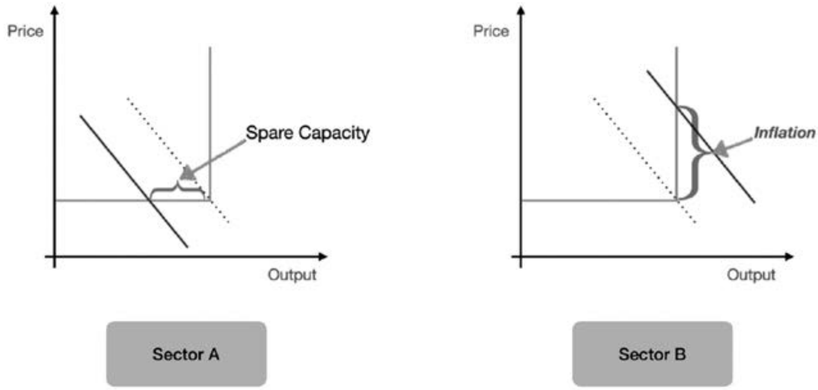
inflation to core inflation in the recent episode, both looking at the U.S. (Ball, Mishra, and Leigh, 2022) and at the international experience (Dao, Gourinchas, Leigh, Mishra, 2024). Finally, the idea that recent wage inflation can be interpreted as an aftershock, due to workers' previous loss of purchasing power, is also consistent with new work that investigate its implications for labor market flows (Afrouzi, Blanco, Drenik, and Hurst, 2024) and for workers' negotiation efforts (Guerreiro, Hazell, Lian, and Patterson, 2024).

Now let us go back to Gauti and Pierpaolo's paper and emphasize some important points of agreement. First, we do not think that labor scarcity played no role and we agree that the models with search frictions can capture well the notion of labor shortages. Second, the one thing on which we absolutely agree with Gauti and Pierpaolo is the idea that of non-linearities in Phillips-curve relations. The idea in simple terms is that when you come close to fully utilizing a resource, the price effects can be dramatically different.

Actually, we believe that nonlinearities play an even more important role when we take a more disaggregated view of the economy and build up the macro picture from the micro level. To underline this point, let us bring up an old graph from our own 2021 Jackson Hole paper, coauthored with Veronica Guerrieri and Ludwig Straub. In that paper, there are two sectors A and B, and in the graph we show an example in which a period of growth that is strongly biased in favor of sector B can produce inflation in that sector, even though the other sector may still be in a state of insufficient demand. Crucial to this asymmetric result was the idea of non-linearity, so one sector can end up in the steep portion of its Phillips curve, while the other is still in the flat region. When you combine non-linear supply curves and multiple sectors, then you can get something that we thought was an important observation: an asymmetric shock across sectors will look like a cost push shock in the aggregate.

Adding multiple sectors is not just nice for realism, though, it also has implications for policy. In Gauti and Pierpaolo's model, after an inflationary shock a quick disinflation is easy and desirable. Reducing output leads the economy down the steep portion of the Phillips curve and the sacrifice ratio is low. In a multi sector world, policy tradeoffs are harder. For example, in the example illustrated in Figure 8, sector B is in the steep portion of the supply curve, but A is in the flat region and experiencing insufficient demand. In general, there always be a distribution of sectors, some characterized by slack and unused capacity and some by tighter supply constraints. And in certain circumstances, this distribution will be more spread out, and policy decisions will be more difficult. The proper welfare analysis of these trade-offs is a fascinating and important open area for the future.

Figure 8
A Two Sector Model



Source: Guerrieri, Lorenzoni, Werning Straub (2021)

Appendix

The model is composed of three sectoral Phillips curves:

$$\pi_m = \rho_m \pi_m(-1) + \beta_1 \cdot SCI + \beta_2 \cdot OIL,$$
$$\pi_s = \rho_s \pi_s(-1) + \gamma_s\left(\alpha_1 w + \alpha_2 p_m - p_s\right),$$
$$\pi_w = \rho \pi_w(-1) + \gamma_w\left(w - p - a\right).$$

The first equation describes manufacturing inflation $_m$, driven by shocks to energy, captured by the crude oil price, OIL, and by shocks to supply chain disruptions, captured by the New York Fed Global Supply Chain Pressure index. The second equation describes inflation in the service sector $_s$, driven by the distance between the current price level (in logs) p_s and nominal marginal costs (also in logs) $\alpha_1 w$ + α_2 p_m, where $_1$ and $_2$ are the relative weights of labor and other inputs. The cost of non-labor inputs in the service industry is captured simply by the price level in the manufacturing sector and the parameters 1 and 2 are calibrated to 0.8 and 0.2. The third equation describes nominal wage inflation π_w, driven by the distance between the real wage (in logs) — and a real wage aspiration which we assume to follow a linear time trend.[3] For each inflation equation we also allow a lagged inflation term, capturing inertia. To close the model we simply assume that the workers CPI is a linear function of the manufacturing and service prices and we estimate the coefficients of this linear function by OLS. We also estimate by OLS the remaining parameters of the model, using monthly data from 2014:1 to 2024:6.

Clearly, this is an extremely simplified model and, on purpose, we have not included any effect of labor market tightness on the workers' real wage aspirations. The objective here is simply to provide a proof-of-concept of the idea that transmission across of sectors, with an impulse starting in the manufacturing sector, can provide a possible rationalization of observed patterns.

Endnotes

[1]Cheremukin and Restrepo-Echevarria (2022) separately measure the tightness that applies to unemployed workers and the tightness that applies to employed workers searching for jobs. They find a weaker increase in tightness for unemployed workers.

An additional issue is whether when computing vacancies to unemployment we need to account for the underlying long- run trend in vacancies measures since around 2010, maybe reflecting the increased availability of online job posting.

Mongey and Horwich (2024) discuss ways of taking account of this trend, which leads to a substantial reduction in the degree of measured tightness post 2020.

[2]Our own previous work on this theme is in Lorenzoni and Werning (2023).

[3]In Werning and Lorenzoni (2023) we discuss the interpretation of aspirations in a broad class of inflation models.

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General Discussion: Insights from the 2020s Inflation Surge

Moderator: Karen Dynan

Karen Dynan (Moderator): Thank you. We're going to turn to the general discussion now. I will try to call on three or four questions at once so that we can get as many questions in as possible. Let me start off with Ayşegül Şahin.

Ayşegül Şahin: Thank you for your presentations. As a labor economist, I'm really happy that now monetary economists are looking deeper into the labor market, and vacancies are getting a lot of attention. But before we move on to discard the select measures that we have been using, I think we should think hard about what we measure when we look at vacancies. We understand that unemployment goes up when people lose their jobs or they have difficulty finding jobs. The same thing happens with vacancies. Vacancies reflect desire to hire, but also inability to hire. What happened in 2021 especially is people started quitting their jobs in search of better opportunities, remote jobs, better locations, sunshine, etc., and that left a lot of vacant jobs. We had to post vacancies for replacement hiring. Then pretty much when the Fed started to tighten, quits started to go down. Maybe this is causal, maybe not. But as a result, vacancies kept going down, but employment was very healthy because we just didn't have to replace people. But labor demand was still pretty good. Now we have started seeing this vertical drop, but at some point, things normalized, and we started seeing the correlation between vacancies and unemployment. So that's one view of how the Beveridge curve evolved. But I think we should realize that not all drop in vacancies should result in a decline in employment or an increase in unemployment because there are also vehicles to replace jobs that quitters leave behind.

Yueran Ma: I'm curious where you think the nonlinearity of your L occurs in your handout. Sometimes the steep section ends at 2% inflation, and in some other graphs, like the right-hand side graph, the steep section ends at 3% inflation. So where that turning point is right now, I'm curious about your assessment. I would also love if you can address Guido Lorenzoni's point about international evidence, how your evidence holds up internationally since you wrote your op-ed in Japanese.

Markus Brunnermeier: Thanks a lot. I have some statistical questions. If you look at vacancies, I was just wondering whether it's much easier to just keep a vacancy on, and it's much more difficult to close it and reopen it later. And has this changed over a century of data, whether the attitude of leaving vacancies open is very different? And then I have a second question. Does this famous SAHM rule, because your analysis has any implications for it as well?

Alan Blinder: Thank you. I'm going to be very brief because my questions have been anticipated. One question is, it seems to me that things should be different if high vacancies come from a surge in demand for labor that's not met or come from a withdrawal of supply. You don't see withdrawal of supplies very much, but we did in COVID, we did in World War II, World War I, and so on. So that's point one. Point two is just a question which Markus Brunnermeier basically asked about the consistency of the data. I just want to put a slightly finer point on it. JOLTS, let's say, is very good data. But it's a very young time series. We can't look at much history on JOLTS. If you go back about another 15 years, you don't have internet searching websites and all of that, and people were counting want ads in the *New York Times* and things like that. So when I see these studies of vacancies that cover large periods of time, I'm always scratching my head and wondering about the consistency of the data.

Gauti Eggertsson: Thanks a lot for all these good observations. Let me start with those that I agreed with most of what Guido said. Let me just highlight the thing that I may disagree with most, which is that he showed us a measure of wage growth, suggesting that it was not very high, as ruling out this mechanism. I want to push against that because, and this relates also to Bernanke and Blanchard's chart paper, what people are typically using is unit labor cost, which is a measure of average cost. So it's all the new hires and all your existing ones. When you think about it, if you're a firm, what is your marginal cost to increase production? Presumably it's to add new people to your existing labor force. So what we should be looking at as a measure of marginal cost is those new workers.

And in fact, one of my favorite labor economists, Ayşegül Şahin, just asked a question that I hope we get back to later. There's a picture that she let me borrow from one of her works with her co-authors that shows you, when you just track the wages of vacancies, that there was a dramatic increase in new wages, especially at the lower end. So this is one of the figures in the paper that shows that there is a dramatic increase in new wages just around the labor source, which explains why we are attributing a lot more to this labor channel than Blanchard and Bernanke, and as well as Guido.

Regarding the international transmission, Pierpaolo Benigno and I do have an AEA Papers and Proceedings paper that just came out where we look at international evidence. One issue there is that data on vacancies is not that well comparable across countries, or at least we haven't been able to. So we just looked at unemployment, but we actually estimated the unemployment rate to be about 2.5%, and we estimated Phillip's original suggested nonlinear Phillips curve—because actually his Phillips curve, that was his main point, was nonlinear, except he had wage growth, and we did it in terms of price growth.

And once you have these unemployment rates and plot them against inflation across different countries, it works remarkably well. But I think it would be hard, though, to compare the view over time because the institutional arrangements were quite different. A lot of these countries, like Germany, tried to maintain employer-employee relationships, so I would expect there to be different Beveridge thresholds there. And I think that's a topic for future research.

In terms of the international evidence, also, I made some very bad arguments in that op-ed that fortunately only a few of you can read, which was the point that inflation was not just rising in the U.S., it was rising in a lot of other places. But I then just realized after having written the op-ed and published it that I actually have a paper on this with Larry Summers, where we emphasized that if you have a — and this was in the context of secular stagnation — fiscal expansion in the U.S., it is going to translate directly to lower—to basically increase the natural rate in all the other countries you have open financial markets with, which should put upward pressure on inflation there, too, which does seem consistent with the evidence.

So I'm sympathetic. Actually, the next thing we've started doing is exactly what Guido was hinting at, which is doing multi-sectors. And there are basic objections to the fact that there are exogenous shifts in the Beveridge curve.

Adriana Kugler: Thank you so much for this paper. I'm also thrilled that you did this really excellent analysis on labor markets. I had some of the same concerns about measurement as Markus Brunnermeier and Alan Blinder on the vacancy side in terms of the increased easiness of posting vacancies due to online job boards, but also due to the gig economy as well as temporary work. But I'm also wondering about the *U* side of it—the *V* to *U* ratio—and the fact that there are many more layoffs now going directly into non-employment as opposed to standard measures of unemployment. So if we were to look at not only *U*3, but *U*4, *U*5, *U*6, you may get a very different picture of what the *V* to *U* ratio is.

I guess what would be great is if you can do some robustness checks with different measures of both vacancies and unemployment as well, because given that this is so critical, right — we're at 1.1 actually right now, and given that your kink suggests that this threshold comes at 1 — it would be nice to have a better idea of where we are. So that's my main comment. And I'm thrilled about the question that Guido posed. You used my favorite measure of the quarterly survey of planned capacity, and ISM has some great measures also on supply chain bottlenecks, so it would be great to extend your Phillips curve estimates to include those measures.

Karen Dynan (Moderator): I know I said I'd take questions in batches, but since this is a second data-related question, building on Alan Blinder's question, do you want to just speak to that, this issue of different metrics?

Gauti Eggertsson: Well, I guess I should come clean here that I see myself as an applied theorist, and I've done less work in the empirical space, so I'm standing on the shoulders of giants here. But let me just make a couple of observations. When we first started talking about this paper and pointed at this huge increase in vacancies and said that we expected it to fall down without changes in unemployment, a lot of people told us, 'Look, all this increase in vacancies is just spurious for all these different reasons in the data.' Lo and behold, they declined just as expected, right?

Second, now it is true the data we have on vacancies collected by BLS since 2000 — that's much higher quality than what we have from 1951 until that date that's constructed by Regis Barnichon. And then that is extended back to 1919 in a JME paper by two authors that I apologize I can't remember their names off the top of my head. So, how comparable are they? I think that's a good question, and I don't have an answer that would probably satisfy anybody at the moment, except just to point out that the proof is a little bit in the pudding.

The very reason we started writing this paper is the picture we showed you. When you see that once the *V* over *U* goes over the Beveridge threshold, it just so happened that inflation has always started surging. And if you look at the scatter plot, they also seem consistent with these observations. So yes, the data can surely be improved, and it's something that I want to consider further. We've started thinking about it in the international context and found it to be difficult, but I think the data that does exist, constructed by people that are more specialists than I am in the field, do seem to be relatively consistent. But I don't want to make little of the fact that they cannot be improved, and there are rooms for alternative interpretation, like Ayşegül Şahin was saying, that the source of why they're declining may be important, and those are all things worth exploring. But I think the spirit here was first just to take the most basic, simple approach. That's what I tend to do — there's a fork in the forest, simple model, two sector, many sector — well, let me first take the simple path, and then I'll get to the other one later.

Karen Dynan (Moderator): Thank you. We're going to take Governor Yaron next.

Amir Yaron: Gauti, a really interesting paper. I want to push, though, on what Guido was saying. The model focuses on aggregate labor market tightness, and that may overlook what happened in this particular event — sectoral dynamics, particularly in scenarios where we see increasing vacancies in one sector like services without a corresponding decrease, at least immediately, in unemployment in another, like the goods sector. And there are a lot of micro-foundations why that might happen.

So, such a situation driven by labor market frictions and skills mismatch between services and goods could push the *V/U* ratio above your aggregate proposed measure. And so that leads to whether that Beveridge threshold — what is the right Beveridge threshold measure when you look at these aggregate measures when there are these huge compositional effects in this scenario and others. So, what is the right star from a policy perspective? We're talking about R-star, NAIRU, and now a Beveridge threshold ratio. Can you tell us how to think about that?

Fatih Karahan: I'm a little bit skeptical of the nonlinear view. If you look at state-level data before COVID, we had a lot of states with low unemployment and a lot of states where the *V/U* ratio was above one, quite above one. You don't really see the kind of increase in inflation in those states at that time. There are some nonlinearities, but really not enough to matter quantitatively. Instead, I think what happened was this shock to preferences, where a lot of people searched for better jobs in terms of wages, amenities, flexibility, what have you.

That led to a lot of job-hopping. And as a lot of work before had shown, when you think about inflationary pressures, it's really the job-to-job transitions that matter rather than the unemployment rate. I'm going to shamelessly plug some work with Aysegul when I was at the Federal Reserve back then. This view actually explains quite a lot of things. It explains why we had missing inflation before COVID despite the unemployment rate coming down, why we didn't see much inflationary pressures coming from the labor market. It explains why we had high inflation after COVID because of this preference shock, and it also explains why we had a fast decline or a healthy decline in inflation without much impact on the unemployment rate. This matters for policy reasons, but it also matters for forecasting because if we have an episode like that again, whether we're going to face a structurally nonlinear Phillips curve or just because there's no shock to preferences like COVID, which is hard to mimic, hopefully. So, I think the two offer a very different outlook.

Karen Dynan (Moderator): Thank you. We're going to go all the way to the other side of the room. Jared Bernstein, and after you're done, Jared, could you hand the mic up to Pierre-Olivier Gourinchas.

Jared Bernstein: Thank you. Great paper and great discussion. I want to get back to the why-does-it-matter question. Gauti, you leaned pretty hard into the kink point, and I wonder why it matters from the perspective of monetary and fiscal policy if that's smooth and not kinked. I'm trying to think about policy implications. Guido, you leaned very hard into the non-labor input point, and at the end of your talk, you said this kind of matters for policy, but you didn't really say how. So, how does — if you're right and that's an important part of what happened — how would that change the policy actions of monetary and fiscal policy measures that we undertook, given that both are maybe not the world's most nuanced tools?

Pierre-Olivier Gourinchas: I think this is a really very interesting paper, and I think the focus on the nonlinearities is really important. I want to make two comments—one that goes back to the second point Alan Blinder made, which is about the nature of the shocks that lead to the economy crossing over the Beveridge threshold that you're focusing on. If I look at the shocks that you identify there, you know, you have World Wars, you have the Korean War, you have the Vietnam War, you have COVID. I want to propose that these are also cases where you have massive labor supply shocks. So, it's not just that we're getting into a tighter part of the Beveridge curve—it's just that we have this massive withdrawal from the labor supply in all of these cases.

And in fact, the one episode in your sample where you cross this threshold and where you don't have a surge in inflation is 2018–2019 pre-COVID—that doesn't lead to a surge in inflation. And that's also a time where we don't see a massive negative labor supply shock. So, I want to think that maybe there is something else beyond just the Beveridge curve here that is happening.

Then, the second point I want to make is I want to come back to the international experience. I think when you think about nonlinearities, there are different types of nonlinearities. I mean, Guido Lorenzoni was mentioning, 'I can top your model with one inverted L curve, with my model with two inverted L curves.' I want to argue that there are different forms of nonlinearities. You can think about nonlinearities coming from the tightness in the labor market, and that's what you're looking at. You can think also of nonlinearities when you think about the transmission of things like cost-push shocks or energy shocks to inflation and how they feed into core inflation. It might be very different when you have very modest shocks to energy prices versus when you have very large shocks to energy prices that are very salient or that feed into the kind of sectoral linkages that Guido is talking about.

In the work we've done at the IMF where we try to put these things side by side and we do it for a sample of 21 countries, both advanced and emerging economies, what we find is it's really the latter that matters. It's a nonlinear transmission of these energy and commodity price shocks that feeds into core inflation with lags and with nonlinear effects, much more so than the tightness in the labor market. Now, the U.S. is the one outlier there where there is a contribution of tightness in the labor market to inflation dynamics, unlike a lot of other countries. I think that, to me, calls into question whether we should put all our chips on the labor market scarcity as an explanatory variable for inflation dynamics in the recent episode.

Karen Dynan (Moderator): Thank you. We have about nine minutes left. I know we've got a batch of questions up here, but let me just turn back to Gauti, if you have a response to the question that Jared asked as well. Just quickly before we go to the next questions.

Gauti Eggertsson: Okay. So I'm trying to keep track of everything here, but I hope I at least keep track of some. First, to Fatih's question. Yes, one of my favorite labor economists that you wrote that paper with had informed me, in fact, about 20 percent of new hires are from unemployment. The rest are job-to-job or entering into the labor force. This is something we take into account in the simple model we have. I didn't emphasize it here, and it also speaks a little bit to Guido because he was talking about the unemployment-to-employment transition not being consistent with our story, but you need to think about it in broader terms since it includes on-the-job search and so on. So it's captured in a pretty reduced form, not as elaborate as in your paper, but we try to take that into account and recognize it.

Now, there's another great question, of course, about the sectoral dynamics, and I'm very sympathetic to that. And one of the things — and a good question is, wouldn't the Beveridge threshold in fact depend on that? I do think that the answer to that is yes. One way of seeing that is we have a formula for the threshold in the paper, and one of the things that shows there is matching efficiency. I think the matching efficiency was moving quite a bit during, so what's matching efficiency? It's basically how many matches you create given the number of unemployed and vacancies. That was moving quite a bit over this time, and I do think that has to do with the sectoral, you know, asymmetric growth in demand for goods versus services.

We have a little bit of a discussion in the paper, although we don't flesh it out fully, that yes, I agree. I think that's important, and it's the natural next step — to see how that affects employment and fiscal policy, and how it's going to affect these different variables. I do not think it affects the Beveridge threshold, but it is an area that we have not explored fully.

So finally, I just want to say it's not that our story here is only about labor inputs. In fact, we do have significant effects of supply shocks — the point is just that they have outside effects when there is a shortage in labor. And I don't think, moving to anecdotal evidence, there can be any doubt about the shortage in labor. You just have to walk around in the U.S. Stores were closed because they said 'due to labor shortage.' You go into a restaurant that is one-third full, and you can't get a table because of labor shortage. This was going on all over the place, and we see it in the measures, but we also just see it by reading the newspapers or walking around wherever you lived at the time.

Finally, it's a great point that Pierre-Olivier made, which is this very interesting period right before COVID where we actually crossed the Beveridge threshold and inflation didn't pick up. So, we have this just in the appendix here, and there are two possible explanations for it. One is that you notice if we do this decomposition looking back—so how does our model explain it? Our model can explain basically the last year of it because there were very negative, you know, positive supply shocks—amount of prices were declining at the time. There's the first year that is more difficult to square, and there, one interpretation is that the Beveridge threshold is in fact higher than one, maybe something close to 1.2. That would be another alternative interpretation, and that goes into also thinking about time variation in that threshold. We just simply don't have enough power in the data yet to speak to that, but I think that's where, once we add sectors and regions, I hope we will go.

Jacob Frenkel: Thank you very much. I would like to come back to the first question that we started with, the permanent transitory discussion. I think that there is here a fundamental asymmetry. What we observe in the market, in the outcomes, is the combination of the shocks, whether they were permanent or transitory, and the policy response. And so, therefore, we really need to disentangle them, and that's what the market participants are trying to do. But when it comes to the policymakers, they are not just another observer. In a way, they are observers with a gun. They will determine whether the shock turns out to be transitory or permanent. And I think that's very important because if they wait to see whether it's transitory or permanent, by definition, we will fall behind the curve. So this brings, therefore, to another perspective, which says really the task of the central bank or the monetary authorities is to ensure that all shocks turn out at the end to be as transitory as they can be rather than sit on the side and decide what it is. And I think that's really the transitory permanent thing is not the focus that needs to be discussed, but rather the outcomes end up being transitory.

Sebnem Kalemli-Özcan: Thank you, great paper, great discussion. I want to come back to this international evidence point because when you were answering, you said, well, we are working on that, but of course we have to get these vacancies to unemployment from many countries. But an alternative to that is exactly to do what Guido is suggesting, which we have done. You have a multi-sector model globally, and now instead of trying to get aggregate measures of vacancies to unemployment, you get sectoral measures of labor supply shock, labor demand, non-labor inputs, and you bring all together. And in fact, when you do that, you actually exactly match this asymmetry and timing point, not just in the United States, but in the Euro area, China, Russia, several countries, because what happens is exactly what you don't pick up in your gray area in your figure, and also the nonlinear interaction. So if you are going to do that, I think one way is to go exactly that. Get all those sectoral data, sectoral measures, and then still map to the aggregate inflation, but using sectoral variation.

Eric Swanson: I want to push back for a minute against the labor market story, and the way I want to do it is by calling attention to the rental market and rents. Rents are a big part of inflation, especially core inflation, and rents skyrocketed in 2021 and 2022. I was renting at the time and experienced this firsthand, and it was horrible. I think it's very, very hard to tell a labor market story for what was going on in the rental market. In particular, the supply of rental units was largely fixed during this period — it's not really affected by the labor market, it's not really affected by supply chain disruptions, and it's not really affected by commodity prices. Instead, I think you have to tell a demand story that there was a huge increase in demand for rental units at this time. And that was coming, I think, from a huge amount of fiscal stimulus and moratoria on student debt loan repayments, which really transfers a lot of spending power to younger households, who are the ones who are the most likely to be renting. So I think a big part of the story is really not labor market related, it has a significant demand component to it.

Karen Dynan (Moderator): Thank you very much. Okay, so we've got like a minute left, but I want to give just Guido just a part of that to talk, and then we're just going to wrap up with you, Gauti. So Guido, do you have anything you want to add?

Guido Lorenzoni: There's so many. It's really hard. I mean, I guess I'm just going to make an easy comment on the policy part, on Jared's question. So what are the policy lessons, I mean, of a multi-sector view apart from the fact that policy is harder? I think there is a bit of a tension between a very widespread view in policy circles, that there are some shocks that we can see through and some shocks that we have to respond to. I don't think the welfare foundations of that view are super strong. So that's why, I mean, really, if we are in Gauti's world, we don't want to see through anything. If we are on the steep part, we have to go back as quickly as we can. That's the optimal thing. So there is no tradeoff, or there is no waiting. It doesn't matter if it's transitory. If you're above the Beveridge threshold for a transitory time, just get back as fast as you can. It doesn't matter if it's transitory or permanent. So I think the sectoral view helps to think more about this idea that sometimes you want to kind of wait for the shock to work through the system, just because it may be very costly to try to push it back, because there may be some sectors that lag. So one way I see it is to kind of give more strong welfare foundations to the view that there may be some shocks where you are a little more patient. It doesn't mean that you don't do anything. There are many other things that you have to do. You have to signal. You have to send a strong signal and so on. But in a sense, when we think about this idea of seeing through some shocks, I think the welfare analysis behind it is not very strong, and we need to make it stronger.

Gauti Eggertsson: I want to agree completely with a comment made about permanent and transitory, that that is obviously a function of policy. I made the terrible mistake of writing essentially similar to what you were saying, that it depended on policy, and making the point that I felt I was wrong in saying that we didn't need to raise rates in the fall because it would come down by itself. That's how I interpreted Team Transitory, that you didn't need to do something with policy. I've never had an explosion of negative comments because this seems to have become a religious debate, what you call transitory or permanent. So I've tried to stay from it since then. But I agree with you. It is a function of policy, and that's how I always thought about it, that the transitory review translated into that you didn't need to start raising rates in the fall, but it was prudent to wait. And I think exposed, it would probably have been not a bad idea to start raising rates.

I agree that I'm all for extensions along borders and sectors, but I think we can do both at the same time. I think my comparative analysis is probably going down first the path of having as simple stripped-down model as possible. And I think then you will have a lot of reduced form parameters that are going to be, you're going to start to understand better as you go into more desegregated sectoral view, then you can get micro-foundation for like, for example, match efficiency and so on. So I don't disagree, but I think we can do both.

Finally, with Eric's point, taking rents, so yeah, but people are going to have to look at, I guess what Paul Krugman called super super, core, which threw out rents as well. Then if you look at super super core, that seems to be supportive of this notion, or at least I self-servantly interpreted it as largely consistent with our notion, but in particular, it became clear then in the fall of 2021 that the underlying inflation when you strip out all sorts of things, including rents, was starting to rise. And that's how I sort of actually flipped my view of what was going on and started focusing on labor tightness.

Government Debt in Mature Economies: Safe or Risky?

Roberto Gomez Cram, Howard Kung, and Hanno Lustig

Abstract

Governments and central banks can protect either taxpayers or bondholders from government spending shocks. When they choose to insulate taxpayers, government bond yields need to increase in response to unfunded fiscal expansions as the government debt is marked to market. The risks of unfunded spending shocks are then borne by bondholders who demand a bond risk premium. This risky debt regime is a better fit for the recent experience of the U.S. and other mature economies. We provide high-frequency evidence from the COVID episode that links U.S. Treasury yield increases to bad news about future government surpluses. In this risky debt regime, large-scale asset purchases in response to large government spending provide temporary price support to government bonds, a net loss for taxpayers.

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1. Introduction

Central bankers have increasingly invoked market dysfunction to ex plain the rationale for large-scale asset purchases in domestic bond markets. In early March 2020, the yields on long-dated U.S. Treasurys spiked. Other sovereign debt markets in advanced economies witnessed similar yield dynamics. Central banks in these countries subsequently intervened in their domestic government bond markets to ensure their smooth functioning. These interventions were not limited to 2020. In 2022, the European Central Bank (ECB) preemptively rolled out its Transmission Protection Instrument, giving itself a license to buy government bonds issued by member countries that experience unwarranted increases in borrowing costs. In September 2022, the U.K. experienced a disruption in gilt markets, which triggered an intervention by the Bank of England.[1]

Central banks and governments have a legitimate interest in maintaining well-functioning government bond markets. We analyze what smooth market functioning in government debt markets entails when the economy is subject to government spending shocks. Bond investors need to mark down Treasury valuations when the government cash flows backing their claims are reduced or become riskier. Large-scale asset purchases by central banks after spending increases may impede this mark-to-market process in the short run.

Central banks and governments can coordinate either on a safe (zero beta) debt regime that insures bondholders or a risky government debt regime that insures taxpayers against government spending shocks (Jiang, Lustig, Van Nieuwerburgh, and Xiaolan, 2020), henceforth JLVX (2020).[2] We illustrate this trade-off in a simple model featuring monetary and fiscal interactions. Following Leeper (1991), we consider two distinct monetary-fiscal policy regimes labeled as monetary dominance and fiscal dominance. Monetary dominance produces a safe debt regime, while fiscal dominance generates a risky debt regime. The safe debt regime rules out unfunded spending shocks because of the fiscal authority's commitment to pay for surprise spending with future taxation.

Using high-frequency evidence, we show that the risky debt regime is a better fit for the recent U.S. experience as well as the experience of other advanced economies. In this regime, large unfunded spending shocks trigger large adjustments in the valuation of the government debt portfolio, even in a well-functioning bond market.

We use COVID-19 as a case study. During COVID, the response of Treasury valuations to the central bank and government actions are broadly consistent with the predictions of the risky debt regime. In the U.S. and other advanced economies, the COVID pandemic was characterized by large increases in government spending that were not matched by increases in current or expected future taxes. During the initial months of the pandemic, from March to May 2020, investors revised their expectations of U.S. government deficits upward by more than 10% of GDP for the subsequent two-year period. Absent expectations of future tax or spending offsets to these fiscal expansions, Treasury investors require that the real value of Treasurys be marked down to reflect news about unfunded government spending throughout the pandemic (Corhay, Kind, Kung, and Morales, 2023).

Between March 2020 and October 2023, U.S. Treasury yields rose by 3.81 pps. The value of the entire portfolio of outstanding U.S. Treasurys was reduced by 26% in real terms. During this episode, the yield dynamics in the U.S. government bond market were quite similar to those in the U.K., France, and Germany. The COVID-19 bond market response in the U.S. sharply contrasts with the Global Financial Crisis (GFC) experience. Instead, the response is closer to that observed during large U.S. wars.

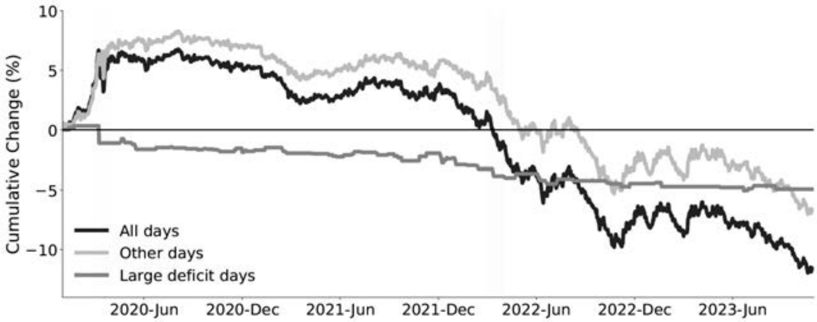
The aggregate market value of U.S. Treasurys was marked down primarily through three channels. The first channel operates through an increase in long-term expected inflation that was front-loaded to the start of the COVID sample period. When governments issue long-term debt, an increase in long-term inflation expectations helps to mark the debt to market in the risky debt regime (e.g., Cochrane, 2001; Lustig, Sleet, and Yeltekin, 2008; Corhay et al., 2023; Bianchi, Faccini, and Melosi, 2023a). The correlation between stock and bond returns also increased significantly, consistent with the predictions of the risky debt regime.

Second, the ‘narrow convenience yield’ channel operates through a decline in convenience yields on long-term Treasurys as a result of the increased supply of government debt at long maturities. The demand curve for the convenience services of Treasurys slopes downward (Krishnamurthy and Vissing-Jorgensen, 2012; Mian, Straub, Sufi, et al., 2021). As a result, the increase in the supply of Treasurys compresses the ’narrow’ convenience yield on Treasurys. Towards the end of our sample, long-dated Treasurys no longer trade at a premium compared to AAA corporates.

Third, the ‘broad convenience yield’ channel operates through real risk-free interest rates. Over this sample, there was a sizeable increase in long-term real rates that was back-loaded, particularly after the quantitative tightening that started in March 2022 and the removal of the central bank’s price support in bond markets. The increase in real rates is broadly consistent with the predictions of incomplete market models in which agents rely on government debt and other safe assets to self-insure against idiosyncratic risk. In these models, an increase in the supply of safe assets, including government debt, increases real rates (see, e.g., Aiyagari and McGrattan, 1998), as the broad convenience yield on safe assets, which measure the self-insurance benefit, declines.

We use high-frequency evidence to connect these yield dynamics to the release of fiscal news. Figure 1 plots the cumulative returns on the U.S. Treasury portfolio (black line) against the returns realized on large deficit days (gray line). We identify these days with news about fiscal expansions using the CBO’s cost estimates of individual bills and Bloomberg news articles, following the approach developed in Gomez Cram, Kung, and Lustig (2023), henceforth GCKL(2023). Consistent with the risky debt view, increases in U.S. Treasury yields were concentrated on days with bad fiscal news throughout the COVID-19 period, starting in March 2020. Before the pandemic, U.S. Treasury investors similarly responded to adverse fiscal news by pushing up yields, as bond investors learned about the

Figure 1
Cumulative Change in the Valuation of all U.S. Treasurys



Notes: This figure shows the cumulative change in U.S. Treasury values on three different sets of days. The black line displays the cumulative change using all trading days. The gray line shows the cumulative change on 79 large deficit days (defined as above median CBO cost releases and/or Bloomberg News articles) that do not coincide with FOMC meeting days and large macroeconomic announcements. The light gray line shows the cumulative change using all 843 remaining trading days. The gray-shaded areas denote March 2020 and March 2022. The sample period runs from January 01, 2020 to October 30, 2023.

long-run stance of fiscal policy, but the effect of adverse fiscal news increased during COVID.

Governments and central bankers face a trade-off between insuring taxpayers and bondholders. In the face of large spending shocks, they determine whether bondholders or taxpayers absorb the fiscal costs. To help the reader, Table 1 provides an overview of the two distinct debt regimes.

To illustrate this trade-off, we analyze the interaction between monetary and fiscal policy in a stylized model adapted from Gomez Cram, Kung, Lustig, and Zeke (2024), henceforth GCKLZ (2024). The model features simple policy rules that determine inflation and the real value of government debt. The nominal short rate rule depends on the inflation gap, while a real tax revenue rule depends on debt relative to the target. The government finances a stochastic stream of expenditures through taxation and issuing nominal debt, implying that the value of government debt is backed by the present value of surpluses.

Under monetary dominance, the monetary authority targets inflation by adjusting the nominal short rate more than one-to-one to the inflation gap. The fiscal authority stabilizes debt by committing to adjust future taxes sufficiently to fully absorb surprise fiscal

Table 1
Taxonomy of Government Debt Regimes

Regime	**Safe**	**Risky**
Leading authority?	Central Bank	Government
Who bears g risk?	Taxpayers	Bondholders
Large $g \nearrow$ fully funded by future τ	Yes	No
Market Beta	Zero	Positive
Persistent Deficits?	No	Yes
High Debt/GDP ⇒ High future s	Yes	Maybe
High Debt/GDP ⇒ Low future returns	No	Yes
	Bond Market Response to Fiscal News	
Treasury Yields (ex CY)	No	Yes ✓
Term Premia	No	Yes ✓
Long-run Expected Inflation	No	Yes ✓
Narrow CY	Yes	Yes ✓
Broad CY	Yes	Yes ✓
	Bond Market Response in March 2020	
	Anticipated	
	Flight to Safety	Mark-to-Market
Stock-Bond Correlation	Negative	Positive ✓
Yields	↘	↗
	Actual: Yields ↗	
Interpretation	Market Dysfunction	Market functioning
Drivers	Dash for Cash	Flight from Maturity ✓
Causes	Market Micro-structure	Macro
	Plumbing	Fiscal News
	Large Scale Asset Purchases in March 2020	
Objective	Liquidity Provision	Price Support ✓
Price Discovery	Improve	Impair
for Taxpayers	Create Value	Destroy Value ✓

g (τ) denotes government spending (tax revenue). s denotes primary surpluses. *CY* denotes convenience yield.

expansions today, insulating inflation from fiscal shocks. Higher government spending in this regime initially requires additional borrowing in real terms that is exactly offset by the higher present value of real future taxes through the fiscal rule. The real return on nominal government debt is protected against fiscal disturbances. Taxpayers are, therefore, insuring the bondholders in this safe debt regime.

Governments have an incentive to manufacture safe debt because it earns convenience yields, thus providing an extra source of revenue (Krishnamurthy and Vissing-Jorgensen, 2012). If debt is safe and has a zero beta, we would expect Treasury valuations to remain unchanged or even increase at the onset of the pandemic because of flight-to-safety in Treasury markets. In the safe debt view, the spike in yields at the start of March is indicative of Treasury markets malfunctioning (see, e.g., He, Nagel, and Song, 2022; Duffie, 2023). The safe debt view naturally leads to a focus on the market micro-structure of Treasury markets as the cause of the March 2020 spike in yields. As investors sold Treasurys, the ability of primary dealers to intermediate in Treasury markets was impaired. The Fed then intervened by using its balance sheet capacity to restore the normal functioning of Treasury markets. In the safe debt regime, the Fed acts as an unconstrained investor, providing liquidity to the bond market by buying underpriced Treasurys, a project that creates positive value for taxpayers.

What if the government wants to shield taxpayers and avoid raising taxes when it confronts large spending shocks? Under fiscal dominance, the fiscal authority pursues tax policies that are not constrained by debt stabilization.[3] Fiscal expansions are not fully offset by future taxation, which reduces the real fiscal backing for debt. Instead, in our stylized model, inflation increases to mark down the real value of nominal debt to align with the present value of surpluses.[4] The nominal revaluations lower bondholders' real returns in response to a surprise increase in government spending. Bondholders demand a risk premium on government debt when unexpected fiscal expansions are associated with high marginal utility states for bondholders, the empirically relevant case. When real bondholder returns are exposed to discount factor innovations, the stock-bond correlation will tend to be positive.[5]

Declines in the narrow and broad convenience yield can also mark the debt to market. Extending our simple framework into a general equilibrium model with real and nominal frictions (GCKLZ (2024)), we show that the spending shocks have significant effects on real rates and convenience yields. Under fiscal dominance, the government shifts the burden to bondholders who experience negative returns after adverse aggregate shocks, leading to a risky debt regime.

Viewing the COVID period through the lens of the risky debt regime, we can think of central banks as effectively providing price support to the government debt market until they started shrinking their balance sheets, as they have done during wars (Hall and Sargent, 2022b). Taxpayers bear the costs of the price support in present-value terms. As long-dated Treasurys were marked to market when they ended the price support programs, central banks realized low returns on their purchases. Large-scale asset purchases thus have first-order implications for public debt management. In the risky debt regime, repricing in bond markets is inevitable. Large-scale asset purchases of long-dated Treasurys transfer part of these losses back from bondholders to taxpayers (see, e.g., Hall and Sargent, 2022b).

If debt is risky and has a positive beta, then Treasury valuations decrease at the onset of the pandemic as investors mark the Treasurys to market. In the risky debt view, the increase in yields at the start of March is indicative of Treasury markets repricing the real value of future surpluses. The Fed then intervened by using its balance sheet capacity to provide price support to government debt markets and pause the mark-to-market process.

The empirical evidence suggests that the risky debt view is a better fit for the COVID-19 pandemic evidence. First, we examine high-frequency evidence to connect Treasury valuations directly to fiscal news about individual spending and tax bills during COVID and its aftermath. Throughout the pandemic, we find that U.S. Treasurys were marked down significantly on days with adverse fiscal news, either in releases of Congressional Budget Office cost estimates for large bills or Bloomberg news articles. This was the case even prior to March 2022, when large-scale asset purchases were putting downward pressure on yields.

Second, the historical evidence for the U.S. and the U.K. supports the risky debt view. During wars marked by large increases in spending, bondholders are typically forced to bear a large share of the fiscal burden. Wars are punctuated by large, negative real returns on the portfolio of outstanding government bonds (Hall and Sargent, 2022b). During COVID, U.S. bondholders experienced real returns of –26%. As shown by Corhay et al. (2023), the real return on the nominal debt portfolio reflects the market's revaluation of the present discounted value (PDV) of surpluses. The spending bills in the U.S. were not perceived to be fiscally backed.

Third, the market reassessed its view on the riskiness of government debt. Consistent with the risky debt view, we observed a large increase in the U.S. stock-Treasury return correlation. The stock-bond correlation, which had been negative for the past two decades (Campbell, Pflueger, and Viceira, 2020), including the Global Financial Crisis (GFC), turned positive in March 2020. Starting in March 2020, long-dated U.S. Treasurys are perceived to be riskier by long-horizon investors. In a regime of fiscal dominance, bond returns largely absorb spending shocks. When large spending shocks occur in bad times, bonds become riskier, and their correlation with stocks increases.

Fourth, in addition to the price evidence above, the quantity evidence also lines up against the safe debt view. We document a flight from maturity in U.S. Treasury markets by private investors, especially foreign ones. The selling of Treasurys by private investors was concentrated at longer maturities without rebalancing to shorter maturities. In contrast, there was no flight from maturity in U.S. corporate bond markets. All else equal, long-horizon investors would reallocate their portfolio away from long-dated Treasurys, given the increased stock-bond correlation.[6]

The paper is organized as follows. Section 2 analyzes the effect of the policy stance on the riskiness of nominal government debt in a stylized model with monetary and fiscal rules and an exogenous real pricing kernel. Section 3 provides an overview of the fiscal response to COVID in the U.S., while section 4 describes the response of U.S. Treasury markets and other sovereign bond markets to COVID. The U.S. bond market's response to the COVID-19 pandemic was largely similar to that of other mature economies but notably different from its reaction during the GFC. While the safe debt regime summarized in Table 1 may have been a good description of the U.S. bond market response during the GFC, it is not for the COVID sample. Section 5 evaluates the safe and risky debt regimes in light of the empirical evidence. We provide high-frequency evidence connecting U.S. Treasury yield increases to the release of bad fiscal news.

2. Theoretical Framework

This section examines how the joint monetary-fiscal stance affects the riskiness of government debt. We start by showing that the government budget equation implies a bondholders' return identity that says the real return on nominal government debt is equal to the return on a hypothetical claim delivering aggregate primary surpluses. We then build a simple frictionless model featuring monetary and fiscal policy rules along with an exogenous real pricing kernel. We use approximate analytical solutions to show how monetary dominance produces a safe debt regime while fiscal dominance generates a risky debt regime with respect to government spending shocks. We use this model to guide our subsequent empirical analysis.

2.1 Bondholders' Return Identity

The government budget identity implies a bondholders' return identity (see Corhay et al., 2023). This identity links the real bondholders' return to inflation and surplus policy, which is therefore affected by the joint monetary and fiscal stance.

We start with the consolidated government budget identity in nominal market values according to

$$R^{\$}_{gt}\mathcal{B}_{t-1} = P_t s_t + \mathcal{B}_t, \tag{1}$$

where B_t is the aggregate nominal market value of government debt held by the public, $R^{\$}_{gt}$ represents the corresponding nominal portfolio return on government debt, P_t denotes the price level, and s_t corresponds to real primary surpluses.

Rearranging the budget identity, we can express it equivalently in terms of returns as

$$R^{\$}_{gt}/\Pi_t = R_{st}, \tag{2}$$

where $\prod t \equiv P_t/P_{t-1}$ is the gross inflation rate, let $\tilde{B}_t \equiv B_t/P_t$ be real market value of nominal debt, and $R_{st} \equiv (\tilde{B}_t + s_t)/\tilde{B}_t{-}1$ is the gross return on a hypothetical claim to real surplus. Corhay et al. (2023) show that $\tilde{B}_t$ is equal to the ex-surplus market value of a claim to aggregate real surpluses. Equation (2) says that the ex-post real return on nominal government debt needs to be equal to the return on real surplus. If the government engineers a safe return on surplus (e.g., through state-dependent tax or spending policies), then the real return on the aggregate public debt portfolio also needs to be safe.

2.2 Simple Model

This subsection aims to characterize how the policy stance plays a key role in determining the real bond risk premium on government debt in a model of monetary-fiscal interactions. The model is a simplified version of Leeper (1991) cast in partial equilibrium with an exogenous real pricing kernel. We use a risk-adjusted log-linear solution method to account for endogenous bond risk premia following Corhay et al. (2023) and GCKLZ (2024).

We analyze government debt valuation in two distinct policy regimes: monetary dominance and fiscal dominance. We show that monetary dominance implies safe government debt (risk-free), while fiscal dominance leads to risky government debt (non-zero real risk premium).

2.2.1 Policy Rules and Government Spending

The monetary authority follows a nominal interest rate rule specified as

$$i_t = i^{\star} + \rho_{\pi}(\pi_t - \pi^{\star}), \tag{3}$$

where i_t is the log nominal short rate, $i^{\star}$ is the risk-adjusted steady state for the short rate, $\rho\pi$ captures the monetary policy stance towards the inflation gap, π_t is log inflation, and $\pi^{\star}$ is the risk-adjusted inflation target set by the central bank.

The fiscal authority follows a real tax revenue rule according to

$$\tau_t = \tau^{\star} + \delta_b(b_{t-1} - b^{\star}), \tag{4}$$

where τ_t is the real tax revenue, $\tau^{\star}$ is the risk-adjusted steady-state tax revenue, δ_b captures the fiscal stance towards debt deviations from target, b_t is the log real market value of debt, and $b^{\star}$ is the risk-adjusted log real value of debt.

Real government spending follows a stochastic process

$$g_t = g^{\star} + x_t, \;\; x_t = \rho x_{t-1} + \sigma \epsilon_t, \tag{5}$$

where $g^{\star}$ relates to the government spending target, ρ captures the persistence of the spending shock, σ represents the volatility of the innovation, and $\epsilon_t \sim$ i.i.d. $N(0, 1)$ is standard normal. Primary real surpluses are tax revenues minus government expenditures, $s_t = \tau_t - g_t$.

We assume that the government issues one-period nominal debt and raises taxes to finance expenditures according to the government budget equation

$$B_{t-1} = P_t s_t + Q_t B_t, \tag{6}$$

where B_t–1 is the nominal face value of government debt and Q_t is the nominal bond price. We can express the budget equation as the bondholders' return identity from Section 2.1, expressed in logs as

$$r^{\$}_{gt} - \pi_t = r_{st}, \tag{7}$$

where $r^{\$}_{gt}$ is the log nominal government portfolio return, and r_{st} is the log return on real surplus. Given that we assumed that the government only issues one-period debt, the nominal return on the government portfolio is equal to the nominal short rate ($r^{\$}_{gt} = i_t$–1).

2.2.2 Real Pricing Kernel

We model investors' risk tastes in reduced form by specifying an exogenous real pricing kernel. To capture the notion that the spending shocks are priced, we assume that the pricing kernel depends on the spending innovations given by

$$-m_{t+1} = \frac{\lambda^2}{2} + \mu + \lambda \epsilon_{t+1}, \tag{8}$$

where m_{t+1} is the log real pricing kernel, and λ is the market price of government spending risk, and μ is a mean parameter. The i.i.d. specification of the log real pricing kernel implies that the shadow real risk-free rate is constant $r_t = \mu$. When $\lambda < 0$, positive spending corresponds to high marginal utility, which is endogenously generated in GCKLZ (2024).

2.2.3 Return Approximation

To obtain approximate analytical solutions for the model, we use a Campbell and Shiller (1988) style approximation of the log return on surplus

$$r_{st+1} = \kappa_0 + \kappa_1 b_{t+1} + \kappa_2 s_{t+1} - b_t, \tag{9}$$

where κ_0, κ_1, and κ_2 are approximating constants that depend on the risk-adjusted steady state of the real value of debt, $b^\star$. To solve for these constants, we employ an iterative procedure following Campbell and Koo (1997). Additionally, we approximate around the level of the surplus to accommodate deficits.

We focus on bounded solutions for inflation and the real market value of debt as in Leeper (1991). The stability conditions depend on the policy parameters ρ_π and δ_b. The two determinacy regions are the regimes of monetary dominance and fiscal dominance, which we characterize next.

2.3 Monetary Dominance and the Safe Debt Regime

Monetary dominance relates to the standard textbook monetary model (e.g., Woodford (2015) and Galí (2015)). This regime is characterized by a monetary authority that determines inflation by adjusting the nominal short rate more than one-for-one with the inflation gap ($\rho_\pi > 1$). The fiscal authority adjusts real taxes sufficiently with respect to debt deviations ($\delta_b > s^\star$) to stabilize the real market value of debt. The Ricardian tax adjustments ensure that the intertemporal government budget equation holds, insulating inflation from fiscal shocks. We show that the real bond return in this regime is also protected from fiscal shocks, implying a *safe debt regime.*

We solve inflation forward in this regime using the Euler equation for nominal bonds and the interest rate rule

$$\exp(-i^\star - \rho_\pi(\pi_t - \pi^\star)) = \mathbb{E}_t\Big[\exp\left(m_{t+1} - \pi_{t+1}\right)\Big], \tag{10}$$

where the stability condition in the steady state for solving inflation forward is given by $\rho_\pi > 1$.[7] The inflation solution is independent of the fiscal disturbances, leading to the constant inflation policy anchored at the target $\pi_t = \pi^\star$.[8] Incorporating monetary policy shocks or persistent real discount factor shocks would generate inflation dynamics, but inflation would still be insulated from the spending shocks in this regime.

We solve for the real value of log debt backward in this regime by substituting the tax rule into the budget identity and using the linearized return on surplus to obtain

$$i^\star - \pi^\star = \kappa_0 + \kappa_1 b_t + \kappa_2\left(s^\star + \delta_b(b_{t-1} - b^\star) - \rho x_{t-1} - \sigma\epsilon_t\right) - b_{t-1}, \tag{11}$$

where the stability condition is given by $\delta_b > s^\star$.[9]

Solving the difference equation backward, we obtain the debt policy as

$$b_t = \Gamma_b + \left(\frac{1 - \kappa_2\delta_b}{\kappa_1}\right) b_{t-1} + \left(\frac{\kappa_2}{\kappa_1}\right) x_t, \tag{12}$$

where the coefficient on the spending shock is positive ($\kappa_2/\kappa_1 > 0$). Therefore, a positive spending shock in this regime leads to an initial debt expansion.

We next show that the real bondholders' return is insulated from the spending shocks. Given that inflation is always anchored at the target, the nominal short rate is fixed at the steady state value $i_t = i^\star$, implying that the nominal government return on debt is also constant. Therefore, the real bondholders' return is given by

$$r^{\$}_{gt+1} - \pi_{t+1} = i^\star - \pi^\star, \tag{13}$$

which is risk-free and only depends on the interest rate and inflation targets.

The Ricardian tax policy ($\delta_b > s^\star$) insures bondholders against government spending risk by decomposing the bondholders' return identity into returns on tax and spending claims. The budget identity links the real bondholders' return to the return on surplus, highlighted in equation (7). The return on the surplus claim is equivalent to a portfolio consisting of a long position in the tax claim and a short position on the spending claim, allowing us to write

$$\frac{R^{\$}_{gt+1}}{\Pi_{t+1}} = R_{st+1} = \left(\frac{P_{\tau t}}{P_{st}}\right) R_{\tau t+1} - \left(\frac{P_{xt}}{P_{st}}\right) R_{xt+1}, \tag{14}$$

where $P_{\tau t}$ is the ex-tax market value of a hypothetical claim that delivers real tax revenues, P_{st} corresponds to the ex-surplus value of a hypothetical claim that delivers real surpluses, $R_{\tau t}$ is the gross return on the tax claim, P_{xt} denotes the gross exspending market value of a hypothetical claim on government spending, and R_{xt} is the gross return on the spending claim. The first equality of equation (14) is the budget identity, and the second equality is a replicating portfolio for the return on surplus.

The Ricardian tax rule under monetary dominance guarantees that the portfolio-weighted tax return fully hedges bondholders against the short position on the spending claim. We show the tax return's hedging properties by pricing the tax claim using the Euler equation according to

$$1 = \mathbb{E}_t\left[\exp(m_{t+1} + r_{\tau t+1})\right]. \tag{15}$$

Using a risk-adjusted approximation for the log return on the tax claim, like what we did for the return on surplus (outlined in Section 2.2.3), we obtain the solution for the log tax claim return as

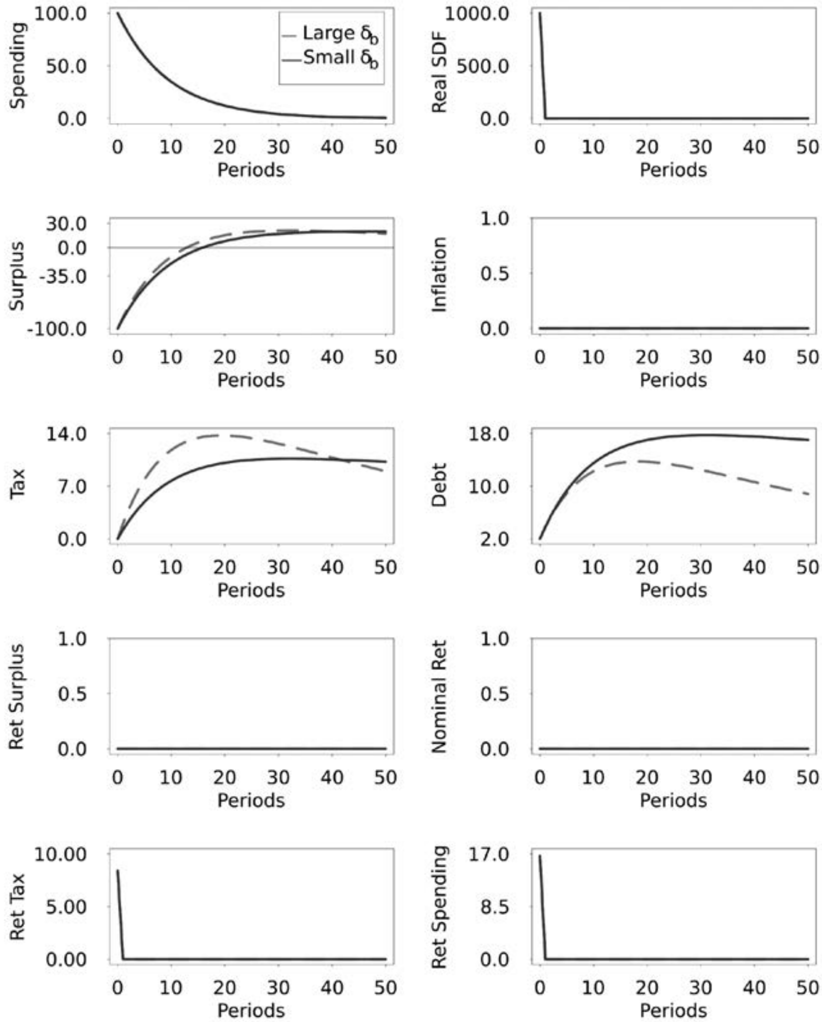
$$r_{\tau t+1} = \bar{r}_\tau + \mathcal{E}_\tau \epsilon_{t+1}, \tag{16}$$

where we can express the coefficient on the spending innovation $\mathcal{E}_\tau$ as a function of the policy parameters and risky steady states and show that it is positive when the tax policy is Ricardian ($\delta_b > s^*$). The tax claim is, therefore, a hedge asset against spending shocks from the bondholders' perspective. Moreover, the commitment by the fiscal authority to raise higher future taxes to fund current spending in present value terms makes the tax asset a perfect hedge against the short position in the government spending claim. The perfect insurance from the tax claim insulates the real bondholders' return against surprise government spending.

Figure 2 plots the impulse responses of model variables to a positive spending shock ($\epsilon_t > 0$) under monetary dominance under two parameterizations of the Ricardian tax rule in a qualitative exercise. We assume in this figure that the parameter related to the market price of spending risk is negative ($\lambda < 0$), implying that high government spending is associated with high marginal states. The parameterization of the pricing kernel is less important under monetary dominance since the return on surplus is risk-free.

Surplus declines initially because of the persistent spending shock but eventually turns positive as the shock decays because of the commitment to increase future taxes to fund the spending. The

Figure 2
Impulse Responses to a Spending Shock Under Monetary Dominance



Notes: This figure plots impulse responses to a positive spending shock ($\epsilon_t > 0$) under monetary dominance for two values of δ_b, labeled as large and small. The variables correspond bps deviations from the stochastic steady state for real government spending (g_t), the log real SDF (m_t), real surpluses (s_t), log inflation (π_t), real tax revenues (τ_t), log real value of debt (b_t), log return on real surplus (r_{st}), nominal return on government debt ($r^{\$}_{gt}$), log return on the real tax claim ($r_{\tau t}$), and the log return on the real spending claim (r_{xt}).

Ricardian tax policy insulates inflation from the fiscal shock. The monetary authority anchors inflation at the target by committing to the Taylor principle.

The persistent spending shock today is initially financed by a debt expansion backed by higher future taxes. Ricardian tax policy ensures that the increase in the real value of debt offsets the initial decline in surpluses, so the return on surplus is insulated from the spending shock. Stricter fiscal policy (large δ_b) front-loads the tax payments more compared to looser fiscal policy (small δ_b), allowing debt to return more quickly to the target. The nominal return on government debt is equal to the nominal short rate, which is constant because inflation is always anchored at the target. The final row of Figure 2 illustrates the real tax asset acting as an insurance claim against the spending shock for bondholders. A levered long position in the tax asset with the proportional market weight (P_τ/P_s) perfectly hedges the short position on the spending asset with the proportional market weight ($-P_x/P_s$). The Ricardian tax policy under monetary dominance, therefore, produces a safe debt regime.

If the debt is truly risk-free, the debt/GDP ratio should be the best predictor of future primary surpluses, because higher surpluses is the only way to bring the debt/GDP ratio back down.[10]

2.4 Fiscal Dominance and the Risky Debt Regime

Fiscal dominance relates to the work of Sargent and Wallace (1981), Leeper (1991), Sims (1994), Woodford (1995), and Cochrane (1998). This regime is characterized by a monetary authority passively responding to the inflation gap ($\rho_\pi < 1$) and a non-Ricardian fiscal authority that does not fully fund surprise government spending by raising taxes ($\delta_b < s^\star$). Consequently, a positive spending shock lowers the real fiscal backing for government debt. Inflation increases to devalue debt under fiscal dominance to satisfy the intertemporal government budget equation, pinning down inflation. The value of debt is stabilized by the passive stance of monetary policy that prevents explosive interest rate paths.

The nominal revaluations expose the real bondholders' return to the spending shocks. When an increase in government spending is associated with high marginal utility states, government bonds command a real risk premium. We also illustrate how the sign of δ_b determines whether the tax claim is a hedge asset or a risky asset, but the fiscal authority cannot provide perfect insurance to bondholders against government spending shocks. However, they are able to perfectly insulate the tax claim from spending shocks $\delta_b = 0$ as a special case of non-Ricardian tax policy. Overall, fiscal dominance produces a *risky debt regime.*

We solve for the log real value of debt forward in this regime using the Euler equation for the return on real surplus and substituting in the approximated log return on surplus and tax rule to give us

$$1 = \mathbb{E}_t\left[\exp\left(m_{t+1} + \kappa_0 + \kappa_1 b_{t+1} + \kappa_2\left(s^\star + \delta_b(b_t - b^\star) - \rho x_t - \sigma\epsilon_{t+1}\right) - b_t\right)\right], \tag{17}$$

where the stability condition in the steady state for solving debt forward is given by the non-Ricardian tax rule ($\delta_b < s^\star$).

Using the method of undetermined coefficients, we obtain the solution for log debt as

$$b_t = A_0 + A_1 x_t, \tag{18}$$

where the coefficient on the spending shock is given by

$$A_1 = \frac{\rho}{(\delta_b - s^\star) + (\rho - 1)\tilde{\mathcal{B}}^\star} < 0, \tag{19}$$

since $\rho < 1$ and $\delta_b < s^\star$. A positive spending shock is not fully backed by future taxation, requiring a devaluation in the real value of debt.

Plugging in the log debt solution into the approximated log return on surplus yields

$$r_{st+1} = \bar{r}_s + \mathcal{E}_s\epsilon_{t+1}, \tag{20}$$

where we can express the coefficient on the spending innovation $\mathcal{E}_s$ as a function of the policy parameters and risky steady states and show that it is negative when the tax policy is non-Ricardian ($\delta_b < s^\star$). A positive spending shock reduces the realized return on surplus and, therefore, the real bondholders' return.

We next show how inflation responds to the spending shocks, providing nominal revaluations of debt to match the fiscal backing. Inflation is solved backward under fiscal dominance by using the budget equation expressed as the bondholders' return identity ($r^\$_{gt} - \pi_t = r_{st}$) and plugging in the solution for the return on surplus to obtain

$$\pi_t = \Gamma_\pi + \rho_\pi \pi_{t-1} - \left(\kappa_1 A_1 - \kappa_2\right)\sigma\epsilon_t, \tag{21}$$

where the stability condition is given by the passive monetary policy stance towards inflation ($\rho_\pi < 1$).[11] Inflation passes the spending shocks through to bondholders under fiscal dominance, making debt risky.

The sign of δ_b under fiscal dominance determines whether the tax rule amplifies or hedges spending shocks. We price the tax claim using the Euler equation as we did above in the monetary regime, yielding the following solution for the log return on the tax claim

$$r_\tau = \bar{r}_\tau + \mathcal{E}_\tau \epsilon_t, \tag{22}$$

where the coefficient on the spending innovation depends on the policy parameters and risky steady states, and we can show that it is signed by δ_b.

When $\delta_b > 0$, the coefficient is negative ($\mathcal{E}_\tau < 0$), making the tax claim risky from the bondholders' perspective as it reinforces the risk exposure to the short position on the spending claim. We can see this amplification effect under this parameterization by decomposing surpluses into the contribution from the tax rule and the spending shock according to

$$s_{t+1} = s^\star + \delta_b(b_t - b^\star) - g_{t+1}. \tag{23}$$

A persistent spending shock today will lower surpluses immediately. Given that the spending shock will not be fully funded in the future because the tax rule is non-Ricardian, the real value of debt gets devalued. When $\delta_b > 0$, future tax revenues are reduced through the feedback rule, amplifying the spending shock on surpluses.

When $\delta_b < 0$, the loading on the spending shock is positive ($\mathcal{E}_\tau < 0$), making the tax claim a hedge asset from the bondholders' perspective. A persistent spending surprise today leads to higher future tax revenues, which dampens the overall surplus response to the spending shock. The non-Ricardian fiscal rule with $\delta_b < 0$ leans against fiscal inflation, offering bondholders partial insurance against spending risk. We show below how the hedging benefits are increasing as δ_b

becomes more negative, but there are limits to how much the fiscal authority can insure bondholders under fiscal dominance.

A special case of non-Ricardian fiscal policy is when $\delta_b = 0$, making the tax claim independent of the spending shocks ($\mathcal{E}_\tau = 0$). The government, therefore, has the ability to fully insure taxpayers from spending risk under fiscal dominance.

We can compute the real risk premium on nominal government debt as the risk premium on the return to surplus, given by

$$\mathbb{E}_t[r_{st+1} - r_t] + \frac{1}{2}\mathrm{Var}_t(r_{st+1}) = \lambda\left[\kappa_1\left(\frac{\rho}{(\delta_b - s^\star) + (\rho - 1)\tilde{\mathbb{B}}^\star}\right) - \kappa_2\right]\sigma, \tag{24}$$

which is positive under fiscal dominance when surprise increases in government spending are associated with high marginal utility states ($\lambda < 0$). Exposing real bondholder returns to pricing kernel innovations can also induce positive comovement with stock returns.

The risk premium increases as δ_b approaches the upper bound of $s^\star$. When δ_b is positive, increasing δ_b enhances the amplification effect from the tax rule, while making δ_b more negative enhances the hedging benefits of the tax rule to bondholders.

However, there are limits to the extent that the fiscal authority can provide insurance to bondholders against spending shocks. As $\delta_b \to -\infty$, the real risk premium on debt converges downward to a positive limit ($\to -\lambda\kappa_2\sigma > 0$). This limit reflects how there is a limit to the extent to which the government can provide insurance to bondholders under fiscal dominance.

Figure 4 plots the impulse response of model variables to a positive spending shock ($\epsilon_t > 0$) under fiscal dominance for three parameterizations of the non-Ricardian tax rule ($\delta_b > 0$, $\delta_b = 0$, and $\delta_b < 0$) in a qualitative exercise. We assume that $\lambda < 0$ so that high government spending is associated with high marginal utility states. We quantitatively explore these mechanisms in GCKLZ (2024).

Surplus declines but without the long-run reversals exhibited under monetary dominance. The spending shock is not fully funded by future taxation under fiscal dominance. Instead, inflation increases to mark down the real value of nominal government debt to align with the reduced fiscal backing. The real return to bondholders also falls to reflect the lower surpluses. Given that this is a high marginal utility state, bondholders need to be compensated with a risk premium.

The tax response is dictated by the sign of δ_b. When $\delta_b < 0$, the government leans against fiscal inflation by partially funding the spending shock through higher future taxes. When $\delta_b > 0$, the tax rule reinforces the spending shock by lowering taxes. Taxes are independent of spending shocks when $\delta_b = 0$. The return on the tax claim naturally reflects the hedging properties of the tax rule.

When the tax rule leans against fiscal inflation ($\delta_b < 0$), the inflation, debt, and return responses to the spending shock are dampened. The government is offering partial insurance to bondholders through the tax rule by making the tax claim a hedge asset. However, the government cannot perfectly insure bondholders under fiscal dominance, as illustrated in Figure 3.

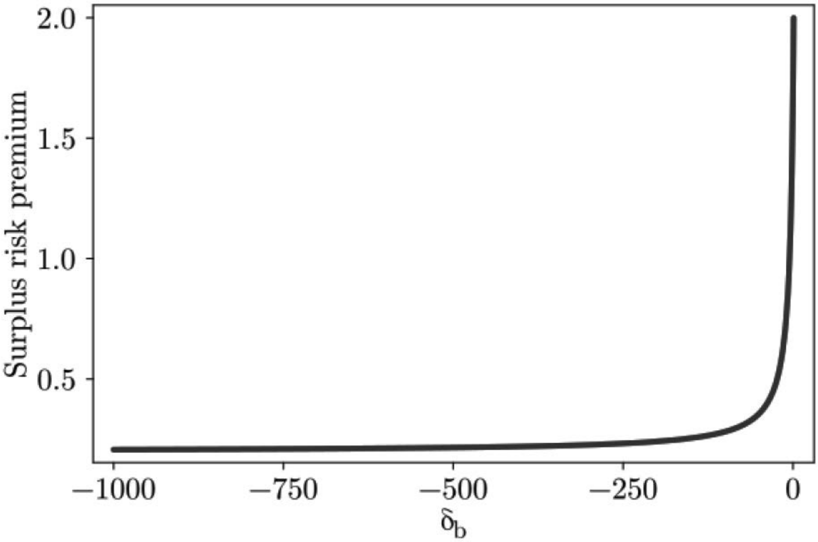
2.5 Extensions

Our model is frictionless and abstracts from monetary policy surprises to illustrate how fiscal dominance can lead to a risky debt regime through nominal revaluations.

This subsection highlights a few additional margins we find relevant to the Treasury market response during the COVID period.

In this stylized model, inflation does most of the work to mark the real value of nominal bonds to market, but there are other empirically relevant mechanisms we have left out. First, our simple model leaves out convenience yields on Treasurys. Krishnamurthy and Vissing-Jorgensen (2012) find evidence supporting a downward-sloping demand for the convenience services of Treasurys. They model this convenience service as a component in the utility function of the representative investor, where the marginal convenience benefit of Treasurys is declining with respect to supply. An expansion in the Treasury supply would, therefore, reduce the convenience benefits and lower Treasury valuations. This is the narrow convenience yield channel. Second, in models with heterogeneous agents and incomplete markets, an increase in the supply of debt will also increase

Figure 3
Real Bond Risk Premium Under Fiscal Dominance



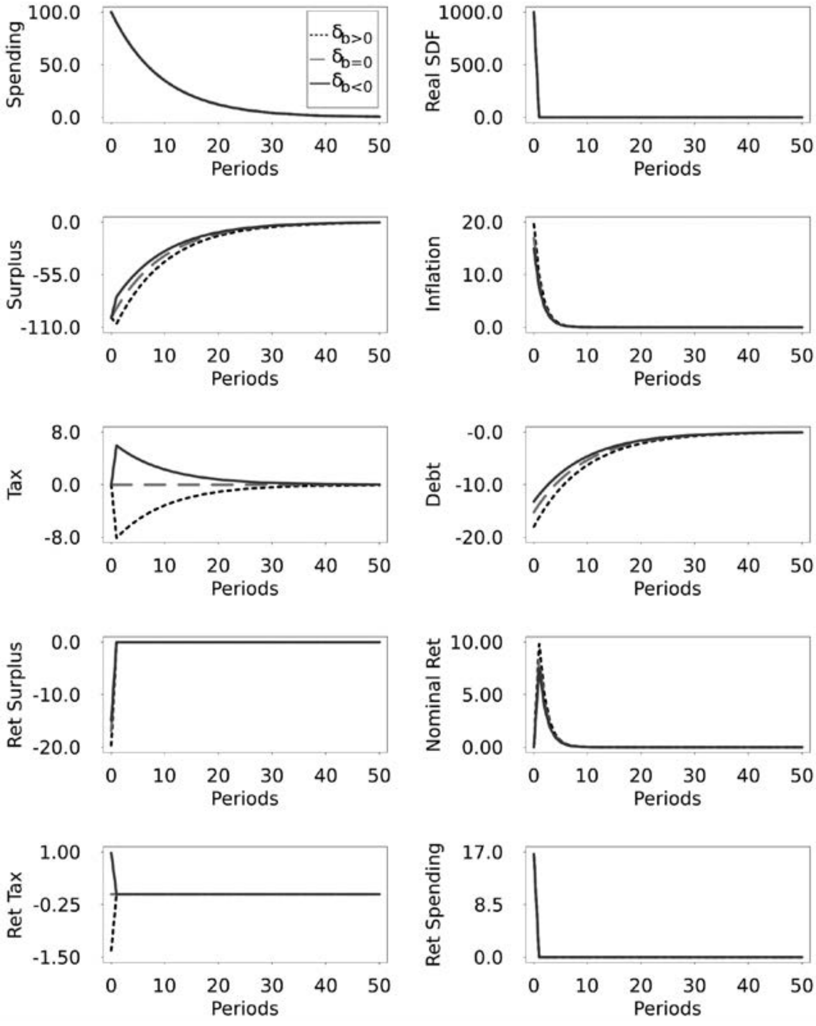
Notes: This figure illustrates how the real risk premium on government bonds varies with the tax rule coefficient on debt δ_b under fiscal dominance.

the real rate. In these models, households use the debt to self-insure against household-specific shocks (see, e.g. Aiyagari and McGrattan, 1998; Reis, 2021; Brunnermeier, Merkel, and Sannikov, 2022). We call this the broad convenience yield channel. We explore these channels in GCKLZ (2024).

In our stylized model, monetary policy does not affect real interest rates. Hanson and Stein (2015) document how monetary policy shocks impact long-term real yields through real term premia. They interpret this evidence as being consistent with segmented markets featuring a set of yield-oriented investors.[12] This variation in real rates may impact valuations in other asset markets as well (Bianchi, Lettau, and Ludvigson, 2022).

Finally, we have specified a Full Information Rational Expectations model in which investors know the nature of the monetary-fiscal regime and all the underlying parameters. That assumption puts a heavy burden on bond market investors to have known the full extent of the large drift in U.S. fiscal policy over the past decades.

Figure 4
Impulse Responses to a Spending Shock under Fiscal Dominance



Notes: This figure plots impulse responses to a positive spending shock ($\epsilon_t > 0$) under fiscal dominance for $\delta_b > 0$, $\delta_b = 0$, and $\delta_b < 0$. The variables correspond bps deviations from the stochastic steady state for real government spending (g_t), the log real SDF (m_t), real surpluses (s_t), log inflation (π_t), real tax revenues (τ_t), log real value of debt (b_t), log return on real surplus (r_{st}), nominal return on government debt ($r^{\$}_{gt}$), log return on the real tax claim ($r_{\tau t}$), and the log return on the real spending claim (r_{xt}).

It seems far more reasonable to assume that Treasury investors have been learning about the underlying parameters governing fiscal policy (see GCKL(2023)). Learning may help to account for the change in yield dynamics from the GFC to COVID.

In fact, in much of the post-World War II sample, U.S. Treasurys were priced as if the U.S. was in the safe debt regime, while the underlying cash flows, the primary surpluses, are risky and procyclical. There is a disconnect between the market's pricing of all Treasurys and the model-implied pricing of a hypothetical claim to surpluses. JLVX (2024b) conclude that the post-World War II valuation of U.S. Treasurys is hard to rationalize: Treasury yields seem too low, or equivalently, the valuation of all Treasurys seems too high relative to the underlying collateral, the PDV of surpluses, even when they include the seignorage from convenience on Treasurys. They refer to this as the U.S. debt valuation puzzle. Furthermore, the valuation of Treasurys seemed insensitive to the macro fundamentals, i.e., the PDV of future surpluses (JLVX (2024c)), which may be related to the unique role of the U.S. as the world's safe asset supplier. CJLVX (2022) find evidence of a similar valuation puzzle for the U.K. in the 19th century, which ended after World War I, when the U.S. took over the role of hegemon in the international financial system. After that, U.K. debt was fully backed by surpluses, but this changed during COVID.

From a welfare perspective, it may be optimal for governments to engineer negative returns when the economy is hit by large shocks that require increases in government spending, e.g., during wars and COVID pandemics (Lucas and Stokey, 1983; Angeletos, 2002; Buera and Nicolini, 2004; Jiang, Sargent, Wang, and Yang, 2022a), thus shielding taxpayers from large tax increases in models with distortionary taxation.

3. Fiscal Policy Response to COVID-19

The U.S. federal government's fiscal response to the COVID-19 pandemic was unprecedented. Between March and July 2020, in the first months of the COVID-19 pandemic, the U.S. federal government outspent all 29 countries in the sample of countries examined by Romer (2021). The U.S. federal government spent 11.9% of GDP in five months. Overall, the federal government implemented \$5.88 trillion in new spending through legislation, with a net impact of \$5.43 trillion on the budget. In addition, another \$875 billion in administrative measures were undertaken, with a net impact of

$232 billion on the budget. The total price tag of all these measures was $6.75 trillion. COVID-19 measures increased the deficit by $5.6 trillion or 26% of 2020 GDP.

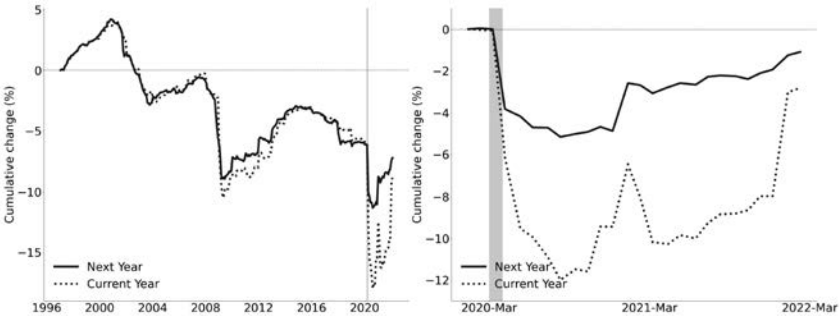
The Coronavirus Aid Relief Economic Security (CARES) Act passed by Congress on March 25, 2020, was the first large bill in a series of them. It was signed into law by President Trump on March 27. The CARES Act would end up costing $2.09 trillion. The government would spend $481 billion on income support, mainly expanded unemployment benefits, $440 billion on business support in the form of the Paycheck Protection Program, $274 billion on stimulus checks, direct cash payments of $1,200 to Americans making less than $75,000. CARES was followed by the $900 billion Response & Relief Act in December 2020 and the $2 trillion American Rescue Plan, signed into law by President Biden in March 2021. In November 2021, Congress passed an Infrastructure Investment and Jobs Act, which would cost $340 billion.

These large bills constitute a large and unexpected fiscal shock. Between March 9 and May 11, the respondents of the Consensus Economics survey revised their median estimate for the FY 2019/2020 deficit from $1.07 trillion (4.82% of 2020 GDP) to $3.15 trillion (14.31 % of GDP). At the same time, they revised their estimate for the FY 2020/2021 deficit from $1.08 trillion (4.92% of 2020 GDP) to $2.01 trillion (9.10% of 2020 GDP), shown in the right panel of Figure 5. Overall, between March and May, market participants inferred an increase in deficits of more than 10% of 2020 GDP over the next two years.

The left panel of Figure 5 extends the sample period back to 1997. Since 2001, analysts have consistently revised their forecasts downward for the current and next fiscal year, indicating a negative trend in the series. The 2020 revisions stand out as one of the largest declines, comparable in magnitude to those observed during the GFC.

The CBO released a long-term budget projection in January and September 2020. We compare the PDV of primary surpluses between January and September.[13] The CBO released its September long-term budget projections before the $900 billion Response &

Figure 5
Cumulative Revisions in Consensus Forecasts for U.S. Budget



Notes: This figure shows cumulative revisions in Consensus Economics forecasts for current and next fiscal year budget balances, expressed as a percentage of GDP. Forecasts are scaled by the most recent GDP value available at the time of each forecast. The left panel covers the sample period from January 1997 to February 2022, while the right panel focuses on the period from January 2020 to February 2022. The gray shaded area in both panels denotes March 2020.

Relief Act and the $2 trillion American Rescue Plan were considered by Congress. We compared the CBO long-term budget projections released in January and September 2020. Just in the first six months of the pandemic, the fiscal COVID shock implies a drop in the PDV of projected surpluses over the next ten years which is equivalent to 18.94% of 2020 GDP.

The COVID-19 pandemic also led to unprecedented levels of public spending across other advanced economies. Figure A.1 in the Appendix illustrates this trend by plotting cumulative Consensus Economics budget revisions for the U.K., France, and Germany. In the initial months of the pandemic, all three countries experienced substantial downward revisions to their budget forecasts. Germany and the U.K. saw revisions of approximately 14% of GDP, while France's revisions were around 8% of GDP.

3.1 Fiscal Backing of Government Debt

The Treasury portfolio's valuation should equal the PDV of all future primary surpluses. The debt in January 2020 is backed by primary surpluses ($\{\tau - g\}_{2020}^{2020+H}$), because the PDV of future debt, say H = 200 years from now, in 2020 dollars, is arbitrarily small. This is often referred to as the no-bubble condition or the transversality condition (TVC).[14]

If the government issues bonds that earn convenience yields, it will produce seigniorage revenue that equals the convenience yields collected on all the outstanding Treasurys. The present value of the seigniorage revenue $PV_{2020}(\{Seign\}_{2020}^{2020+H})$ should be added to the tax revenue.[15]

	Assets	Liabilities
Until 2020 + *H*	$PV_{Jan,2020}(\{\tau\}_{2020}^{2020+H})$	$PV_{Jan,2020}(\{g\}_{2020}^{2020+H})$
Until 2020 + *H*	$PV_{Jan,2020}(\{Seign\}_{2020}^{2020+H})$	
After 2020 + *H*	$PV_{Jan,2020}(\tilde{B}_{2020+H}) \rightarrow \$0$	
		$\tilde{B}_{Jan,2020} = PV_{Jan,2020}(\{\tau - g + Seign\}_{2020}^{2020+H})$

For the debt to be effectively risk-free (e.g., monetary dominance), investors have to anticipate a fiscal correction of exactly the same size to offset this increase in deficits, which could occur after 2029. In that case, they do not have to revise their debt valuation $\Delta PV_{Jan\rightarrow Sept,2020}(\{\tau - g + Seign\}_{2020}^{2020+H}) = 0$, for large H.[16] To rationalize Treasury valuations that are invariant to fiscal shocks, investors would have to believe in a future fiscal correction of \$4 trillion. The arrival of COVID in early March 2020 did not change the investors' perception of the PDV of future surpluses. In this case, the debt portfolio does not need to be marked to market. As of yet, there is no evidence of offsetting future surpluses. In June 2024, the CBO projected a debt/GDP ratio of 122% for 2034, up from 97% today. In post-war U.S. data, JLVX (2024c) found no evidence that a high debt/GDP ratio predicts high future primary surpluses, in contrast with the predictions of risk-free debt.

In the absence of any anticipations of a future fiscal correction (e.g., fiscal dominance with $\delta_b = 0$) not embedded in the September 2020 CBO projections, the valuation of Treasurys should drop by 18.8%: $\Delta \log PV_{Jan\rightarrow Sept,2020}(\{\tau - g\}_{2020}^{2029}) = \Delta \log \tilde{B}_{Jan\rightarrow Sept,2020}$.

4. Treasury Markets in the COVID-19 Pandemic

We analyze U.S. Treasury yield dynamics before and after March 2022 during the COVID-19 pandemic. We then compare these dynamics to sovereign debt markets in other advanced economies.

4.1 Broad Trends from 2020–2023 in U.S. Treasury Markets

Between February 2020 and October 2023, the portfolio of marketable Treasurys experienced significant losses, declining 26% in real terms and 15% in nominal terms, as illustrated in the left plot of Panel A in Figure 6. During this period, the 10-year nominal Treasury yield increased by 381 bps, as shown by the black line in the middle plot of Panel A of the same figure.

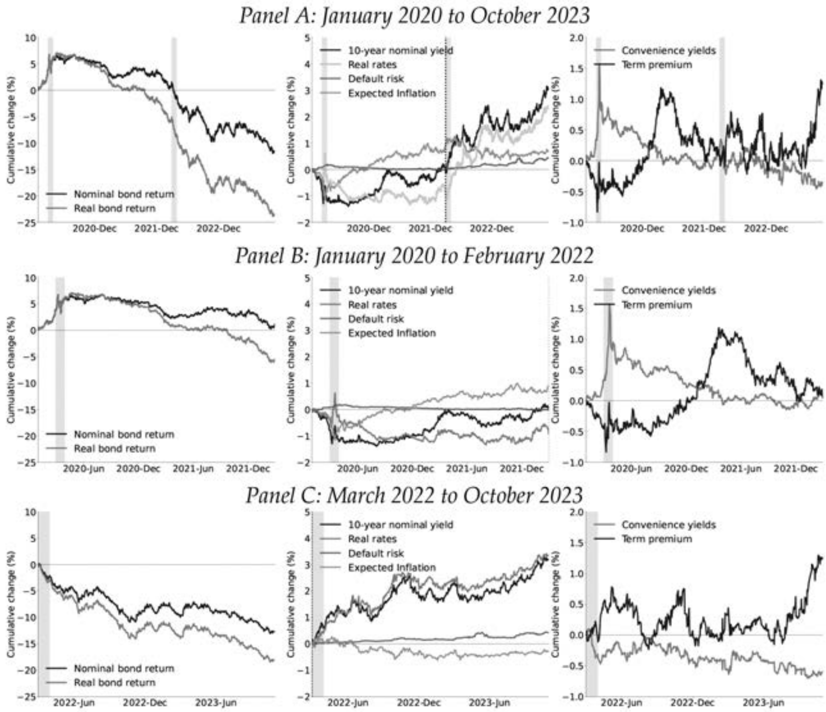
As explained in Section 2.1, the real return on the nominal government debt portfolio measures the real return on a claim to surpluses: $R^{real}_{March,2020\rightarrow Oct,2023}(\{\tau - g\}^{\infty}_{2020})$. During the COVID-19 pandemic, there is no evidence suggesting that the U.S. government insured bondholders. Instead, bondholders bore a significant share of the pandemic's burden, aligning with the Lucas and Stokey (1983) view.[17] This is evidenced by the 26% real-term value loss of the aggregate Treasury portfolio. The bond market effectively priced in a large unbacked fiscal expansion.[18]

We have observed similar patterns during wars in the U.S. and other countries. The COVID pandemic is comparable to wars from a fiscal and macroeconomic perspective (Hall and Sargent (2022b,a) and JLVX (2024a)). During large wars, governments ramp up spending. The increased spending is only partially offset by increased tax revenue.

The U.S. and U.K. governments certainly seem to favor protecting their taxpayers over bondholders from the fallout of wars. In World War I and World War II, the cumulative real return on U.S. Treasurys (in logs) is –36% from 1914–1918 and –12% from 1939–1945, compared to –26% during COVID. The cumulative real return in logs on U.K. debt is –60% from 1914–1918, –11% from 1939–1945, and –40% from 2020–2022 (JLVX (2024a)).

Panel A of Table 2 decomposes the 10-year yield increase into its main drivers, which are also illustrated in the middle and right plots of Panel A in Figure 6. The most significant contributor was the increase in real rates, with the 10-year TIPS yield rising by 271 bps. Expected inflation increased by 104 bps, while the term premium grew by 170 bps. Conversely, the AAA-Treasury spread, our measure of Treasury convenience yields, declined by 68 bps.

Figure 6
Cumulative U.S. Treasury Returns and Changes in U.S. Treasury Yields



Notes: The left panels present cumulative daily changes in nominal and real government debt portfolio returns, computed using methods similar to Hall and Sargent (2011). Real values are calculated by subtracting realized inflation over the period. The middle panels show cumulative daily changes in the 10-year nominal yield, real rates (10-year TIPS), default risk (10-year U.S. credit default swaps), and expected inflation (10-year inflation swaps). The right panels display cumulative daily changes in convenience yields (spread between long-term Aaa-rated corporate bonds and 10-year Treasury yields) and term premia (estimated using Adrian, Crump, and Moench (2013) methodology). Panel A covers January 1, 2020, to October 31, 2023. Panel B covers January 1, 2020, to February 28, 2022. Panel C covers March 1, 2022, to October 31, 2023. The gray-shaded areas denote March 2020 and March 2022.

In March 2022, the Federal Reserve announced its intention to start tightening. Columns (2) and (3) of Table 2 split the sample at this date, while Panels B and C in Figure 6 plot the cumulative changes in the series before and after March 2022, respectively. After March 2022, Treasury investors incurred a 15.11% loss. The analysis reveals a different timing in the expected inflation and real rate responses. Expected inflation exhibited a front-loaded increase of 127 bps before March 2022 but subsequently decreased by 23 bps. Conversely, the entire 271 bps increase in real rates occurred

Table 2
U.S. Treasury Returns and Changes in U.S. Treasury Yields

A. Cumulative changes from February 28, 2020, to October 30, 2023

		Break in March 2022	
	February 28, 2020 to October 30, 2023 (1)	February 28, 2020 to March 31, 2022 (2)	March 31, 2022 to October 30, 2023 (3)
Nominal bond returns	–14.56	–3.93	–10.48
Real bond returns	–26.35	–11.12	–15.11
10-year nominal yield	3.81	0.74	3.07
Real yield	2.71	–0.54	3.25
Default risk	0.37	–0.05	0.42
Expected inflation	1.04	1.27	–0.23
Convenience yield	–0.68	–0.15	–0.53
Term premium	1.70	0.50	1.20

B. Cumulative changes from March 9, 2020, to March 31, 2020

		Break in March 18, 2020	
	March 9, 2020 to March 31, 2020 (1)	March 9, 2020 to March 18, 2020 (2)	March 19, 2020 to March 30, 2020 (3)
Nominal bond returns	0.01	–2.54	1.71
Real bond returns	0.24	–2.43	1.84
10-year nominal yield	0.17	0.68	–0.52
Real yield	0.34	1.10	–0.76
Default risk	0.07	0.06	0.01
Expected inflation	–0.10	–0.42	0.32
Convenience yield	0.37	0.62	–0.24
Term premium	0.47	0.76	–0.29

Notes: This table presents cumulative changes in the following variables: nominal government debt portfolio returns, computed using procedures similar to Hall and Sargent (2011); the 10-year nominal yield; convenience yields, proxied by the spread between long-term Aaa-rated corporate bonds and 10-year Treasury yields; real rates, measured via 10-year TIPS; default risk, gauged through 10-year U.S. credit default swaps; expected inflation, captured by 10-year inflation swaps; and term premia, estimated employing the methodology outlined in Adrian et al. (2013). All values are in percentage points.

after the March 2022 quantitative tightening announcement. In fact, real yields rose by 325 bps from March 2022 to the end of the sample period.

The large increase in real rates after March 2022 is consistent with the price support provided by the Fed to Treasurys before that date and the tightening of monetary policy afterward. In contrast, prior to March 2022, the real yield declined by 54 bps. The strong effects of monetary policy on long-term real yields accord with the evidence from Hanson and Stein (2015) and Nakamura and Steinsson (2018).

Over this entire period, Treasury convenience yields declined by 68 bps. Table 3 presents various measures of the convenience yield,

Table 3
Different Measures of Convenience Yield

A. Cumulative changes from February 28, 2020, to October 30, 2023

		Break in March 2022	
	February 28, 2020 to October 30, 2023 (1)	February 28, 2020 to March 31, 2022 (2)	March 31, 2022 to October 30, 2023 (3)
10-year AAA-Treasury spread	–0.68	–0.15	–0.53
AAA/AA CDS adjusted — Treasury spread	–0.32	–0.03	–0.29
3-month GC rate — Treasury spread	–0.02	0.01	–0.03

B. Cumulative changes from March 9, 2020, to March 31, 2020

		Break in March 18, 2020	
	March 9, 2020 to March 31, 2020 (1)	March 9, 2020 to March 18, 2020 (2)	March 19, 2020 to March 30, 2020 (3)
10-year AAA-Treasury spread	0.37	0.62	–0.24
AAA/AA CDS adjusted — Treasury spread	0.22	0.74	–0.52
3-month GC rate — Treasury spread	–0.11	0.32	–0.43

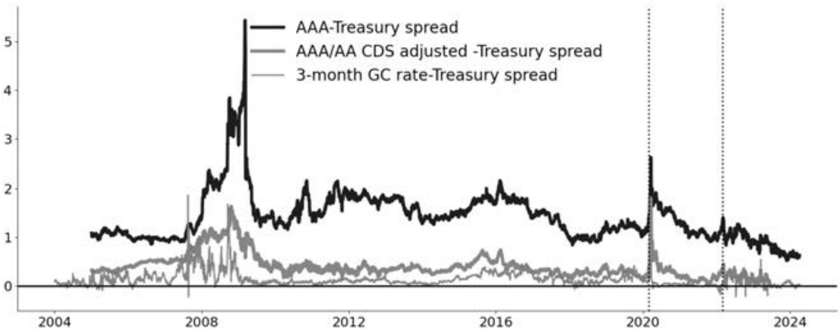
Notes: This table presents cumulative changes in three measures of convenience yield. The first is the 10-year AAA corporate-Treasury spread. The second, AAA/AA CDS adjusted — Treasury spread, comes from Mota (2023) and is computed by hedging the credit risk for each senior corporate bond using a maturity-matched CDS. This convenience yield is calculated as the spread between the resulting synthetic corporate bond and a duration-matched U.S. Treasury bond, then aggregated at the AAA/AA rating bucket using face values as weights. The third measure is the 3-month GC rate-Treasury spread, denoting the difference between three-month General Collateral (GC) repo contract rates and the three-month Treasury Bill rate. The AAA/AA CDS adjusted — Treasury spread series covers February 28, 2020 to June 16, 2023. All values are in percentage points.

including the 10-year AAA corporate-Treasury spread, its CDS-adjusted version,[19] and the 3-month GC Treasury spread for shorter maturities. The CDS-adjusted AAA-Treasury spread decreased by 32 bps over the entire sample, approaching zero by the end of the period. This indicates that investors became nearly indifferent between holding synthetic and actual Treasurys, effectively eliminating the convenience yield for longer-maturity Treasurys.

Figure 7 illustrates the AAA-Treasury spread from before the GFC. During the GFC, the AAA-Treasury yield spread surged to over 300 bps. However, it has been trending downward since then, despite large Federal Reserve Treasury purchases. While it briefly spiked in early March 2020, the spread continued to decline during the COVID episode, in contrast to what happened during the GFC, approaching zero by 2023.

Even if the debt has zero beta, the increased supply of debt would decrease convenience yields if investors derive utility from

Figure 7
Convenience Yield on U.S. Treasurys



Notes: This figure shows two different measures of convenience yields. The black line uses as a proxy for convenience yields the spread between 10-year AAA corporate and Treasurys. The dark gray line is the CDS-adjusted version of the AAA/AA-Treasury spread as in Mota (2023). The thin gray line denotes the 3-month GC rate-Treasury spread. The vertical dotted lines denote March 2020 and March 2022.

their holdings of Treasurys. Using variation in yields around CBO releases, GCKL(2023) estimate that a percentage point increase in the expected Treasury supply to GDP corresponds to a –7.56 bps (= –0.09/1.19 × 100 bps) response in the convenience yield on large negative legislative proposal days.

The news released in March represented an enormous fiscal shock. The 10.38% of GDP increase in Treasury supply implied by the Consensus forecast revision between March 9 and April 6, 2020 translates into a 78 bps decrease in convenience yields. For comparison, Krishnamurthy and Vissing-Jorgensen (2012) estimate a smaller elasticity of –4.25 bps per percentage point increase in Treasury supply, implying a smaller decrease of 44 bps. However, the Fed started its large-scale asset purchases, absorbing much of the initial increase in supply. As reported in Table 2, the convenience yield decreased by 68 bps over the entire 2020–2023 sample.

4.2 Broad Trends from 2020–2023 in Other Advanced Economies

The U.S. bond market experience during COVID-19 was mirrored in other major economies. Table 4 shows similar sovereign bond yield dynamics in the U.K., Germany, and France from March 2020 to October 2023. These countries saw increases in nominal

Table 4
Cumulative Returns and Changes in Yields in Other Countries

A. United Kingdom

		Break in March 2022	
	February 28, 2020 to October 30, 2023 (1)	February 28, 2020 to March 31, 2022 (2)	March 31, 2022 to October 30, 2023 (3)
Real Bond Return	–43.57	–14.07	–34.32
10-year nominal yield	4.82	1.74	3.08
Real yield	3.58	–0.19	3.78
Expected inflation	0.50	1.19	–0.69
Default risk	0.12	–0.10	0.22

B. Germany

		Break in March 2020	
	February 28, 2020 to October 30, 2023 (1)	February 28, 2020 to March 31, 2022 (2)	March 31, 2022 to October 30, 2023 (3)
Real Bond Return	–32.24	–12.13	–22.89
10-year nominal yield	3.12	0.51	2.61
Real yield	1.92	–0.48	2.40
Expected inflation	1.35	1.31	0.04
Default risk	0.04	–0.08	0.12

C. France

		Break in March 2020	
	February 28, 2020 to October 30, 2023 (1)	February 28, 2020 to March 31, 2022 (2)	March 31, 2022 to October 30, 2023 (3)
Real Bond Return	–30.94	–11.08	–22.33
10-year nominal yield	4.00	1.25	2.75
Real yield	2.12	–0.89	3.00
Expected inflation	1.79	1.31	0.48
Default risk	–0.02	–0.08	0.06

Notes: This table presents cumulative changes in the 10-year nominal yield, real rates, breakeven expected inflation, and credit default swaps for three countries. Panel A displays results for the United Kingdom, Panel B for Germany, and Panel C for France. All values are in percentage points.

yields of 482 bps, 312 bps, and 400 bps, respectively, compared to 381 bps in the U.S. As in the case of the U.S., these increases were largely driven by rising 10-year real rates: 358 bps in the U.K., 192 bps in Germany, and 212 bps in France. Expected inflation also rose during this period by approximately 50 bps in the U.K., 135 bps in Germany, and 179 bps in France. Consequently, investors holding sovereign bonds have experienced real losses of 43% in the U.K., 32% in Germany, and 31% in France.

The timing of these changes was also similar across countries. Expected inflation increases were front-loaded in the first year of the pandemic, while real rate increases were heavily back-loaded. Before March 2022, real yields declined by 89 bps in France, 48 bps in Germany, and 19 bps in the U.K. After March 2022, real yields surged by 300 bps in France, 240 bps in Germany, and 378 bps in the U.K.

4.3 U.S. Treasury and Other Bond Markets in March 2020

This section analyzes the bond yield dynamics in the U.S. and other advanced economies in March 2020. The U.S. experience aligns closely with international trends, suggesting that impaired the functioning of U.S. Treasury markets alone cannot fully explain the spike in U.S. Treasury yields in early March.

Between March 9 and March 18, 2020, the nominal 10-year U.S. Treasury yield rose by 68 bps. Panel B of Table 2 decomposes this increase into its main drivers. The real yield increased by 110 bps, while expected inflation decreased by 42 bps.

Similar yield dynamics were observed in other advanced economies during this period. Table 5 presents a comparable decomposition for the U.K., Germany, and France. Their 10-year nominal yields increased by an average of 64 bps, with real 10-year yields rising even more sharply, averaging an 86 bps increase across the three countries. Conversely, the 10-year expected inflation decreased by an average of 18 bps in these nations.

There are two ways to view the response of Treasury markets to the COVID shock in March 2020. Table 1 provides a taxonomy of government debt regimes.

First, we can adopt the safe or zero beta debt view. Viewed through this lens, Treasury markets were dysfunctional in March 2020. The yield on the 10-year T-Note increased by 68 bps over the course of eight trading days between March 9 and March 18. A typical one-standard deviation movement in a single day would be five basis points. Treasury yields increased as stocks were declining in value and as the VIX peaked, a departure from the typical negative U.S. stock-bond correlation (Campbell et al., 2020).

These yield dynamics stood in sharp contrast to the GFC when flight-to-safety demand pushed up Treasury valuations (He and

Table 5
Cumulative Changes in Yields and Returns in Other Countries During March 2020

A. United Kingdom

		Break in March 18, 2022	
	March 9, 2020 to March 31, 2020 (1)	March 9, 2020 to March 18, 2022 (2)	March 19, 2022 to March 30, 2023 (3)
10-year nominal yield	0.20	0.63	–0.43
Real yield	0.08	0.72	–0.64
Expected inflation	0.08	–0.10	0.18
Default risk	0.12	0.20	–0.08

B. Germany

		Break in March 18, 2022	
	March 9, 2020 to March 31, 2020 (1)	March 9, 2020 to March 18, 2022 (2)	March 19, 2022 to March 30, 2023 (3)
10-year nominal yield	0.38	0.60	–0.22
Real yield	0.50	0.87	–0.37
Expected inflation	–0.13	–0.24	0.11
Default risk	0.06	0.11	–0.05

C. France

		Break in March 18, 2022	
	March 9, 2020 to March 31, 2020 (1)	March 9, 2020 to March 18, 2022 (2)	March 19, 2022 to March 30, 2023 (3)
10-year nominal yield	0.37	0.71	–0.34
Real yield	0.64	1.00	–0.37
Expected inflation	–0.04	–0.22	0.18
Default risk	0.09	0.20	–0.11

Notes: This table presents cumulative changes in the 10-year nominal yield, real rates, breakeven expected inflation, and credit default swaps for three countries. Panel A displays results for the United Kingdom, Panel B for Germany, and Panel C for France. All values are in percentage points.

Krishnamurthy, 2020; He et al., 2022). Typically, during these episodes, Treasurys become more expensive relative to other securities. However, in early March 2020, Treasurys became cheaper. He et al. (2022) refers to a Treasury inconvenience yield. According to He et al. (2022); Duffie (2023), primary dealers had exhausted their balance sheet capacity as investors sold U.S. Treasurys in a dash for cash (Vissing-Jorgensen, 2021). This 'plumbing view' motivates why the Fed has to step in and use its balance sheet to intermediate in U.S. Treasury markets, essentially taking over intermediation from primary dealers. This perspective implicitly assumes that debt is risk-free or has zero beta. As explained, the government faces a trade-off between insuring taxpayers and bondholders against adverse macro shocks, such as wars and pandemics (JLVX (2020)). The 'plumbing view' implicitly relies on the assumption that the government and the central bank choose to insure bondholders and force taxpayers to bear most of the macro risk.

Second, we can view the government debt portfolio as risky when investors expect government spending to be partially unfunded, as we showed in Section 2.4. Viewed through this lens, the bond market was reappraising the value of the Treasury portfolio. This view is supported by the empirical evidence from other countries and other episodes. As investors learned about the scale of the government's massive fiscal effort, the fiscal news was priced into Treasury yields, causing yields to rise as investors marked the Treasury portfolio to market. Yield increases could reflect an increase in expected inflation, a rise in the bond risk premium, a higher default risk premium, or an increase in real rates.

This mark-to-market process for Treasurys would have started in March 2020 when Treasury yields started to climb. Market observers were preparing for large increases in the supply of U.S. Treasurys.

4.4 Price Support

Between March 9 and March 18, 2020, the U.S. 10-year Treasury note yield rose by 68 bps, causing a 2.54% loss in value for the Treasury portfolio (Panel B, Table 2). This mark-to-market process was suspended in mid-March. As pointed out by Hall and Sargent (2022b), the Fed's response to COVID is similar to that in World War I and World War II, characterized by a massive expansion of its balance sheet through asset purchases, effectively providing price support to government bonds.

The Fed started an expansion of its balance sheet in mid-March 2020. On March 15, the Fed announced Treasury purchases of at least $500 billion and Mortgage Backed Security purchases of $200 billion 'To support the smooth functioning of markets for Treasury securities and agency mortgage-backed securities that are central to the flow of credit to households and businesses, over the coming months.' On March 23, the FOMC added that its purchases were open-ended. The Federal Reserve ended up buying $2.7 trillion in long-term Treasurys, $1.36 trillion in Mortgage-backed Securities, funding an additional $447 billion in liquidity measures, $110 billion in other loan purchases, and $88 billion in lending facilities.

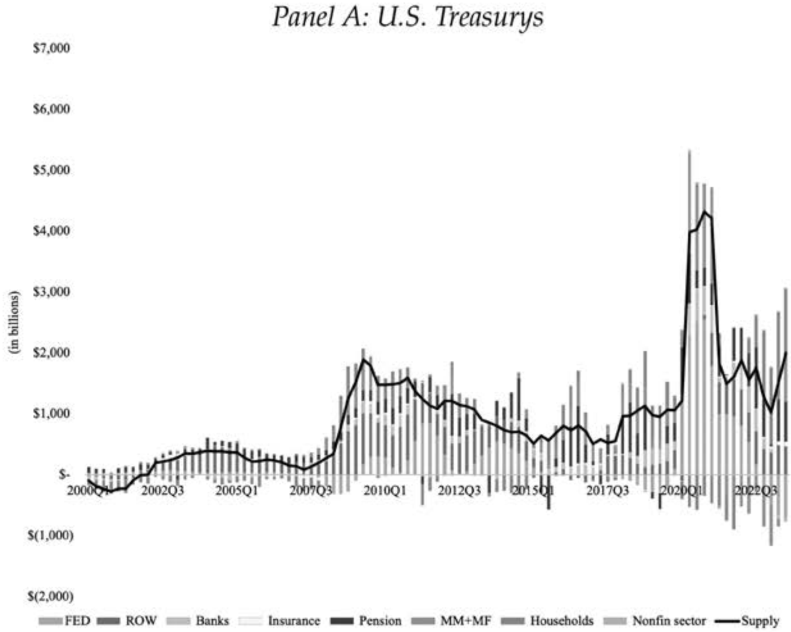
The Fed absorbed a significant fraction of the total issuance of U.S. Treasurys (including T-bills, Bonds, and Notes) starting in March 2020. Panel A of Figure 8 plots a 4-quarter moving average of purchases by sector. The flows are annualized. At the peak in 2020 Q4, the Treasury was issuing $4.3 trillion per year. The Fed was absorbing Treasurys at a rate of $2.5 trillion per year. The household sector and the ROW were selling Treasurys in 2020Q1. The purchases by money market funds are exclusively T-bills, not Notes and Bonds. Money market and mutual funds were selling Notes and Bonds in Q1. Panel B excludes T-bills. The Fed was buying more than the Treasury's issuance from Q2 to Q4 in 2020. For example, in 2020 Q4, the Fed was purchasing Notes and Bonds at a rate of $2.4 trillion per year, which exceeded the annual rate at which the Treasury was issuing these securities of $1.77 trillion per year. Excluding T-bills, the Fed had absorbed 99% of Bond and Note issuance between 2020Q1 and 2021Q1, regularly purchasing much more than what was being issued by the Treasury.

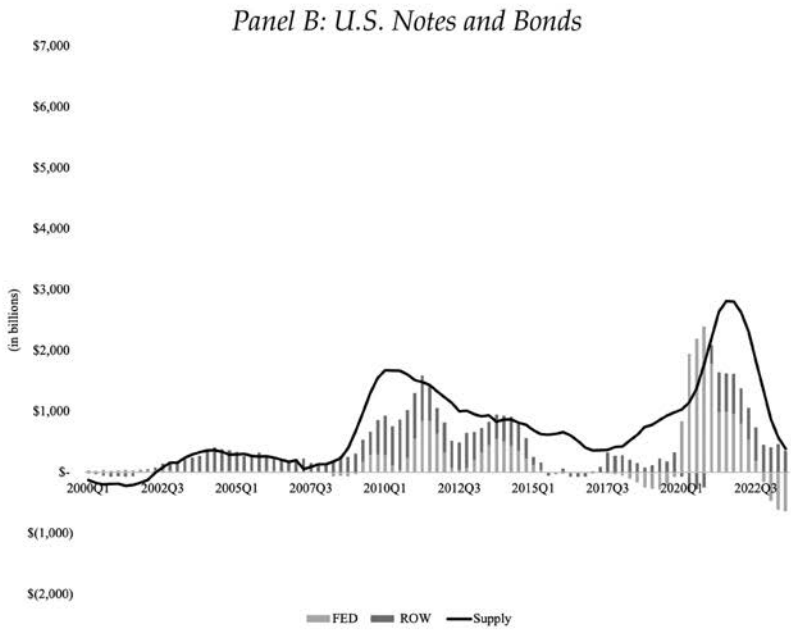
At the longer end of the yield curve, the Fed was crowding out all other investors.[20]

The mark-to-market process only really resumed in March 2022, when the Fed announced an end to its balance sheet expansion program. Consistent with our price support interpretation, there is no evidence the Fed was buying under-priced securities prior to March 2022. The Fed reported mark-to-market losses of $1.08 trillion in 2022 — $672 billion on the Treasury portfolio; the rest on agency and GSE MBS — and $948 billion in 2023 — $585 billion on the Treasury portfolio — on its portfolio of securities.[21] The large-scale asset purchases destroyed value from the perspective of taxpayers.

In buying these long-dated bonds, the Fed reduced the duration of the consolidated government's IOUs by substituting bank reserves held at the Fed for long-dated Treasurys, thus adding a massive fixed-for-floating interest rate swap to the government's balance sheet, where the government pays floating and receives fixed, rather than

Figure 8
Purchases and Issuance of U.S. Treasurys





Notes: Plots a 4-quarter moving average of U.S. Treasury purchases by sector. The flows are annualized. The units are in billions. Panel A aggregates all U.S. Treasurys. Panel B excludes T-Bills. *Source:* U.S. Flow of Funds. Table F210.

locking in historically low long rates by extending the duration. The central bank's mark-to-market losses measure the cost to taxpayers of reducing the duration (JLVX (2022)).

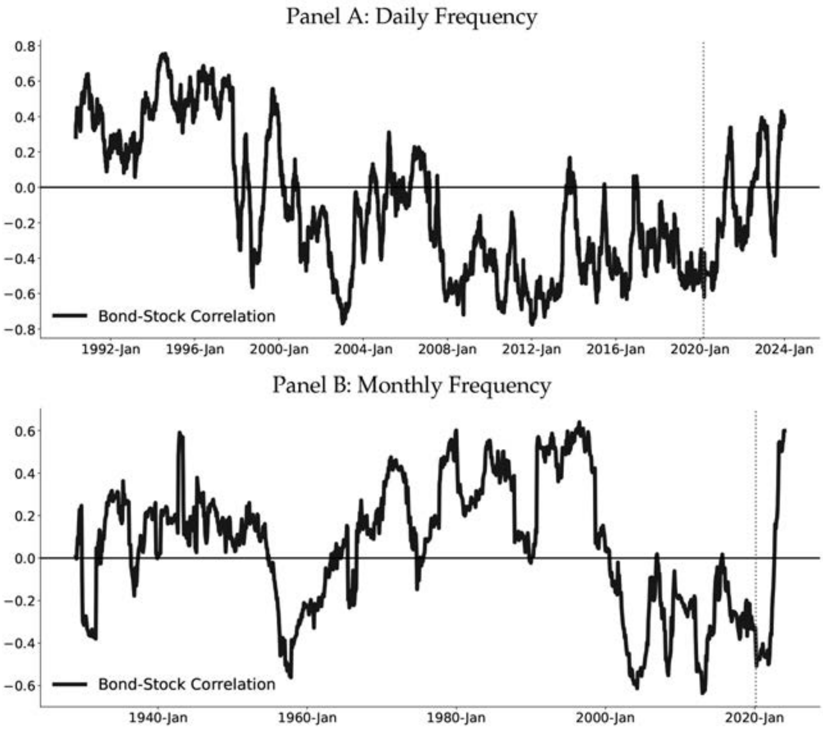
There is a normative literature on optimal taxation and public debt management starting with Barro (1979)'s seminal work on tax smoothing. Risky debt is not undesirable. In their normative analysis, Lucas and Stokey (1983) argued that returns on debt should be negative in the case of large spending shocks, such as wars. From an optimal taxation perspective, risky debt may be optimal because it shifts part of the fiscal burden in the face of large spending shocks onto bondholders while shielding taxpayers (Lucas and Stokey, 1983; Angeletos, 2002; Buera and Nicolini, 2004). Long-term nominal debt may be particularly useful in shielding taxpayers from large spending shocks, as increases in expected future inflation reduce the market value of debt (Lustig et al., 2008). Large-scale asset purchases transfer these bondholder losses back to taxpayers.

4.5 Stock-Bond Correlation

Consistent with the risky debt regime under fiscal dominance, U.S. Treasury investors revised their assessment of Treasury riskiness. The U.S. stock-bond correlation, consistently negative since 1998 (including the 2008 GFC),[22] switched to positive around March 2020. Figure 9 illustrates this shift in correlation using returns from the entire U.S. Treasury bond portfolio and an aggregate stock market index. Panel A, based on daily data, shows the correlation changing from –0.6 to 0.4. Panel B, using monthly data, demonstrates a change from –0.4 to 0.6. Figure A.4 in the Appendix shows similar patterns for the U.K., Germany, and France.

The shift in bond riskiness should have prompted rational U.S. Treasury investors to reassess their Treasury portfolios. As Treasuries transitioned from a hedge to an equity-like instrument, rational long-horizon investors would have recognized that Treasury allocations now increased their overall portfolio risk. Holding expected returns constant, investors would have reduced their exposure to long-dated Treasuries, and the expected returns on long-dated Treasuries would have needed to increase.

Figure 9
U.S. Bond-Stock Correlation



Notes: Panel A shows rolling correlations between bond and stock returns over a three-month window. The bond returns are calculated using daily log returns on the portfolio of U.S. government debt, while the stock returns are based on the daily log returns, including dividends of the S&P 500 value-weighted stock market index. The gray vertical line denotes March 2020. The sample ranges from January 1990 to December 2023. Panel B shows rolling nominal correlations between bond and stock returns over a three-year window. The bond returns are calculated using monthly log returns on the portfolio of U.S. government debt, while the stock returns are based on the monthly log returns, including dividends of the S&P 500 value-weighted stock market index. The sample ranges from January 1926 to December 2023.

The repricing in early March with the Treasury yield spiking is reinforced by the switch in the stock-bond correlation. However, central banks, including the Fed, paused that adjustment by absorbing more than issuance at the long end of the maturity spectrum, effectively controlling the long end of the yield curve. The term premium eventually did increase by 170 bps. However, 120 bps of that increase came after March 2022.

4.6 Flight from Maturity in Treasury Markets

Long-horizon investors want a larger bond risk premium in light of the increased riskiness. However, the Fed paused the repricing. As a result, long-horizon investors sold long-term bonds. We establish three stylized facts. First, in 2020 Q1, selling in U.S. Treasury markets was concentrated exclusively at longer maturities. Second, foreign investors conducted the majority of this selling. Third, there was no corresponding sell-off in U.S. corporate bonds. We characterize this phenomenon as the (foreign) flight from maturity in U.S. Treasury markets.

We start by analyzing the evidence from the Flow of Funds data more closely. Figure A.5 in the Appendix plots purchases of U.S. Treasurys, including T-Bills, during the pandemic. In the first quarter of 2020, the Federal Reserve purchased \$1.019 trillion, \$863 billion of which was in the form of Notes and Bonds. Other investors were selling Treasurys during the first quarter, including the U.S. household sector (\$372 billion) and foreign investors (\$284 billion). In Q2, the Fed followed up by purchasing another \$1.03 trillion, all of which were Notes and Bonds. In the second quarter, money market and mutual funds started buying T-bills (\$1.35 trillion), but they were still selling Notes and Bonds (\$71 billion).

As shown in Figure 8, the COVID episode looks quite different from the GFC. Early on in the GFC during 2008, the Treasury benefited from significant purchases of Treasurys by foreign investors (ROW). In the first quarter of the COVID-pandemic, the ROW was selling Notes and Bonds. Next, we analyze the TICS data to take a closer look at the rest of the world's purchases of Treasurys. To add more detail, Figure A.6 in the Appendix plots the monthly net purchases of U.S. bonds by foreign investors computed using the Bertaut and Judson (2014) TICS data. In March 2020, foreign investors sold more than \$400 billion of U.S. Treasury Notes and Bonds, a 7-sigma decline in holdings –standard deviations measured over the 2012–2022 sample. In April 2020, foreign investors sold another \$200 billion. Importantly, foreign investors were not selling corporate bonds or agency bonds.

Finally, we use EMAXX data on the holdings of institutional investors to analyze the maturity composition of bond sales.[23] The selling of Treasurys at the start of COVID by foreign private investors was concentrated at longer maturities above ten years. Figure 10 plots the changes in the par value of Treasury Notes and Bonds (excluding T-bills) by maturity. Private investors sold 14% of their holdings in the longest maturity bucket. This pattern is quite different from what happened during the Great Financial Crisis, as can be seen from Figure A.7 in the Appendix.

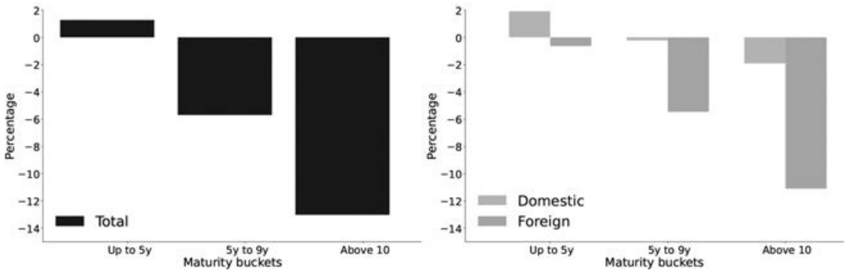
We do not observe a similar pattern across maturities in institutional investors buying and selling of corporate bonds. Corporate bond sales by institutional investors were concentrated at the short end of the maturity spectrum. Interestingly, we find that the main sellers of U.S. Treasurys were buying both U.S. and non-U.S. corporate bonds during 2020Q1 and continued afterward. Figure A.9 shows the same results for U.S. corporate bond holdings. We find that institutional investors bought long-term (above six years) U.S. corporate bonds and slightly sold short-term (below six years) U.S. corporate bonds.

If the plumbing view is correct, investors who sold in early March 2020 should have realized lower dollar-weighted returns due to selling at distressed prices. To test this conjecture, we used the EMAXX dataset to compute dollar-weighted returns between 2019:Q4 and 2022:Q4 for investors who sold and did not sell U.S. Treasury Notes and Bonds in 2020:Q1, following Dichev and Yu (2011). The results indicate that investors who sold during 2020:Q1 realized dollar-weighted returns of –1.40% on their notes and bonds investments, compared to –3.70% for those who did not sell. For notes and bonds with a duration above five years, the dollar-weighted returns were –1.60% for sellers versus –5.31% for non-sellers. For context, during the same period, the Federal Reserve's dollar-weighted returns on U.S. Treasuries (excluding T-bills) were –7.73%.

5. Safe or Risky? High-frequency Evidence

This section examines high-frequency evidence demonstrating that Treasury yields responded significantly to fiscal news releases during

Figure 10
Change in Institutional Investor Holdings of U.S. Bonds and Notes



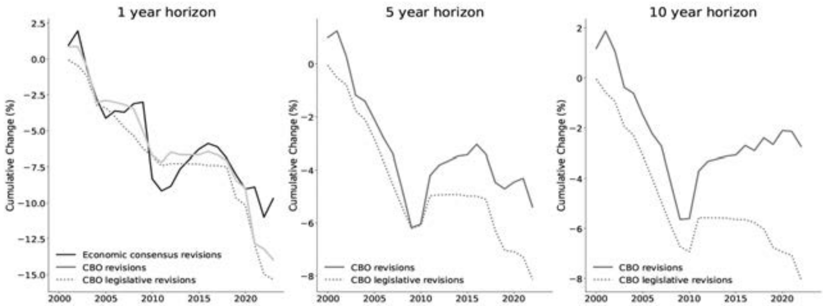
Notes: Change in holdings of U.S. Bonds and Notes as a percentage of total holdings in each maturity bucket. The right panel separates the change in Treasury holdings into foreign and domestic investors. The changes shown are for 2020Q1. Based on EMAXX Holdings data.

the COVID-19 pandemic. These findings are inconsistent with a safe debt regime but align with a risky debt regime.

We adopt the high-frequency identification strategy of GCKL(2023) who construct a measure of a proposal's budgetary impact by aggregating the cash flow estimates for each CBO cost release.[24] We extend their sample to include data up to 2023 and augment the CBO cost releases with time-stamped news on fiscal spending sourced from Bloomberg. For a Bloomberg article to be included in our sample, we apply strict classification criteria, requiring that the article's title contains news directly related to spending and specify the total amount. An example of such a title would be "EXTRA: U.S. Senate reaches deal on new stimulus worth 480 billion dollars."[25]

We focus on fiscal news directly linked to legislative actions, as these have been the primary drivers of deficits over recent decades. The left panel of Figure 11 illustrates this point. The black line plots the Economic Consensus cumulative revisions for the next fiscal year's deficit (similar to Figure 5), while the gray line shows cumulative revisions in CBO baseline budget projections from the Budget and Economic Outlook report. CBO categorizes its baseline budget projection revisions into legislative, economic, and technical components. The dashed line represents cumulative budget revisions resulting from laws enacted since the CBO's previous baseline projections.

Figure 11
Cumulative U.S. Budget Revisions in Consensus Forecast and CBO Projections



Notes: This figure displays cumulative revisions in budget forecasts, scaled by GDP, from Consensus Economics (black line) and CBO projections (gray solid line). The dotted line represents cumulative changes from the budgetary effects of laws enacted since the CBO's previous baseline projections. All forecasts/projections are scaled by the most recent CBO GDP forecast for the corresponding horizon. The left panel shows the one-year ahead budget balance forecast, while the middle and right panels display the 5-year and 10-year CBO projections, respectively. The sample goes from 2000 to 2023.

Both analysts and the CBO have consistently revised their deficit forecasts and projections downward, with Economic Consensus forecast revisions closely tracking CBO projection revisions. The dotted line in Figure 11 indicates that legislative actions account for the majority of these revisions. The middle and right panels of the same figure display cumulative CBO projection revisions for 5 to 10-year horizons. While these longer horizons do not exhibit the business cycle patterns seen in shorter horizons, they still show consistent downward revisions over the past two decades. Notably, these long-term revisions are primarily driven by new legislative actions with persistent effects spanning multiple years.

Table 6 presents the average daily change and cumulative effect in Treasury values around large negative proposals using CBO and Bloomberg news from February 28, 2020, to October 30, 2023. Following GCKL(2023), large bills are identified as those above the median CBO cost estimate, and this cutoff is also used to select relevant Bloomberg news. Columns (1) to (3) report the average daily change and cumulative effect over the sample period for all trading days, non-deficit announcement days, and deficit announcement days, respectively. On large deficit days, the Treasury portfolio falls by

Table 6
Changes in U.S. Treasury Values on Large Deficit Days

	All days	Other days	Deficit days	Deficit days and controlling for other news		
	(1)	(2)	(3)	(4)	(5)	(6)
Mean bps	–1.58	–0.54	–4.10	–4.70	–6.65	–8.34
t-statistic	[–1.98]	[–0.54]	[–2.81]	[–2.53]	[–2.84]	[–2.09]
p-value	–	–	(0.03)	(0.02)	(0.04)	(0.04)
Cumulative change in %	–14.55	–3.55	–11.00	–10.91	–5.25	–3.67
p-value	–	–	(0.03)	(0.02)	(0.04)	(0.04)
Observations	922	654	268	232	79	44
			Controls			
FOMC days			No	Yes	Yes	Yes
Large Macro News			No	No	Yes	Yes
Small Macro News			No	No	No	Yes

Notes: This table presents the average daily and cumulative changes in Treasury values across three sets of days: all trading days (Column 1), days without large deficit announcements (Column 2), and days with large deficit announcements (Column 3). Columns 4 through 6 control for other news occurring on the same day as the large deficit announcements by excluding those days and re-computing the changes in Treasury values. Column 4 excludes large negative deficit days that overlap with FOMC meeting days. Column 5 further excludes days with large news from macroeconomic announcements, while Column 6 excludes days with both large and small news from macroeconomic announcements. Macroeconomic news is categorized as large (small) when the absolute value of the analysts' forecast error exceeds (falls below) its rolling window median for each of the top 50 macroeconomic indicators. *t*-statistics are in square brackets. Parentheses report the percentage of simulated Treasury value changes that fall below the actual realizations, based on 10,000 samples generated by randomly selecting, without replacement, the number of observations in the actual sample for large deficit days and calculating the average daily and cumulative changes in Treasury values for each sample. The sample goes from February 28, 2020 to October 30, 2023.

an average of –4.1 bps (*t*-statistic = –2.81), with a cumulative effect of –11.0% out of the total –14.5% decline shown in Column (1) (see also Column (1) of Table 2). Table A.3 in the Appendix shows that the mean Treasury value change on deficit days is 3.56 bps lower than on other days, with the difference being statistically significant (*t*-statistic = –2.15).

Our identifying assumption is that on large deficit days, the information contained in the CBO and Bloomberg News is the main driver of changes in Treasury valuations. However, other relevant news coinciding with deficit days could also be driving changes in Treasury values on these days. Columns (4) to (6) progressively add more stringent controls. Column (4) excludes Treasury value changes that occur on large deficit days but fall within a three-day window around FOMC announcements. Column (5) further excludes days with large news from macroeconomic announcements, while Column (6) excludes days with both large and small news from macroeconomic announcements. Macroeconomic news is categorized as large (small) when the absolute value of the analysts' forecast error exceeds (falls below) its median value for each of the top 50 macroeconomic indicators.[26]

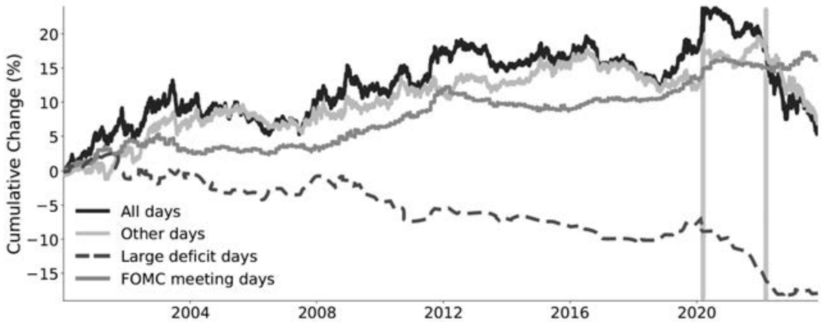
Table 6 demonstrates that as we move from column (4) to column (6), the average daily effect of fiscal news doubles in magnitude from –4.03 bps (t-statistic = –2.58; Column 4) to –8.34 bps (t-statistic = –2.09; Column 6), while the number of relevant days drops from 232 to 44. This evidence suggests that we are indeed measuring the effect of fiscal news on Treasury valuations, as other days with relevant news for Treasuries generate background noise, introducing attenuation bias.[27]

Figure 1 plots the cumulative returns around the large deficit days after controlling for FOMC meeting days and large macro announcements, helping us better understand when the drop in Treasury valuations occurs. As shown in the figure, the effect of adverse fiscal news consistently decreases Treasury valuations throughout the pandemic. Notably, prior to March 2022 (highlighted by the gray shaded area), Treasury values were increasing on other days. After adding the FOMC and macro controls, around 36 percent of the overall –14.55% drop in Treasury valuations occurred on days with large deficit announcements, despite these days accounting for only about 8.5 percent (=79/922) of the sample's trading days.

Figure 12 expands the sample to include the two decades prior to 2020, as in GCKL(2023). The figure plots the cumulative change in Treasury values on three non-overlapping sets of days: the gray line represents the three days centered around FOMC meetings, the dashed line depicts large deficit days measured by CBO cost projections that do not coincide with FOMC meeting days, and the light gray line shows cumulative changes on other days. The black line illustrates the cumulative change on all trading days.

The cumulative change in the Treasury portfolio valuation on large negative proposal days exhibits a smooth downward trend over the extended sample, implying that the effects are attributed to a consistent flow of fiscal news rather than a few large observations. Notably, between March 2020 and March 2022, indicated by the two gray shaded bars, the effect is much larger, as shown by the significant

Figure 12
Cumulative Changes in the Valuation of U.S. Treasurys



Notes: This figure shows the cumulative change in Treasury values across four distinct sets of days. The black line represents the cumulative change using all trading days. The gray line plots the cumulative change using a three-day window around FOMC meeting days. The dashed line shows the cumulative change on large deficit days measured by the release of above-median CBO cost projections that do not coincide with the three-day window around FOMC meeting days. The light gray line depicts the cumulative change on all remaining trading days. The vertical gray-shaded areas denote March 2020 and March 2022. The sample covers 2000 to 2023.

steepening of the dashed line. During the COVID period, Treasury values increased on other days and remained largely flat during FOMC announcement days. Hence, the overall value changes observed during this time, as shown by the black line, were primarily driven by fiscal news.

The gray line in Figure 12 shows that on FOMC meeting days, Treasury values increased significantly, reflecting the fact that until 2020, Fed policy imputed a secular downward drift to long-term bond yields (Hillenbrand, 2021).[28] Most of the FOMC-induced yield changes accelerated after the Fed's large-scale asset purchases at the start of the Financial Crisis in 2008, suggesting that the Fed may have been leaning against the fiscal wind.[29] However, this is no longer the case after 2020, when the FOMC-day returns (gray line) diverge from the total returns (black line). The cumulative effect of FOMC announcements on Treasury returns is zero after March 2020 because, during COVID, yields decline when the Fed actually purchases long-dated Treasurys, not when they announce the purchases (Vissing-Jorgensen, 2021).

Next, we compute the effect of fiscal news on nominal and real yields, as well as on measures of default risk, expected inflation, convenience yields, and term premia (i.e., the same variables as in Table 2). Table 7 presents daily average changes in Panel A and cumulative changes in Panel B. This decomposition allows us to quantify the proportion of cumulative changes in these variables that occurred during large deficit news announcements. The main takeaway is that these days had a substantial impact on these measures. For instance, 26.8% of the nominal yield increases, 19.7% of the real yield increases, and 31% of the term premium increases took place on large deficit announcement days, despite these days accounting for only about 8.5% of all trading days from February 28, 2020, to October 30, 2023.

Figure 13 shows the cumulative changes in these variables throughout the sample period. We observe that even before March 2022, there are substantial increases in real and nominal yields, as well as in the term premia, on large deficit announcement days. Such increases are not evident on other days before 2022. This is particularly noteworthy given that, as documented in Figure 6, most of the observed increase in nominal and real yields occurred primarily after March 2022.

6. Conclusion

Central banks and governments need to ensure that bond markets function smoothly. Before the arrival of COVID, the U.S. had not witnessed large responses to fiscal shocks in Treasury markets in the past decades, including during the GFC. Based on extrapolation from recent U.S. experience, one might have expected Treasury yields to be insensitive to fiscal news when bond markets function well.

The U.S. Treasury market's actual response to COVID was markedly different from its response during the GFC and more in line with the predictions of standard valuation models. Throughout COVID, U.S. Treasurys were marked down along with the sovereign bonds issued by the governments of other advanced economies, such as France, Germany, and the U.K. We provide direct high-frequency evidence that these U.S. Treasury yield increases were concentrated on days with significant fiscal news, the footprint of the risky debt regime. In a large class of standard asset pricing models, the valuation

Table 7
Cumulative U.S. Treasury Returns and Changes in U.S. Treasury Yields Around Deficit Days

A. Average daily changes from February 28, 2020, to October 30, 2023

	All days (1)	Deficit days (2)	Other days (3)
Nominal bond returns	–1.58	–6.65	–1.10
t-statistic	[–1.99]	[–2.84]	[–1.30]
Real bond returns	–2.85	–7.98	–2.37
t-statistic	[–3.50]	[–3.49]	[–2.73]
10-year nominal yield	0.39	1.23	0.31
t-statistic	[1.87]	[2.40]	[1.39]
Real yield	0.29	0.68	0.25
t-statistic	[1.40]	[1.52]	[1.19]
Default risk	0.04	0.01	0.04
t-statistic	[1.22]	[0.14]	[1.22]
Expected inflation	0.11	0.42	0.08
t-statistic	[–0.45]	[0.63]	[–0.55]
Term premium	0.17	0.66	0.12
t-statistic	[0.87]	[1.07]	[0.59]
Observations	923	79	844

B. Cumulative changes from February 28, 2020, to October 30, 2023

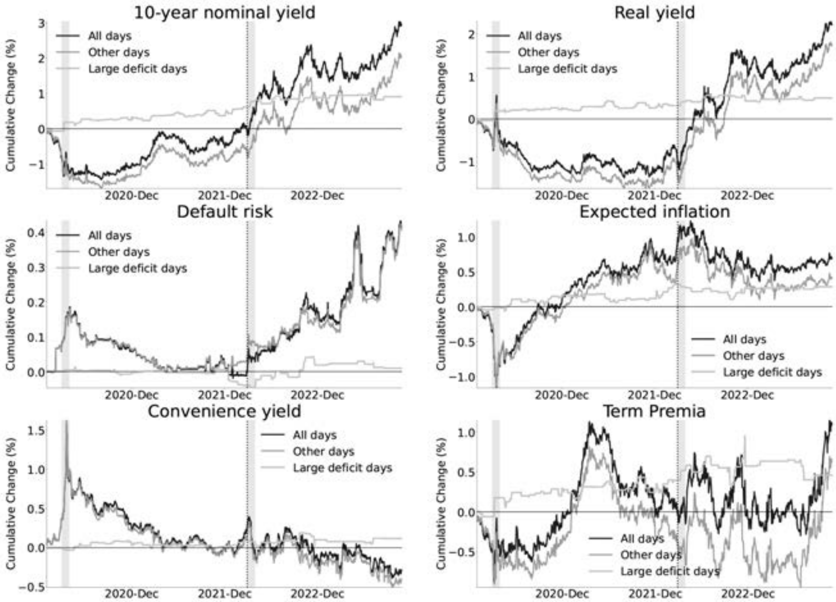
	All days (1)	Deficit days (2)	Other days (3)
Nominal bond returns	–14.56	–5.25	–9.31
Real bond returns	–26.35	–6.30	–20.04
10-year nominal yield	3.65	0.98	2.67
Real yield	2.68	0.53	2.14
Default risk	0.35	0.01	0.34
Expected inflation	0.98	0.33	0.65
Convenience yield	–0.61	0.11	–0.72
Term premium	1.66	0.52	1.14
Observations	923	79	844

Notes: This table presents daily average changes (Panel A) and cumulative changes (Panel B) in the following variables: nominal government debt portfolio returns, computed using procedures similar to Hall and Sargent (2011); the 10-year nominal yield; convenience yields, proxied by the spread between long-term Aaa-rated corporate bonds and 10-year Treasury yields; real rates, measured via 10-year TIPS; default risk, gauged through 10-year U.S. credit default swaps; expected inflation, captured by 10-year inflation swaps; and term premia, estimated employing the methodology outlined in Adrian et al. (2013). Both panels show changes across three sets of days: all trading days (Column 1), days with large deficit announcements (Column 2), and days without large deficit announcements (Column 3). In Column 2 of both panels, we control for other news coinciding with large deficit announcements by excluding days that overlap with FOMC meetings and days with large macroeconomic news, defined as days when the absolute value of analysts' forecast errors exceeds the rolling window median for each of the top 50 macroeconomic indicators. Square brackets contain *t*-statistics. The sample period spans from February 28, 2020, to October 30, 2023.

of the government's IOUs is marked down when the economy is hit by unfunded spending increases.

In March 2020, foreign investors did not flee to the safety of U.S. Treasurys. Instead, they sold long-dated U.S. Treasurys in a flight from maturity. The convenience yield on long-dated Treasurys declined throughout the COVID period. During COVID, U.S. Treasurys were not trading as the world's safe asset of choice, but

Figure 13
Decomposing Cumulative U.S. Treasury Returns and Changes in Yields on Large Deficit Days



Notes: This figure presents the cumulative changes in the 10-year nominal yield, real yields, default risk, expected inflation, convenience yield, and term premia across three different sets of days. The black line represents the cumulative change using all trading days, while the light gray line shows the cumulative change on large deficit announcement days that do not coincide with FOMC meeting days or large macroeconomic announcements. The dark gray line illustrates the cumulative change using all remaining trading days. Convenience yield is measured by the spread between long-term Aaa-rated corporate bonds and 10-year Treasury yields. Real rates are based on 10-year TIPS. Default risk is measured using 10-year U.S. credit default swaps. Expected inflation is derived from 10-year inflation swaps. Term premia are calculated using the Adrian et al. (2013) measure. The vertical black dotted line marks March 2020. The sample spans from January 01, 2020, to October 30, 2023.

rather, Treasurys were trading much like the sovereign bonds issued by other mature economies. Towards the end of the sample, AAA corporates are priced as close substitutes for long-dated Treasurys.

In response to COVID, U.S. Treasury investors seem to have shifted to the risky debt model when pricing Treasurys. Policymakers, including central banks, should internalize this shift when assessing whether bond markets are functioning properly. In the risky debt regime, valuations will respond to government spending shocks, which may involve large yield changes in bond markets. In this environment, large-scale asset purchases by central banks in response to a large government spending increase have undesirable public finance implications. These purchases, which provide temporary price support, destroy value for taxpayers but subsidize bondholders.

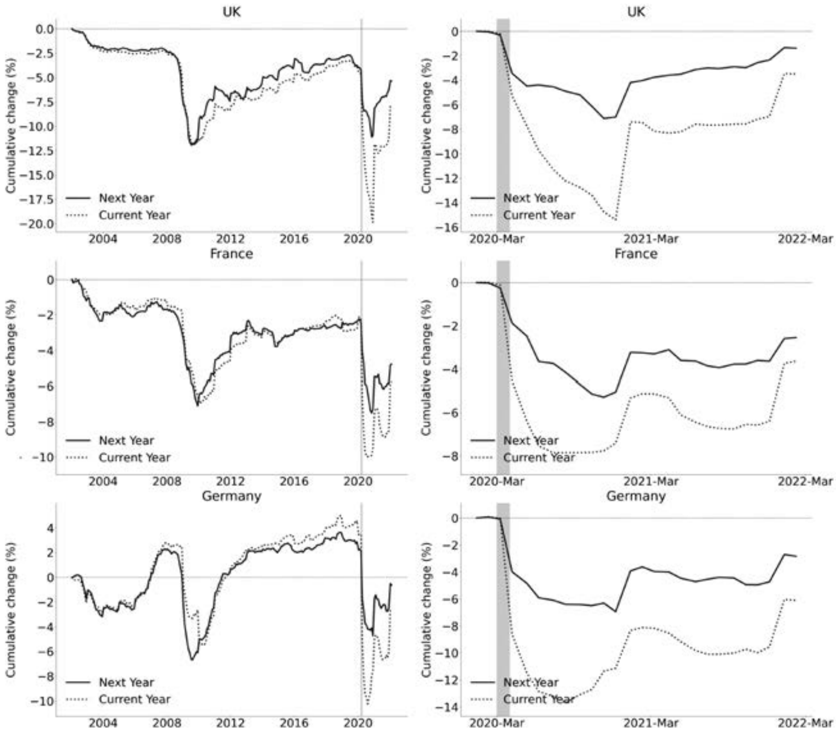
These purchases may also distort the incentives of governments and impair the price discovery in government bond markets. It is not inconceivable that governments in some mature economies have overestimated their true fiscal capacity as a result of these large-scale asset purchases.[30]

Appendix

Government Debt in Mature Economies

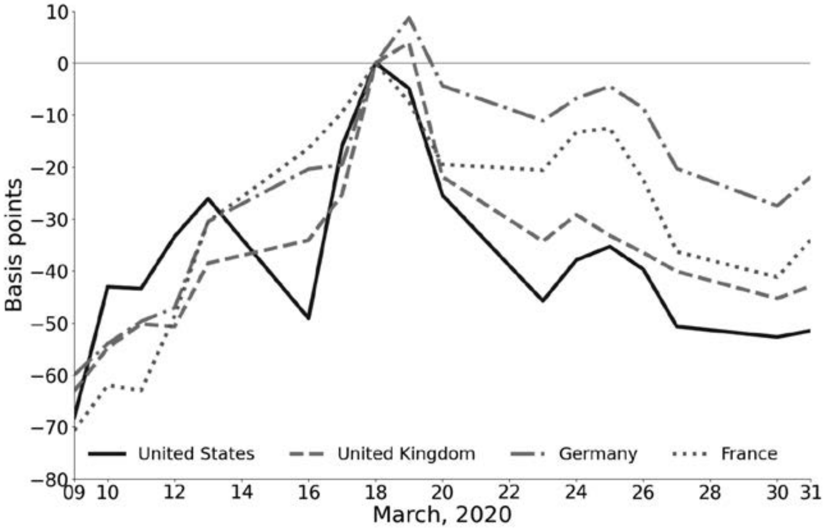
Appendix A

Figure A.1
Cumulative Revisions in Consensus Forecasts for Budget Balance in Other Countries



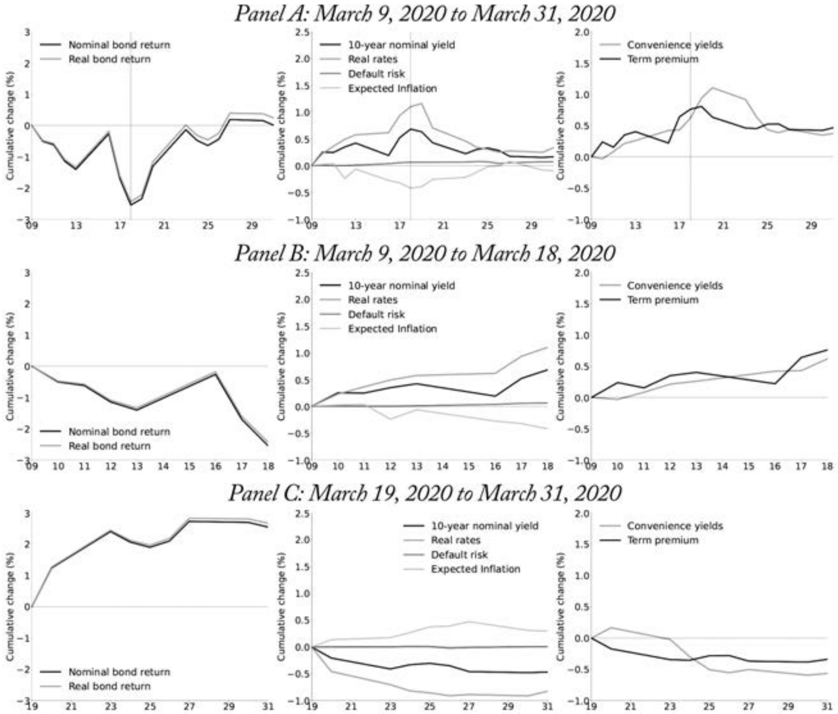
Notes: This figure shows the cumulative revisions in the consensus forecast for the current and next fiscal year's budget balance. For each country, we scaled the consensus forecast by the most recent GDP value available at the time the forecasts were made. The data comes from Consensus Economics. In the left panel, the sample ranges from 2002 to 2022, while in the right panel, the sample ranges from 2020 to 2022.

Figure A.2
10-Year Benchmark Yields



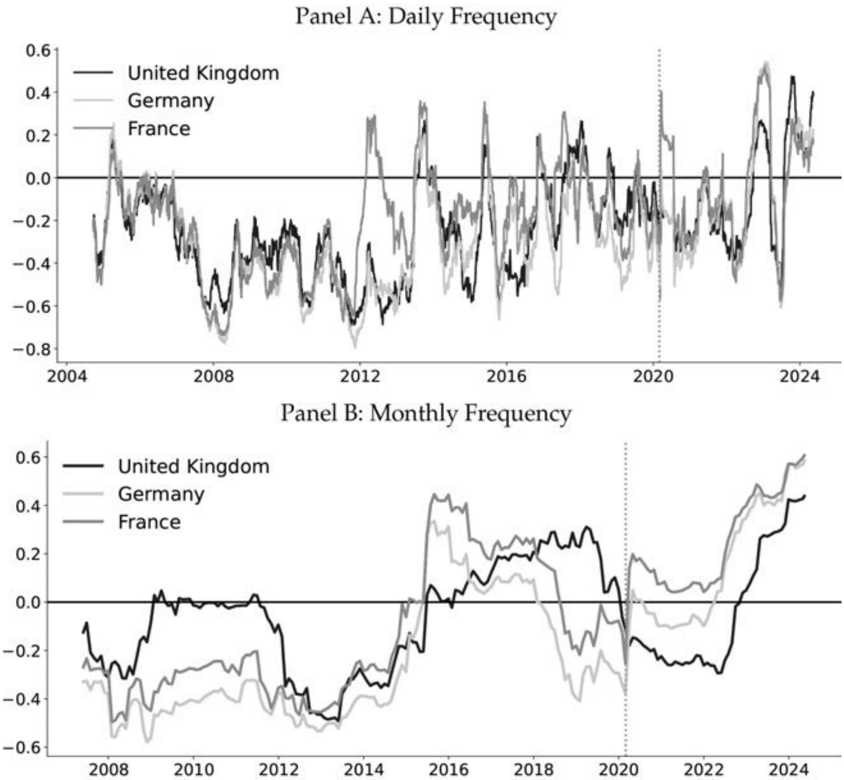
Notes: 10-Year Benchmark Yields for Government Bonds issued by the U.S., the U.K., Germany and France.

Figure A.3
Cumulative U.S. Treasury Returns and Changes in U.S. Treasury Yields During March 2020



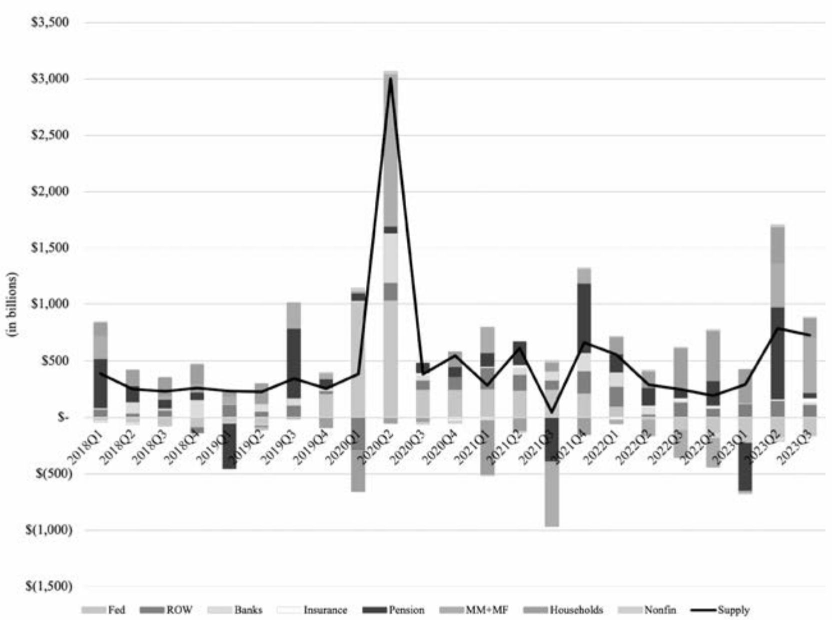
Notes: The left panels present cumulative daily changes in nominal and real government debt portfolio returns, computed using methods similar to Hall and Sargent (2011). Real values are calculated by subtracting realized inflation over the period. The middle panels show cumulative daily changes in the 10-year nominal yield, real rates (10-year TIPS), default risk (10-year U.S. credit default swaps), and expected inflation (10-year inflation swaps). The right panels display cumulative daily changes in convenience yields (spread between long-term AAA-rated corporate bonds and 10-year Treasury yields) and term premia (estimated using Adrian et al. (2013) methodology). Panel A covers March 9, 2020, to March 31, 2020. The dotted line denotes March 18, 2020. Panel B covers March 9, 2020, to March 18, 2020, 2022. Panel C covers March 19, 2020, to March 31, 2020.

Figure A.4
Bond-Stock Correlation for the U.K., Germany, and France



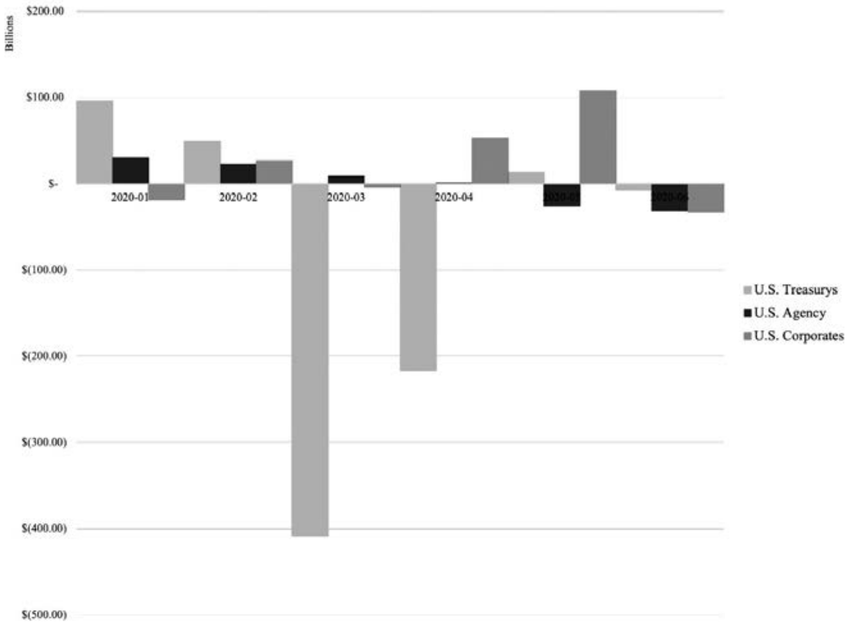
Notes: Panel A shows rolling correlations between bond and stock returns using bond indices and stock indices for the U.K., Germany, and France over a three-month window. The bond and stock returns are calculated using daily log returns. Panel B shows nominal correlations between bond and stock returns over a three-year window using monthly bond and stock returns. The vertical dotted line denotes March 2020. The sample period is from May 2004 to May 2024.

Figure A.5
Purchases and Issuance of U.S. Treasurys by Sector



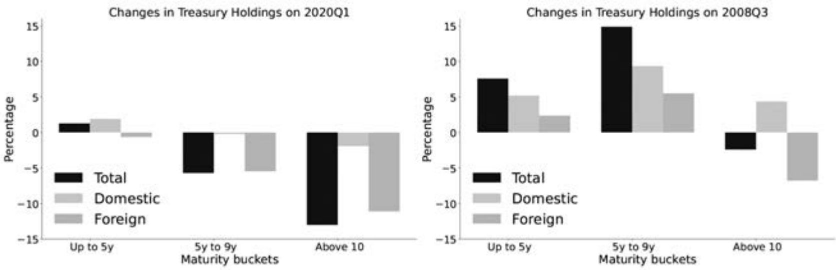
Notes: Quarterly net purchases of U.S. Treasury by sector. The flows are not annualized. *Source:* Flow of Funds data Table F210.

Figure A.6
Net Foreign Purchases of U.S. Bonds



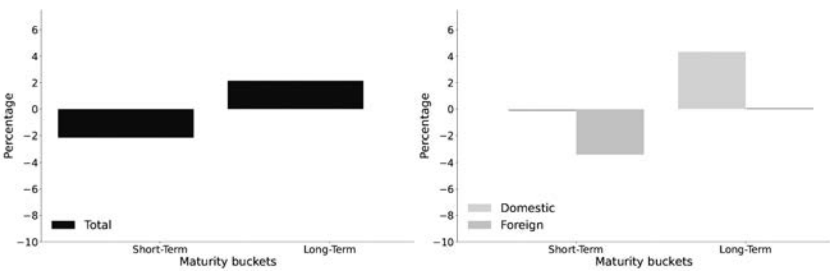
Notes: Net foreign purchases of U.S. Treasury bonds, Agency bonds, and U.S. corporate bonds. Estimates based on Bertaut and Judson (2014) TICS (Treasury International Capital System) data.

Figure A.7
Change in Institutional Investor Holdings of U.S. Bonds and Notes: 2020Q1 vs 2008Q3



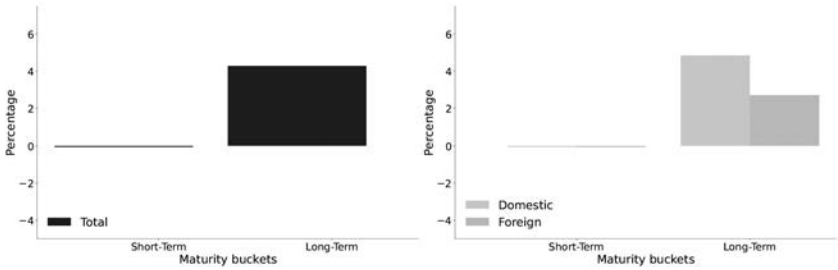
Notes: Change in Treasury holdings of bonds and notes as a percentage of total holdings by maturity bucket. We separate the change in Treasury holdings into foreign and domestic investors. The left panel shows changes for 2020Q1, while the right panel shows changes for 2008Q3. Based on EMAXX Holdings data.

Figure A.8
Change in Institutional Investor Holdings of Corporate Bonds



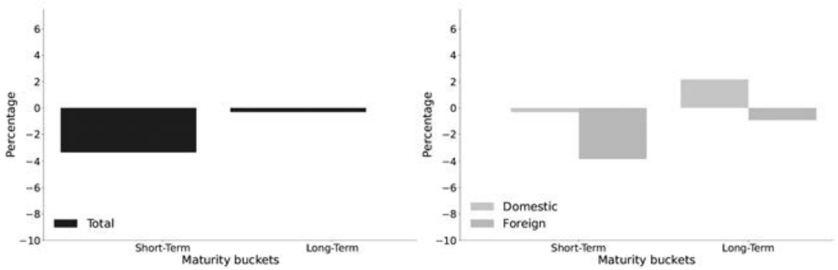
Notes: This figure presents the change in corporate bond holdings as a percentage of total holdings in each maturity bucket for the first quarter of 2020. The short-term bucket includes securities with maturities below six years, while the long-term bucket includes securities with maturities above six years. The right panel separates the change in Treasury holdings into foreign and domestic investors. The data is based on EMAXX Holdings.

Figure A.9
Change in Institutional Investor Holdings of U.S. Corporate Bonds



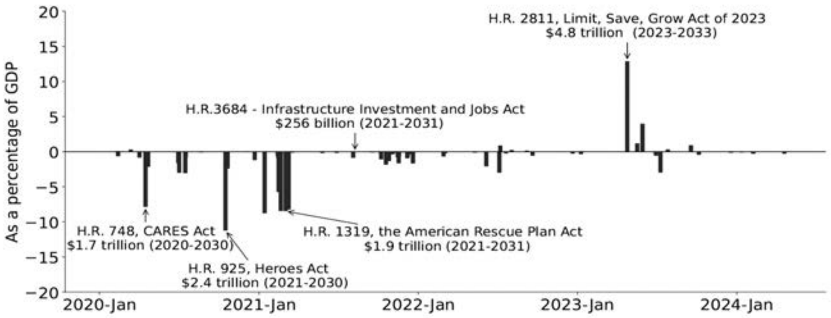
Notes: Change in U.S. corporate bond holdings as a percentage of total holdings in each maturity bucket. The right panel separates the change in Treasury holdings into foreign and domestic investors. The changes shown are for 2020Q1. Based on EMAXX Holdings data.

Figure A.10
Change in Institutional Investor Holdings of Non-U.S. Corporate Bonds



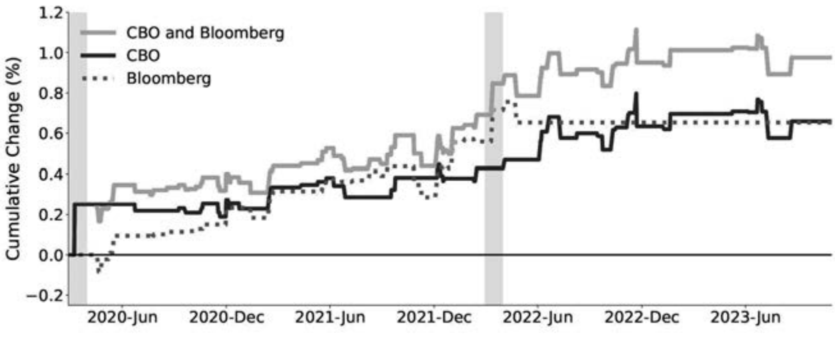
Notes: This figure presents the change in non-U.S. corporate bond holdings as a percentage of total holdings in each maturity bucket for the first quarter of 2020. The short-term bucket includes securities with maturities below six years, while the long-term bucket includes securities with maturities above six years. The right panel separates the change in Treasury holdings into foreign and domestic investors. The data is based on EMAXX Holdings.

Figure A.11
Bill-level Cash Flow Contributions



Notes: This figure shows the aggregate cash flow contribution of proposal *z* at time $t + \Delta t$, expressed as $_{t+\Delta t}^{(z)} \equiv \tilde{\mathbb{E}}_{t+\Delta t} \sum_{j=1}^{T} \nu^{j-1} \hat{S}_{t+j}^{(z)}$. The subscript $t + \Delta t$ indicates the release date of the cost estimate. The figure aggregates the cost estimates at the daily level by summing the costs of each bill reported on the same day. The steady-state annual discount rate, denoted by $\nu = 0.996$, is calculated as the average annual return of the nominal government debt portfolio, adjusted for growth and inflation. The dataset encompasses 998 unique cost estimates, spanning from January 2020 to April 2024.

Figure A.12
Cumulative Changes in Long-term Nominal Yields



Notes: This figure displays the cumulative change in the 10-year nominal yield around large deficit days. The gray solid line shows yield changes on days identified by both CBO cost estimates and Bloomberg articles as having large deficits, excluding days coinciding with FOMC meetings and major macroeconomic announcements. The black line uses only CBO cost estimates, while the dotted line uses only Bloomberg news articles to identify large deficit days. The combined effect does not equal the sum of individual CBO and Bloomberg effects because on days with both types of news, the impact is counted twice in the individual measures but only once in the combined effect. The gray shaded areas indicate March 2020 and March 2022. Sample period: March 1, 2020 to October 30, 2023.

Table A.1
Macroeconomic Announcements

Event	Ticker	Relevance	Time
Change in Nonfarm Payrolls	NFP TCH Index	99.213	08:30:00
Initial Jobless Claims	INJCJC Index	98.425	08:30:00
FOMC Rate Decision (Upper Bound)	FDTR Index	97.638	14:00:00
GDP Annualized QoQ	GDP CQOQ Index	96.850	08:30:00
CPI MoM	CPI CHNG Index	96.063	08:30:00
ISM Manufacturing	NAPMPMI Index	95.276	10:00:00
U. of Mich. Sentiment	CONSSENT Index	94.488	10:00:00
Conf. Board Consumer Confidence	CONCCONF Index	93.701	10:00:00
Durable Goods Orders	DGNOCHNG Index	92.913	08:30:00
Retail Sales Advance MoM	RSTAMOM Index	92.126	08:30:00
New Home Sales	NHSLTOT Index	91.339	10:00:00
Industrial Production MoM	IP CHNG Index	90.551	09:15:00
Markit U.S. Manufacturing PMI	MPMIUSMA Index	90.000	09:45:00
Unemployment Rate	USURTOT Index	89.291	08:30:00
Housing Starts	NHSPSTOT Index	88.976	08:30:00
Existing Home Sales	ETSLTOTL Index	88.189	10:00:00
ADP Employment Change	ADP CHNG Index	87.402	08:15:00
PPI Final Demand MoM	FDIDFDMO Index	86.614	08:30:00
Personal Spending	PCE CRCH Index	85.827	08:30:00
Personal Income	PITLCHNG Index	85.827	08:30:00
Factory Orders	TMNOCHNG Index	85.039	10:00:00
Trade Balance	USTBTOT Index	84.252	08:30:00
Leading Index	LEI CHNG Index	83.465	10:00:00
Empire Manufacturing	EMPRGBCI Index	82.677	08:30:00
MNI Chicago PMI	CHPMINDX Index	81.890	09:45:00
Wholesale Inventories MoM	MWINCHNG Index	81.102	10:00:00
ISM Services Index	NAPMNMI Index	79.528	10:00:00
Philadelphia Fed Business Outlook	OUTFGAF Index	78.740	08:30:00
GDP Price Index	GDP PIQQ Index	77.480	08:30:00
Import Price Index MoM	IMP1CHNG Index	77.165	08:30:00
CPI Ex Food and Energy MoM	CPUPXCHG Index	76.850	08:30:00
Pending Home Sales MoM	USPHTMOM Index	76.378	10:00:00
Monthly Budget Statement	FDDSSD Index	75.591	14:00:00
ISM Prices Paid	NAPMPRIC Index	74.016	10:00:00
Current Account Balance	USCABAL Index	71.653	08:30:00
Richmond Fed Manufact. Index	RCHSINDX Index	70.866	10:00:00
CPI YoY	CPI YOY Index	70.079	08:30:00
Markit U.S. Services PMI	MPMIUSSA Index	70.000	09:45:00
Change in Manufact. Payrolls	USMMMNCH Index	69.449	08:30:00
Continuing Claims	INJCSP Index	68.898	08:30:00
FHFA House Price Index MoM	HPIMMOM Index	68.504	09:00:00
Personal Consumption	GDPCTOT Index	67.795	08:30:00
PPI Final Demand YoY	FDIUFDYO Index	67.716	08:30:00
PPI Ex Food and Energy MoM	FDIDSGMO Index	66.142	08:30:00
PPI Ex Food and Energy YoY	FDIUSGYO Index	65.354	08:30:00
Retail Sales Ex Auto MoM	RSTAXMOM Index	64.488	08:30:00
Dallas Fed Manf. Activity	DFEDGBA Index	63.779	10:30:00
Capacity Utilization	CPTICHNG Index	63.386	09:15:00
Building Permits	NHSPATOT Index	62.283	08:30:00
NFIB Small Business Optimism	SBOITOTL Index	61.417	06:00:00

Note: The table lists the macroeconomic announcements we use as controls in our analysis. We identified the top 50 macroeconomic announcements based on their relevance score, which is a metric calculated by Bloomberg. The relevance score is determined by the number of 'alerts' set by all users for a particular event relative to all alerts set for other U.S. economic events. Time denotes the Eastern Time (ET) at which the announcement was most commonly released during our sample period.

Table A.2
Bloomberg News Articles

Date	Link	Title
2020-04-20	NSN Q92BV2T0G1KW	Mnuchin, Democrats Close on Virus Aid Deal Nearing $500 Billion
2020-04-20	NSN Q93KRR0799MO	U.S. senators propose $500 billion rescue for state, local govts
2020-04-20	NSN RT1GDK0799MQ	Oil Tanks as Congress and Mnuchin Near a $500 Billion Aid Deal — Barrons.com
2020-04-20	NSN Q93OHFT0AFB9	Farm Backers See $19 Billion Rescue as Down Payment on More Aid
2020-04-20	NSN Q93S463V7U9S	White House, Congress Get Closer on $450B Virus Aid Talks
2020-04-20	NSN Q93ORS3V2800	McConnell Adds Senate Session Amid $450B Virus Aid Talks
2020-04-20	NSN Q92SAX3H0JKR	Deal Nears for $450 Billion to Replenish Aid to Taxpayers and Small Businesses
2020-04-21	NSN Q939SBDWLU6F	Senate Passes $484 Billion for Small-Business, Hospitals, Tests
2020-04-21	NSN Q95LKRBUJSAU	Democrats reportedly reach a $450 billion deal with the White House to expand funding for small-business loans, and Trump says
2020-04-21	NSN Q95H2TBUJSAP	Democrats reach a $450 billion-dollar deal with the White House in order to expand funding for small business loans, and Trump
2020-04-21	NSN Q95P2Q3PR6RM	1ST LEAD U.S. lawmakers reach deal on 480 billion dollars in new stimulus By Sophie Wingate and Shabtai Gold, DPA
2020-04-21	NSN Q95L5E3PR6RK	EXTRA U.S. Senate reaches deal on new stimulus worth 480 billion dollars
2020-04-21	NSN Q95PCMAA7G8Z	Senate passes $484 billion interim coronavirus funding bill
2020-04-21	NSN Q95RCB3HBS3K	Senate Passes $484 Billion Bill That Would Expand Small Business Aid, Boost Money for Hospitals And Testing
2020-04-21	NSN Q93ZESDWRGG4	Manu Raju: As part of the $25 billion for testing in emerging deal, Democrats want a national testing strategy just as Trump
2020-04-21	NSN Q95PYRALADJ5	Senate Passes $484 Billion Interim Relief Package. Here's What's In It—And What's Missing
2020-04-21	NSN Q95PLU3PR6RK	EXTRA Senate passes 484-billion-dollar additional coronavirus stimulus
2020-04-21	NSN Q95P6ADWLU6U	Senate Passes $484 Billion Interim Economic Stimulus Package
2020-04-21	NSN Q95PJM3V2800	Senate Approves $500B Virus Aid Deal; Sends to House
2020-04-21	NSN Q95JCW073NCW	U.S. Congress, White House agree on nearly $500 billion more coronavirus bailout
2020-04-21	NSN Q95O823V2800	Congress, Trump Reach $500B Virus Aid Deal; Senate Debates
2020-04-21	NSN Q95I6J3V7U9S	Congress, Trump in Tentative Deal on $500B Virus Relief Bill
2020-04-21	NSN Q95RH53V7U9S	Senate Approves $500B Virus Aid Deal, Sends It to House
2020-04-21	NSN Q95PAIT0G1LH	*SENATE PASSES $484 BILLION FOR SMALL BUSINESS, HOSPITALS, TESTS
2020-04-21	NSN Q95JDD073NCW	U.S. coronavirus bill provides $321 bln for small business: aide
2020-04-27	NSN Q9GP3TDWX2PX	Coalition Seeks $150B for Clean Cars, Tax Credit Extension
2020-04-27	NSN Q9GBIMT0G1L1	Top Court Backs Insurers on $12 Billion Obamacare Payments (1)
2020-05-11	NSN QA4YTGDWX2PT	F-35's Image as $428 Billion Bundle of Flaws Improved by Fixes
2020-05-11	NSN QA6HX2T0G1KZ	Republicans Willing to Back $500 Billion Stimulus Bill: Menendez
2020-05-11	NSN QA6MFGDWRGG2	Some Republicans Open to $500B Aid; White House Requires Masks
2020-05-18	NSN QAJOQPDWX2PS	Treasury Has Spent Small Part of $500 Billion in Coronavirus Aid
2020-08-19	NSN QFAIJ3T0G1KW	Trump Team Sees Path to Pared-Down $500 Billion Stimulus Deal
2020-08-19	NSN QFBOO6T0G1L5	White House Open to $25 Billion for Postal Service, McEnany Says
2020-08-19	NSN QFBWM7DWX2PU	White House Open to $25 Billion for USPS; Harris Readies Speech
2020-09-28	NSN QHDZ86T0AFB4	Colleges Battling Covid Upsurge Seek $120 Billion as Costs Mount
2020-10-09	NSN RUQFWC0799MP	White House Preparing New $1.8 Trillion Stimulus Proposal–2nd Update
2020-10-21	NSN QIKD7TBUJSAO	Democrats block a $500 billion 'skinny' coronavirus aid bill identical to another that Republicans unveiled a month ago

Table A.2 continued

Date	Link	Title
2020-10-21	NSN QIK355DWLU6K	U.S. Sees Spending $10 Billion on Missile Defense Through 2025
2020-12-01	NSN QKNWM13HBS3K	Bipartisan Group of Senators Prepares $908 Billion Stimulus Plan, Aiming to Break Partisan Logjam
2020-12-01	NSN QKOJ7BBP8R2C	Mitch McConnell rejects bipartisan proposal by Senate moderates for $900 billion COVID relief package — day after accusing Nancy
2020-12-01	NSN QKO5Z40799MP	U.S. bipartisan lawmakers propose $908 billion COVID-19 relief bill
2020-12-01	NSN QKO8O8T0AFB7	Bipartisan Senate Group Pitching $908 Billion Stimulus Plan (3)
2020-12-01	NSN QKOJREDWX2Q2	Mnuchin Says Congress Must Redirect $455 Billion, Not Biden
2020-12-01	NSN QKOG8NT0G1KX	Senate GOP Relief Package Includes $332.7 Billion for PPP Plan
2021-01-13	NSN QMVYUST1UM16	Schumer Asks Biden to Seek More Than $1.3 Trillion in Relief (1)
2021-01-13	NSN QMVXHSDWLU6Q	Stocks Gain, Schumer Wants Stimulus North of $1.3T: Macro Squawk
2021-02-16	NSN QON00R3HBS3K	Focus on Capitol Hill Turns to Passing Biden's $1.9 Trillion Coronavirus Relief Bill
2021-02-16	NSN QOMZ213HBS3K	Focus on Capitol Hill Turns to Passing Biden's $1.9 Trillion Covid Relief Bill
2021-02-16	NSN QON3VJBUJSAV	Biden's $1.9 trillion stimulus plan is popular with voters, but it's crashing into strong Republican resistance in Congress
2021-02-22	NSN QOXYJVBP8R29	Midday Report: Most U.S. Stocks Fall While Copper Hits Decade High; $1.9 Trillion Stimulus to Reach House of Representatives
2021-02-22	NSN QOXZPQBP8R2B	Most U.S. Stocks Fall While Copper Hits Decade High; $1.9 Trillion Stimulus to Reach House of Representatives Shortly
2021-02-22	NSN QOXG5PDWX2PU	Biden Stimulus Dash; M&T's $7.6b Deal: N.A. Financials Premarket
2021-02-22	NSN QOXRJO0799MQ	$1.9T plan a 'bailout for lockdowns' Top GOPer rips COV bill
2021-02-22	NSN QOS5DFT1UM0W	Biden's $1.9 Trillion Stimulus Plan Enters 3-Week Congress Dash
2021-05-19	NSN QTD99FHTXJ40	The Senate is weighing a bill that would invest $120 billion in technology research to counter China.
2021-05-19	NSN QTBW5BHTXJ40	Senate Weighs Investing $120 Billion in Science to Counter China
2021-05-19	NSN QTBNW5T1UM0W	Senate China Bill to Add $52 Billion for U.S. Chip Making (1)
2021-05-19	NSN QTBS18073NCW	Senate Democrat proposes $52 billion for U.S. chips production, R
2021-05-19	NSN QTD0D4DWX2PX	GOP's $400 Billion Highway Bill Focuses on 'Core Infrastructure'
2021-05-26	NSN QTOG9HT0G1KZ	Bipartisan $304b Highway Bill Advanced by Senate Panel
2021-05-26	NSN QTPNWLDWRGGD	Biden's American Jobs Plan Will Include $318 Billion for Housing
2021-06-22	NSN QV4EA6DWLU7L	Biden's $6.5 Billion Biomedical Agency Backed in Bipartisan Bill (1)
2021-06-22	NSN QV469DDWRGG6	Biden's $6.5 Billion Biomedical Agency Backed in Bipartisan Bill
2021-06-22	NSN QV4DBSDWLU6L	Warren Leads Letter Seeking $700B for Child-Care Infrastructure
2021-07-12	NSN QW4MHEDWLU76	Biden's $579 Billion Plan Is a Tiny Step in the Right Direction
2021-08-09	NSN QXL7OXDWLU6T	Democrats Unveil $3.5 Trillion Budget Plan; Crypto Deal Reached
2021-08-09	NSN QXKRBHT0AFB9	Democrats Release Budget Enabling Biden's $3.5 Trillion Plan (2)
2021-08-10	NSN QXMS1WT0G1KW	*SWEEPING $550 BILLION INFRASTRUCTURE BILL PASSES U.S. SENATE
2021-08-10	NSN QXMAC7DWLU6P	Senate Poised to Pass $550 Billion Infrastructure Bill (Video)
2021-08-10	NSN QXMT7NT1UM0W	Senate Passes $550 Billion Infrastructure Plan in Win for Biden
2021-08-10	NSN QXMVVH073NCW	U.S. senate passes $550 billion infrastructure bill that could unleash biggest burst of spending in decades
2021-08-10	NSN QXMYY56QRTHC	Senate Approves Bipartisan, $1 Trillion Infrastructure Bill, Bringing Major Biden Goal One Step Closer
2021-08-10	NSN QXN38Q0799MO	Treasury yields end higher as Senate passes $1 trillion bipartisan infrastructure bill
2021-08-10	NSN QXMWQ1T0G1KW	Senate Passes $550 Billion Infrastructure Bill (Video)
2021-08-30	NSN QYNZR1T0G1L3	Top Defense Republican to Propose $25 Billion Pentagon Boost
2021-08-30	NSN QYO6SUT0G1KZ	Democrats Pressured to Add $10 Billion to Transit in Budget Bill

Continued on next page

Table A.2 continued

Date	Link	Title
2021-08-30	NSN QYO2QJ073NCW	Groups, mayors urge U.S. Congress to back $10 billion in new public transit funding
2021-08-30	NSN QYNR2TDWLU70	Modeling Impact of $4 Trillion Fiscal Stimulus on U.S. Outlook
2021-09-10	NSN QZ8MLUT0G1KW	Senators Push for $6 Billion Bailout for Private Bus Industry
2021-09-10	NSN QZ7QPCDWRGG5	ENERGY BRIEFING: House Panel Readies $150B Clean Energy Plan
2021-09-10	NSN QZ8FS5T0G1KY	Extra $28 Billion to Appease Farms Promised in Full Budget Bill
2021-10-27	NSN R1LUGWT0AFBD	Democrats Near Deal on $500 Billion to Fight Climate Change (1)
2021-11-09	NSN R2B2NCDWLU6V	BI's Companies to Watch in Biden's $1.2T Infrastructure Bill
2021-12-06	NSN R3PTNL33O5C0	Senate Revs Up Work on $2 Trillion Spending Proposal, Aiming to Complete Vote on Biden-backed Bill Before Christmas
2021-12-07	NSN R3QZCKT1UM0Y	U.S. to Spend $11b in 3yrs to Fight Global Malnutrition: Blinken
2021-12-07	NSN R3RLTWA30ZR4	House Prepares to Pass $768 Billion Defense Policy Bill
2021-12-08	NSN R3RORKT0G1KW	House Passes Defense Policy Bill With $25 Billion Funding Boost
2021-12-08	NSN R3S0EU073NCW	House Approves $778 Billion Defense Bill — Update
2021-12-08	NSN R3TA7Y073NCX	U.S. Likely Ran A $193 Billion Deficit In November Versus $145 Billion A Year Earlier, CBO Says — MarketWatch
2021-12-08	NSN R3RT50A30ZR4	House Prepares to Pass $768 Billion Defense Policy Bill
2021-12-08	NSN R3RPQ26QRTHC	Congress Strikes Compromise on $768 Billion Defense Bill, But Key Omissions Prompt Fury Among Some Democrats
2021-12-08	NSN R3RRTODTVIF8	House Set to Pass $768 Billion Bill Providing Big Boost to
2021-12-08	NSN R3S08JA30ZR4	House Passes $768 Billion Defense Policy Bill
2021-12-08	NSN R3SNHQ6QRTHC	House Approves $768 Billion Defense Bill With Strong Support, Despite Some Discord Among Democrats
2021-12-20	NSN R4EA3EB2RNYA	Elon Musk says he will pay over $11 billion in taxes this year
2021-12-20	NSN R4EW0MDWLU6P	Infrastructure Funds Contract Spending Can't Exceed $125 Billion
2021-12-20	NSN R4F1F1BJXPU7	Elon Musk said he'll pay more than $11 billion in taxes this
2021-12-27	NSN R4S82QDWRGG0	Biden Signs $768.2 Billion Annual Defense Policy Bill
2021-12-27	NSN R4SOQVA30ZR4	Biden Signs $770 Billion Defense Bill
2022-01-03	NSN R55GL0DWRGG0	USTs Hold Losses After Early Slide; IG Slate Kicks Off With $11b
2022-02-09	NSN R70NFC6QRTHC	House Republicans And Democrats Agree on $57 Billion USPS Overhaul
2022-03-14	NSN R8QBM0DWX2PT	BGOV OnPoint: Congress Clears $1.5 Trillion Fiscal 2022 Omnibus
2022-03-14	NSN R8QHCKT0AFBE	Where Did $6 Trillion in Covid Funding Actually Go?: Editorial
2022-04-04	NSN R9TV5VBP8R2E	Democrat and Republican lawmakers reach a DEAL for an extra $10billion extra in funding for the U.S. COVID response — without the
2022-04-04	NSN R9SX0U073NCW	U.S. News: Lawmakers Aim to Get $10 Billion Covid Deal
2022-04-04	NSN R9TS6C073NCW	Congressional Negotiators Settle on $10 Billion for Covid Tests, Treatments — WSJ
2022-04-04	NSN R9U40X073NCX	Congressional Negotiators Settle on $10 Billion for Covid-19 Tests, Treatments — 2nd Update
2022-04-04	NSN R9TTNV073NCX	Congressional Negotiators Settle on $10 Billion for Covid Tests, Treatments — Update
2022-04-04	NSN R9SY8W073NCX	Lawmakers Aim to Get $10 Billion Covid Deal — WSJ
2022-04-04	NSN R9U3ICALADJ8	Senate Reaches A Deal On $10 Billion Pandemic Response Package. Here's What's In It.
2022-04-04	NSN R9U13FDWLU70	Senate Reaches Deal on $10 Billion Covid Bill Without Global Aid
2022-04-04	NSN R9TPZJT1UM0X	Feds' Annual Climate Tab May Near $128 Billion, White House Says
2022-04-04	NSN R9U3RWAA7G8Y	Senators reach deal on bipartisan $10 billion COVID package
2022-04-04	NSN R9U7GMDTVIF6	Senators Reach Deal on $10 Billion Covid Aid Package
2022-04-25	NSN RAWI16073NCW	The $67 Billion Tariff Dodge That's Undermining U.S. Trade Policy — WSJ

Table A.3
U.S. Treasury Returns and Fiscal News

Coefficient	Variable	(1)	(2) Controlling for other news	(3)	(4)
a	1	–0.54	–0.53	–1.10	–1.24
t-statistic		[–0.51]	[–0.45]	[–1.21]	[–1.35]
b	I_t	–3.56	–4.18	–5.54	–7.11
t-statistic		[–2.15]	[–1.84]	[–1.91]	[–1.55]
Observations		922	922	922	922
			Controls		
FOMC days		No	Yes	Yes	Yes
Large Macro News		No	No	Yes	Yes
Small Macro News		No	No	No	Yes
Number of Deficit Days in I_t		268	236	79	44

Notes: This table presents coefficient estimates from the regression: $\Delta b_t = a + b \cdot I_t + \epsilon_t$, where Δb_t is the daily Treasury value change on day t, and I_t is an indicator variable equal to 1 for large deficit announcement days, 0 otherwise. Column 1 shows results without controls. Columns 2 to 4 progressively control for other news by setting $I_t = 0$ on specific days: Column 2 excludes FOMC meeting days, Column 3 further excludes days with large macroeconomic news, and Column 4 excludes days with both large and small macroeconomic news. Macroeconomic news is categorized as large (small) when the absolute value of analysts' forecast errors exceeds (falls below) the rolling window median for each of the top 50 indicators. *t*-statistics in brackets use Newey-West standard errors with lag length $L = [1.3 \times T^{1/2}]$. Sample period: February 28, 2020 to October 30, 2023.

Table A.4
U.S. Treasury Returns: Robustness Results

	50%	40%	25%	10%	5%	1%
	Percentile threshold for classifying a large deficit day					
Deficit over GDP in %	–0.00	–0.01	–0.04	–0.27	–0.81	–5.77
Mean bps	–6.65	–5.39	–6.19	–7.81	–7.87	–20.67
t-statistic	[–2.84]	[–3.20]	[–3.02]	[–2.56]	[–2.15]	[–3.88]
p-value	(0.04)	(0.10)	(0.09)	(0.08)	(0.09)	(0.03)
Cumulative change in %	–5.25	–3.72	–3.28	–2.66	–2.20	–1.45
p-value	(0.04)	(0.10)	(0.09)	(0.08)	(0.09)	(0.03)
Observations	79	69	53	34	28	7

Notes: This table presents the average daily and cumulative changes in Treasury values on large deficit announcement days, with each column varying the percentile threshold for classifying a large deficit day from the 50th to the 1st percentile. To control for other news occurring on the same day as the large deficit announcements, we exclude large deficit days that overlap with FOMC meeting days and days with large news from macroeconomic announcements, defined as days when the absolute value of the analysts' forecast error exceeds its rolling window median for each of the top 50 macroeconomic indicators. *t*-statistics are in square brackets, and parentheses indicate the percentage of simulated Treasury value changes that fall below the actual realizations, based on 10,000 samples randomly selected without replacement of the number of observations in the actual sample for large deficit days. The sample period is from February 28, 2020, to October 30, 2023.

Table A.5
U.S. Treasury Returns on CBO and Bloomberg News Days

A. Large deficit days using CBO cost projections	Large deficit days (1)	Other days (2)	All days (3)
Mean bps	–7.15	–1.25	–1.58
t-statistic	–2.65	[–1.50]	[–1.98]
p-value	(0.06)	–	–
Cumulative change in %	–3.72	–10.83	–14.55
p-value	(0.06)	–	–
Observations	52	870	922
B. Large deficit days using Bloomberg news	**Large deficit days (1)**	**Other days (2)**	**All days (3)**
Mean bps	–8.40	–1.30	–1.58
t-statistic	[–3.12]	[–1.60]	[–1.98]
p-value	(0.06)	–	–
Cumulative change in %	–3.02	–11.53	–14.55
p-value	(0.06)	–	–
Observations	36	886	922

Notes: This table presents the average daily and cumulative changes in Treasury values across three sets of days: days with large deficit announcements (Column 1), days without large deficit announcements (Column 2), and all trading days (Column 3). Panel A uses CBO cost projections to select large deficit announcement days, while Panel B uses Bloomberg News to select large deficit announcement days. In Column 1 of both panels, we control for other news coinciding with large deficit announcements by excluding days that overlap with FOMC meetings and days with large macroeconomic news, defined as days when the absolute value of analysts' forecast errors exceeds the rolling window median for each of the top 50 macroeconomic indicators. *t*-statistics are in square brackets, and parentheses indicate the percentage of simulated Treasury value changes that fall below the actual realizations, based on 10,000 samples randomly selected without replacement of the number of observations in the actual sample for large deficit days. The sample period is from February 28, 2020, to October 30, 2023.

Endnotes

[1]On September 23, 2022, Kwasi Kwarteng, then Chancellor of the Exchequer, released the Truss cabinet's first budget. The bond market responded to the tax plan by aggressively marking down U.K. gilt prices in the days following the announcement.

[2]Risky government debt simply means that the real return is risky and covaries negatively with the size of the spending shock. Risk does not specifically refer to sovereign default.

[3]The fiscal dominance regime builds on the seminal work of Sargent and Wallace (1981), followed by Leeper (1991), Sims (1994), Woodford (1995), and Cochrane (1998).

[4]Monetary policy passively adjusts the nominal short rate to stabilize fiscal inflation and the real value of debt.

[5]Under fiscal dominance, the government can partially insure the bondholders by distributing some of the risks to taxpayers through the fiscal rule, but, unlike under monetary dominance, it cannot provide full insurance. Fiscal dominance leads to a risky debt regime.

[6]The increase in the expected return on long-dated Treasurys was delayed by the intervention of central banks. The large increase in the U.S. term premium of 170 bps was mostly back-loaded after March 2022.

[7]The two-sided condition is $\rho_\pi > 1$ and $\rho_\pi < -1$.

[8]The interest rate target is set to center inflation around the target ($i^* = \mu + \pi^*$).

[9]The two-sided stability condition is $2\exp(b^*) + s^* > \delta_b > s^*$.

[10]JLVX (2024c) find no evidence in post-war U.S. data that the debt/GDP ratio predicts future surpluses.

[11]The two-sided bound is $-1 < \rho_\pi < 1$.

[12]When the Fed hikes interest rates, these investors would rebalance their portfolio towards short-term bonds and away from long-term bonds. The selling pressure on long-term bonds increases long-term real yields.

[13]The Congressional Budget Office (CBO) releases budget projections for the federal government that are based on current law.

[14]The transversality condition requires that the expected present-discounted value of debt in the far future, $E_t[M_{t+T}\tilde{B}_{t+H}]$, goes to zero as the horizon H goes to infinity. The TVC is an optimality condition in an economy with long-lived investors. JLVX (2020) show that the TVC is satisfied as long as the GDP risk premium exceeds the gap between the growth rate and the risk-free rate.

[15]Given that convenience yields tend to increase in bad times for the global economy, this is a counter-cyclical source of revenue for the Treasury, which could render the Treasury portfolio safer. As the world's safe asset supplier, the U.S. may be able to relax this trade-off between insuring bondholders and taxpayers when the convenience yields on Treasurys increase in the face of adverse global shocks, as future seigniorage revenue increases. While this counter-cyclical convenience yield channel may have been potent during the GFC, there is less evidence of this during the pandemic.

[16]Alternatively, investors should be pricing in much larger convenience yields in the future. However, the convenience yields on long-dated Treasurys have disappeared by the end of COVID.

[17]Their normative analysis envisions a world in which the government issues state-contingent debt which pays off only in peacetime, when government expenditures are low, but not in wartime.

[18]In a cross-country study, Barro and Bianchi (2023) infer that 80% of the spending was unbacked from the inflation response.

[19]The CDS-adjusted series comes from Mota (2023). For each senior corporate bond, Mota (2023) hedge its credit risk by matching it with a CDS of the same maturity, creating a synthetic risk-free bond if held to maturity. The CDS-bond basis is then calculated as the spread between this synthetic bond and a duration-matched U.S. Treasury bond, serving as a measure of the relative convenience yield of Treasuries. The final series represents the face-value weighted CDS-bond basis for the AAA/AA rating bucket. We are grateful to Lira Mota for providing us with this CDS-bond basis series.

[20]Haddad, Moreira, and Muir (2024) argue that instituting a QE program can have an impact on yields even when the central bank is not actively purchasing assets.

[21]Source: Federal Reserve Bank Combined Financial Statement. Cumulative unrealized gains on total SOMA.

[22]Campbell et al. (2020) attribute the change in the stock-bond correlation around 1998 to the change in the correlation between the output gap and inflation. Higher inflation goes hand in hand with higher output, implying lower real bond returns but higher stock returns. We show that the joint monetary-fiscal stance also informs the riskiness of government bonds.

[23]EMAXX provides fixed income holdings data for a diverse range of institutional investors, including U.S. and some European insurance companies, U.S. mutual funds, top public pension funds, and European, Canadian, and Asian mutual funds. The database covers $7 trillion in total fixed income par value held across more than 19,000 funds. Each entry in the EMAXX holdings data includes bond identification (CUSIP), holding institution information (e.g., country), type of holding institution (e.g., mutual fund, insurance company), par amount of the position, and reporting

date. To select U.S. Treasuries from the EMAXX dataset, we apply the following filters: GEOCODE == 'USA', CREDITSEC == 'SOV', ENTITYCODE == 'GT' (Federal/ Sovereign Government (Treasury)), and ALPHANAM starts with 'UNITED ST'. For corporate securities, we use ENTITY == PC (Public/Private Corporation).

[24]This measure cannot be interpreted as news because some of the budgetary impact could have already been priced in when the bill was first introduced. Instead, we use this measure as a way to classify proposals by the sign (positive and negative) and magnitude (large and small) of the budgetary impact. To capture the news component, we compute Treasury value changes around the cost release dates.

[25]In the Appendix, Figure A.11 illustrates the bill-level cash flow contributions, Table A.2 lists all Bloomberg news articles that do not coincide with contemporaneous releases of macroeconomic news, and Table A.1 provides the list of macroeconomic announcements included as controls.

[26]The top 50 macroeconomic indicators are selected based on the Bloomberg relevance score, as in Bianchi, Go´mez-Cram, Kind, and Kung (2023b). This score represents the number of alerts set on Bloomberg Terminals for an economic event relative to all alerts set for the 130 macro events in the U.S. We control for macroeconomic announcements given the large influence of these events on Treasury values (e.g., Balduzzi, Elton, and Green, 2001; Gu¨ rkaynak, Kısacıkog˘ lu, and Wright, 2020).

[27]Table A.4 in the Appendix presents robustness checks with respect to the median classification, varying the percentile threshold for classifying a large deficit day from the 50th to the 1st percentile. As we switch to higher cutoffs (smaller percentiles), the measured average effect on Treasury valuations increases monotonically from –6.65 bps at the 50th percentile to –20.67 bps at the 1st percentile. Furthermore, Table A.5 in the Appendix presents results using CBO and Bloomberg news separately, with a mean effect of –7.15 bps (-8.40 bps) on CBO news releases (Bloomberg news) days. Figure A.12 in the Appendix further shows the individual contribution of Bloomberg News and large CBO bills to the overall fiscally driven yield increases. Including fiscal news from Bloomberg is valuable, as these news items primarily capture discussions surrounding the legislative process, while CBO news provides information about the budgetary impact of legislation.

[28]Alam (2022) show that the secular decline in interest rates observed around FOMC meetings is primarily concentrated on days when these meetings coincide with macroeconomic announcements.

[29]Hall and Sargent (2022b) compare U.S. fiscal and monetary policy during the pandemic and the world wars.

[30]More generally, a recognition that the portfolio of all government liabilities in mature economies may be inherently risky will also lead to more realistic assessments of that country's fiscal capacity (JLVX (2020); JLVX (2024b) and Jiang et al. (2022a)).

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Commentary: Bond Market Perceptions of Monetary and Fiscal Policy

Anna Cieslak

Roberto Gomez Cram, Hanno Lustig, and Howard Kung have written a timely and thought-provoking paper. The authors argue that from the onset of the Covid pandemic in March 2020, the U.S. switched to a fiscal regime, in which monetary policy passively accommodates actions of the fiscal authority. This makes Treasury debt risky for bondholders, who now require a higher risk compensation.

The key question I will focus on in my remarks is whether the markets truly believed that a fiscal switch occurred in March 2020 and persisted through the end of the authors' sample period in October 2023. I will propose an alternative interpretation and a somewhat different timeline: Rather than a shift to a fiscal equilibrium, the markets were pricing in the Fed's policy mistake, or more subtly, a "delay" to respond to the inflation surge.

The 2021 inflation was in part fueled by excess demand from fiscal stimulus.[1] The Fed's delayed response may have created a temporary perception of a passive monetary policy as uncertainty about its reaction function increased. However, I will argue that the origins of the delay predate the 2021 inflation, and that was likely understood by the market at the time.

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1. Alternative Interpretations of Bond Market Dynamics

Figure 1 summarizes facts in the data, which the authors consider in support of a switch to a fiscal regime. Panel A illustrates a rise in the long-term U.S. Treasury yields and inflation swap rates from January 2020 to October 2023. Panel B uses the authors' fiscal events classification and estimates the contribution of the "large deficit days" to the U.S. ten-year nominal yield at around 100 basis points.

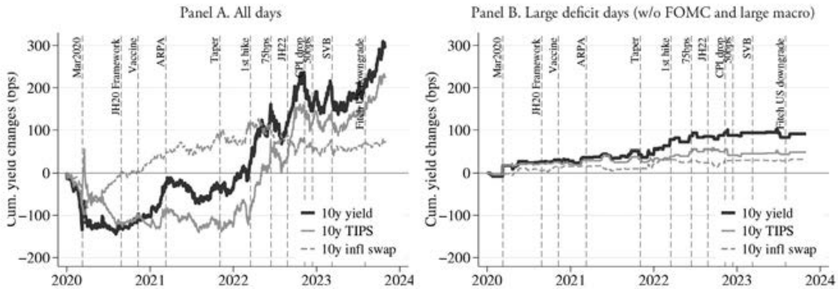
The authors argue that market beliefs switched already at the beginning of the pandemic as investors updated about the size of the fiscal expansion. They point to several telltale signs of a risky debt regime: Yields spiked in March 2020, inflation expectations moved up in a front-loaded way from March through late 2020, and increases in the term premium and the real rate followed from early 2021 through 2022.

Let us consider an alternative interpretation of these facts. There is convincing evidence that liquidity constraints triggered a "dash-for-cash" in March 2020. This led to a wave of Treasuries sales, satisfying the liquidity need (e.g., Vissing-Jorgensen, 2021; Duffie, 2023). Notably, despite the disruptions in the Treasury market, the stock-bond comovement in March 2020 actually remained negative (see Appendix Figure A-1).

The initial Covid shock spurred deflationary fears, as seen in the sudden drop in long-term inflation swap rates. Thus, the "front-loaded" rise of inflation expectations reflected their recovery from depressed back to pre-pandemic levels by early 2021.

The rise in nominal yields starting in 2021 is particularly revealing in the context of the paper's hypothesis. It suggests term premium increased around the time the massive American Rescue Plan Act (ARPA) was passed in 2021Q1. I will specifically discuss how that period around ARPA could be consistent with market perceptions of the Fed accommodating fiscal expansion. However, I will also argue that such perceptions were temporary and tied to the Fed's pre-commitments. Lastly, the rapid increase in real rates shows how active monetary policy has become since 2022.

Figure 1
Nominal and TIPS Yields and Inflation Swap Rates, January 2020–October 2023



Note: The figure presents cumulative changes in nominal yields, TIPS yields, and inflation swap rates at the 10-year maturity. Panel A shows cumulative yield changes across all days in the authors' sample from January 2020 through October 2023. Panel B shows cumulative yield changes using authors' large deficit days, with the FOMC announcement days and large macro announcement days excluded.

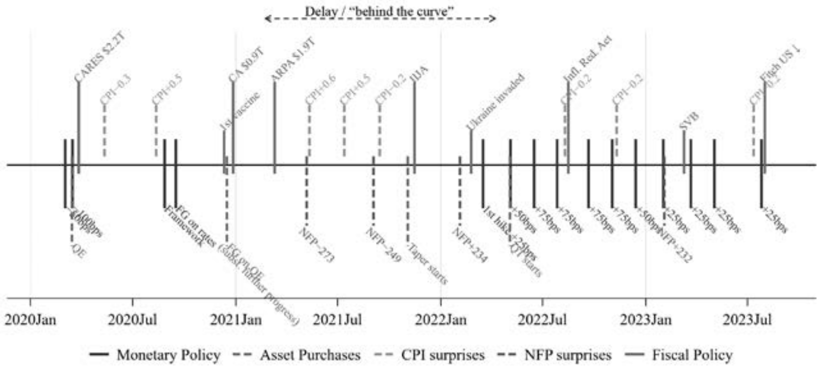
2. Origins of the Fed's "Delay" Predate the 2021 Inflation

In the paper's framework, unfunded fiscal spending is the only bad shock that raises marginal utility and generates inflation when the Fed is passive. However, context matters in understanding the data. Figure 2 portrays a complex environment, with supply and demand shocks and conflicting macroeconomic signals occurring in close succession. Among these events, a notable change in the Fed's strategic framework also takes place.

Policy mistakes invariably happen. Although I've marked the "delay" period at the top of Figure 2, one should recognize a significant uncertainty around its endpoints. This uncertainty still exists today even though we are looking at the data with the benefit of hindsight the policymakers did not have as decisions were made. So, was this period different with the Fed becoming fiscally led? Or, as Alan Greenspan once reflected, *"From time to time, the FOMC made decisions, some to move, some not to move, that we came to regret"* (Greenspan, 2004).

In the model, the researcher assumes an equilibrium where the Fed accommodates fiscal actions by not responding enough to inflation. Yet, in practice, what leads to that outcome? In my view, the origins of the Fed's "delayed" response predate the fiscal expansion

Figure 2
Timeline of Main Events

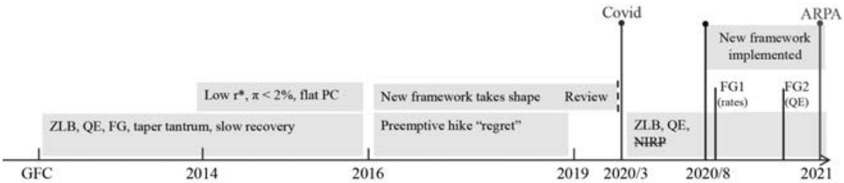


during Covid. Since the 2020 Jackson Hole symposium, the Fed has been operating under a new strategic monetary policy framework.[2] This baby turns four today, but the framework was construed much before the pandemic.

Figure 3 presents a stylized timeline back to the Global Financial Crisis, reviewing the experiences and thinking that shaped the Fed's framework design: the zero lower bound, low *r**, inflation below 2%, flat Phillips curve, dominant demand shocks, and the preemptive liftoff starting in December 2015 that the FOMC likely came to regret.[3] Following the Fed's review that started in 2019, the new framework took its final shape in early 2020, but the pandemic outbreak postponed its announcement until the summer of that year.

The framework introduced two new elements: asymmetric focus on employment short-falls and flexible average inflation targeting (FAIT), which effectively removed preemptive strikes against inflation. With the Covid shock, the Fed's ability to respond appeared limited. The framework gave a little extra space at a time of considerable uncertainty and when prospects of additional fiscal support still remained unclear. The "lower for longer" policy and the Fed's desire to overshoot the inflation target were clearly communicated in advance and understood by financial markets (Cieslak et al., 2024). Importantly, the framework announcement was soon followed by two powerful pieces of forward guidance: the September 2020

Figure 3
Evolution of the Fed's Strategic Policy Framework



interest rates guidance that removed preemption and the December 2020 guidance on tapering asset purchases before rate hikes. These pre-commitments, ultimately, appear to have reduced the Fed's flexibility to address the shocks that occurred later.

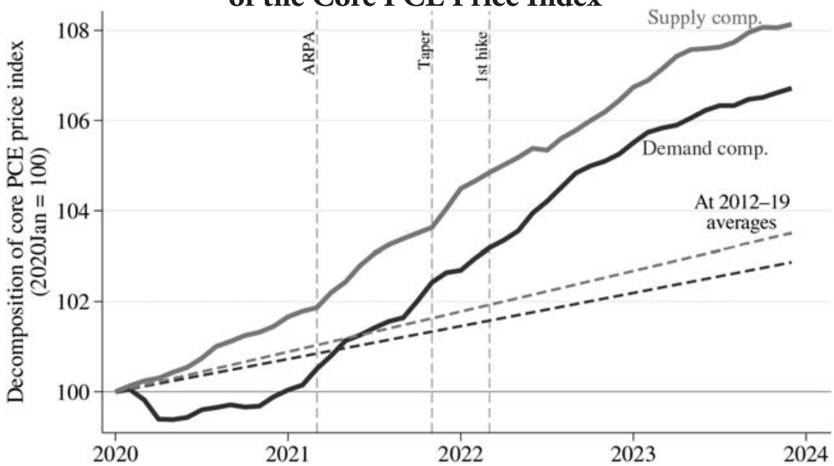
3. Inflation Drivers and the Fed's Beliefs

The post-2020 environment was very different from prior years that informed the framework. Figure 4 displays the demand and supply components of the core personal consumption expenditure (PCE) price index using decomposition from Shapiro (2024). For comparison, the dashed lines show the price indices extrapolated at the average monthly component-specific inflation rates over the 2012–2019 period.

Supply shocks propelled inflation from early on in the pandemic. The initial deflationary pressures from weak demand resolved quickly, helped by stimulative monetary and fiscal policies. The output gap was likely closing sometime in early 2021. Then, the demand-driven inflation accelerated when Congress passed the $1.9T ARPA stimulus in March 2021.

Did the Fed's pre-commitments play a role in delaying the response? Figure 5 provides suggestive evidence based on the Fed's own forecasts. The black line (circles) shows the FOMC's perceptions of inflation using the risk diffusion index from the Summary of Economic Projections. The risk diffusion index equals one when all FOMC members perceive risk weighted to the upside of their individual forecasts. FOMC's inflation risk perceptions tilted rapidly to the upside from early 2021, reaching the highest levels since 2007 when the risk diffusion index is available. At the same time,

Figure 4
Supply- and Demand-Driven Components of the Core PCE Price Index



Note: The figure presents the supply and demand components of the core PCE price index using Shapiro (2024) decomposition. The dashed lines are based on average rates of supply- and demand-driven inflation components over the 2012–2019 sample.

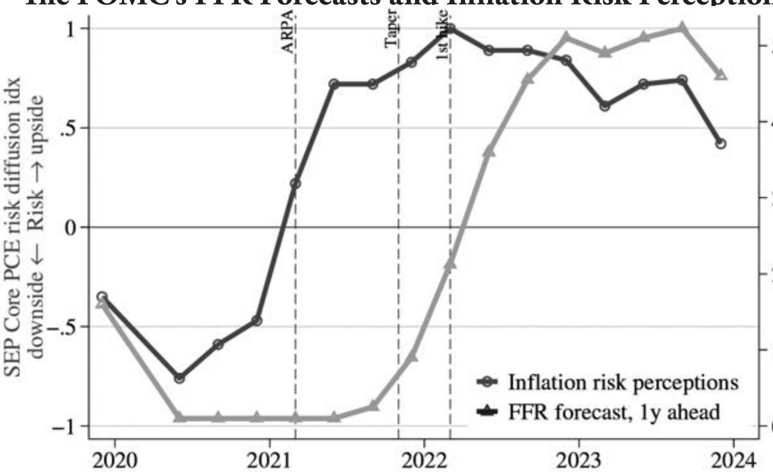
the FOMC's forecast for the policy rate one year ahead barely moved (gray line, triangles). Thus, despite recognizing inflationary buildup and judging the employment risks to be balanced (not shown in the graph), the FOMC decided it would delay raising rates for some time, consistent with its readiness to overshoot the inflation target communicated earlier.

4. Market Inflation Perceptions and Risk Premia

Did markets believe in a full-blown switch to a fiscal regime? On balance, the evidence from survey inflation expectations, perceived inflation tails, and inflation risk premia suggests the answer is No.

Figure 6 compiles inflation surveys from various sources, including the Survey of Primary Dealers (SPD), the Blue Chip Financial Forecasts (BCFF), and the Survey of Professional Forecasters (SPF) to proxy for the range of market's beliefs, and the Fed's Summary of Economic Projections (SEP). As Covid broke out, short-run inflation expectations abruptly dropped. Market participants (SPD) and the Fed (SEP) largely agreed in their one-year forecasts (Figure 6,

Figure 5
The FOMC's FFR Forecasts and Inflation Risk Perceptions



Note: The figure plots the risk diffusion index of the FOMC participants for the core PCE inflation against the FOMC's projections of the FFR path one year ahead. The data is available from the Summary of Economic Projections.

Figure 6
Inflation Expectations

Note: The figure presents measures of inflation expectations in different surveys. Panel A compares the median one-year-ahead core PCE inflation forecasts in the FOMC's Summary of Economic Projections (SEP) and the New York Fed Survey of Primary Dealers (SPD). Panel B displays public CPI inflation expectations at different horizons. The current quarter inflation nowcast is from the Blue Chip Financial Forecasts (BCFF), and one-year ahead inflation is from the Survey of Professional Forecasters (SPF). Average inflation over the next five years (0–5y) and from five to ten years ahead (5–10y) is the expected inflation computed from CPI inflation probability distributions in SPD.

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panel A), and hence, in ex-post forecast errors. From the 2020 perspective, the inflation surge that ensued came as a surprise to both.

The 2021 ARPA stimulus was inflationary, consistent with unfunded fiscal spending occurring when the economy was nearing its full potential. However, investors' beliefs reversed fast to the Fed's inflation target (Figure 6, panel B), even though the fiscal deficit woes did not resolve and potentially deteriorated throughout the sample period. The stability of long-run inflation expectations suggests market's conviction that the Fed would act to defend the target.

Perhaps markets in March 2020 made a probabilistic assessment of a regime change. This interpretation also appears unlikely. An upgraded probability of a fiscal regime could show more prominently in beliefs about inflation tail risks and risk premia than expectations. These are depicted in Figure 7. March 2020 saw a jump in the market-perceived probability of low, not high, inflation realizations (Figure 7, panel A). The probability of inflation below 1% over the next year increased by 17 percentage points to 61% from January to June 2020, while the probability of inflation above 3% dropped by two percentage points to 3%. With positive inflation surprises in 2021, the right inflation tail and inflation risk premia did rise (Figure 7, panel B), but they came down as factors behind inflationary pressures weakened and the Fed followed through with an aggressive action. Overall, the market's dominant scenario appears to have focused on an active Fed.

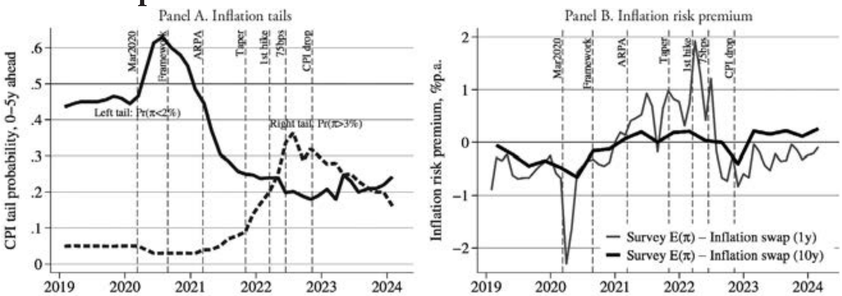
5. Uncertainty About the Fed's Reaction Function

Even if the markets did not believe in a full-blown fiscal regime, the Fed's passive stance in 2021 may have temporarily raised the probability of a fiscal switch, especially when the ARPA checks arrived.

Figure 8 zooms in onto this critical period, plotting the ten-year term premium and two-year short-rate expectations from the Kim and Wright (2005) model.[4] Starting in early 2021, the term premium rose by more than 50 basis points through 2021 Q1. Simultaneously, the uncertainty surrounding the passage of ARPA was gradually resolved between the Georgia runoff elections in early January 2021 — when the Democratic majority was established — and March 2021, when the bill was signed into law.[5] Bonds were indeed priced as riskier, and financial conditions tightened against the Fed's communicating "lower for longer" policy intentions and successfully anchoring short-rate expectations.

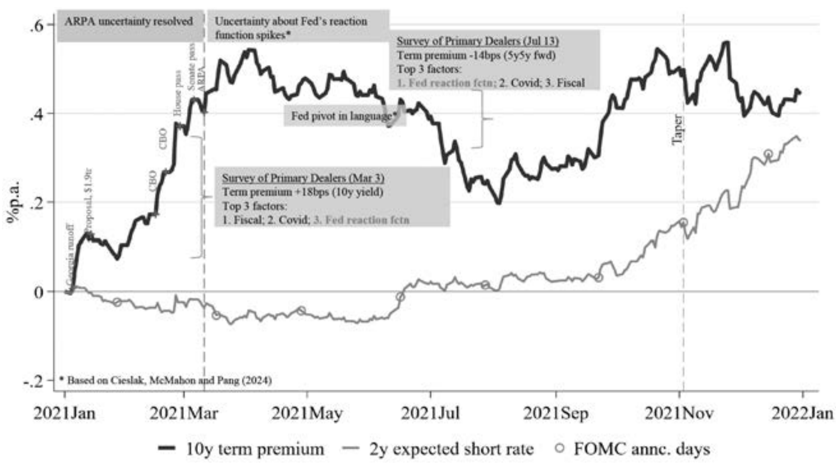
As we argue in Cieslak et al. (2024), early 2021 is when markets became especially uncertain about the Fed's reaction function and

Figure 7
Market-perceived Inflation Tails and Inflation Risk Premia



Note: Panel A presents the CPI inflation tail risk perceived by the SPD forecasters: probabilities of average CPI inflation rate over the next five years (0–5y) falling below 2% or rising above 3%, respectively. Panel B plots inflation risk premium at one- and ten-year horizons proxied by the difference between the inflation swap rate and the expected inflation in the survey. The one-year inflation risk premium is the difference between the one-year inflation swap rate and the BCFF's expected inflation from the current quarter to three quarters ahead. The maximum horizon of three quarters accounts for the indexation lag in the inflation swap contract. The ten-year inflation risk premium is the difference between the ten-year swap rate and the average expected CPI inflation over the next ten years from the SPF.

Figure 8
Cumulative Term Premium and
Short-Rate Expectations Changes in 2021



Note: The figure presents cumulative ten-year term premium changes and two-year short-rate expectations changes from January through December 2021. The yield curve decomposition follows Kim and Wright (2005). The events related to passing the ARPA stimulus during 2021Q1 are indicated against the term premium path. The results from the Survey of Primary Dealers conducted in March and July 2021 are summarized on the plot.

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priced in a monetary policy mistake. Participants in the Survey of Primary Dealers conducted in March 2021 also identified a mix of fiscal policy, improved Covid outlook, and the Fed's reaction function as the main factors behind the premium increase.

Early 2021 does have features of an incipient fiscal regime. However, with the Fed's pivot to more hawkish language soon after, the market's perceptions of the Fed's reaction function changed, and term premia started to decline. The July 2021 Survey of Primary Dealers again highlights the Fed's reaction function as the primary reason behind declining long-term rates. These dynamics appear consistent with the Fed's delay hypothesis. Separately, they also show that markets were able to impound risk compensation in bonds despite ongoing QE.

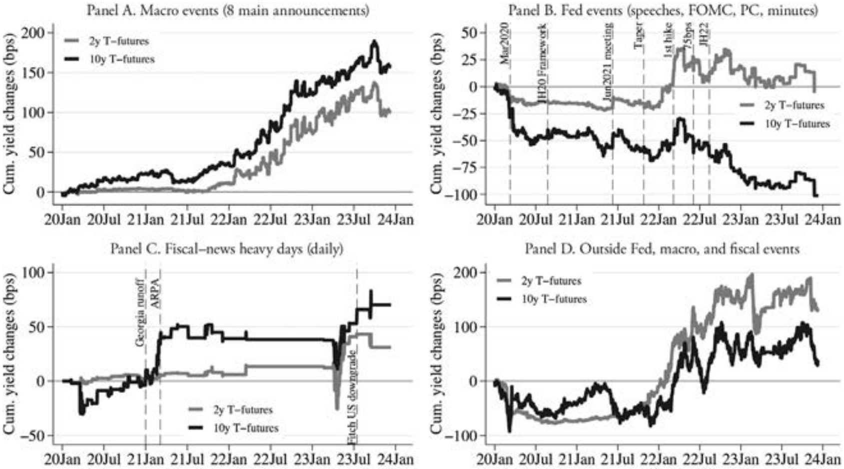
6. Macro, Fed, and Fiscal News in Yields

To cut through some of the complexity of the post-2020 period, I now take a stab at characterizing the types of news driving yields during that time. Figure 9 displays cumulative yield changes in high-frequency windows around key macro and Fed communication events, extending the analysis in Cieslak et al. (2024), and in daily windows on days identified as "heavy" with fiscal news.[6]

The top panels of Figure 9 reveal a striking fact. A small set of macro announcements (30-minute windows around eight announcements) contributed 160 basis points to the long-term yield from January 2020 to December 2023 (panel A). Notably, however, the Fed's communication windows offset about 100 basis points of that rise (panel B). Additional analysis reveals that the offset largely happened in narrow Fed communication windows just following macro news. One interpretation of these dynamics is that investors were learning about the appropriate policy stance, given incoming macro data. The Fed's communication lowered long yields, in large part through the term premium, especially after the 2022 hawkish pivot.

This is not to say that fiscal news is an unimportant driver of yields over this period. Panel C shows that fiscal news-heavy days contributed around 70 basis points to the long-term yield, a significant number and in the ballpark of the authors' estimate. Although my identification differs from the authors', this result confirms the importance of fiscal news in marking down the U.S. Treasury debt value.

Figure 9
Event Study: Macro, Fed, and Fiscal News in Yields



Note: The figure presents cumulative yield changes in narrow windows around macro announcements (panel A) and Fed communication events (panel B), as well as on days classified as fiscal news-heavy (panel C). Cumulative yield changes in windows outside macro events, Fed events, and fiscal days are reported in panel D. Panel D also includes the "dash-for-cash" from March 9 to March 19, 2020, and the SVB collapse on March 9–10, 2023. The yield changes are obtained from returns on the two- and ten-year Treasury futures contracts by adjusting log returns by duration. The ten-year contract is the Ultra 10-Year U.S. Treasury Note futures. Macro, minutes, and Fed decision windows span from ten minutes before to 20 minutes after the announcement. Speeches and press conference windows span from ten minutes before to 120 minutes after the event's start. The sample runs from January 2020 to December 2023.

7. Good and Bad Fiscal News

There is, however, a more nuanced interpretation of the fiscal news contribution to long-term yields. Markets do not necessarily perceive all fiscal news as "bad," and not all yield increases happen because investors demand higher compensation for unfunded fiscal shocks. Investors value bonds as a hedge against negative demand shocks, as shown yet again by the flight to safety in the early pandemic. Arguably, the initial fiscal stimulus in March 2020 supported the economic recovery in the face of liquidity constraints and helped protect the U.S. tax base. This should raise yields from depressed levels, as bonds now become less desired as hedges, without spurring excess inflation fears.

Figure 10 provides evidence suggesting that 2020 was dominated by fiscal news of such a "good" variety. Panel A uses a narrative approach to measure public beliefs about fiscal policy. Specifically, I construct proxies for sentiment toward fiscal policy and its perceived inflationary impact based on a textual analysis of *Wall Street Journal* articles.[7] Fiscal sentiment was positive in 2020 and was not associated with inflationary worries, indicating public support for fiscal measures at that time. However, when ARPA came online in 2021Q1, the sentiment declined fast, and inflation worries emerged in full force, consistent with the earlier evidence (Figure 8).

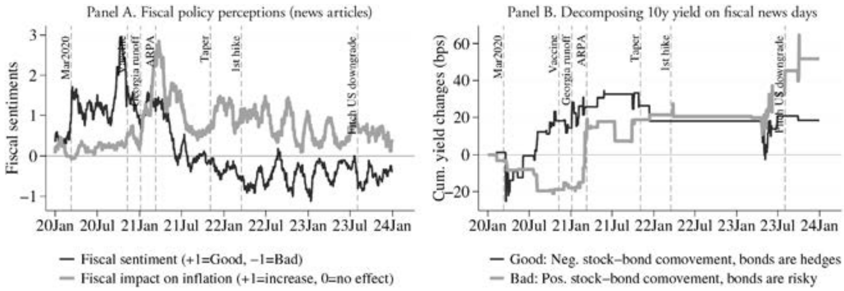
How much did the good and bad fiscal news contribute to long-term yields? In Panel B of Figure 10, I split the fiscal days by the sign of the stock-bond comovement into a good type (bonds are hedges: stocks and bonds move in opposite directions) and a bad type (bonds are risky: stocks and bonds move in the same direction). By this metric, the 2020 yield increases were mainly of the good type, reflecting mean-reversion from depressed levels due to the flight to safety when the pandemic first hit. Less benign are the two later episodes: ARPA and the second half of 2023. Both have the bad fiscal flavor that the authors highlight.

Conclusions

The authors warn against the dire consequences of a fiscal regime. I do not see clear evidence that this scenario materialized in 2020, and bonds are still *relatively* safe today. However, the more recent events in the second half of 2023, at the end of the authors' sample, should serve as a warning. They manifest the importance of the fiscal-monetary interaction.

What lessons can we take away? First, central bank credibility is a valuable fiscal asset. While the Fed's credibility buffer was strong in 2021, the sheer perception of accommodating fiscal policy can be costly. Second, forward guidance can be constraining. When realized shocks and market beliefs diverge from policymakers' assumptions, forward guidance can weaken the central bank's control, especially with risk premia involved. Finally, the credibility of communication is vital. Policymakers should clearly explain the objectives and the reaction function. A well-argued economic assessment and its uncertainties are integral to a credible narrative.

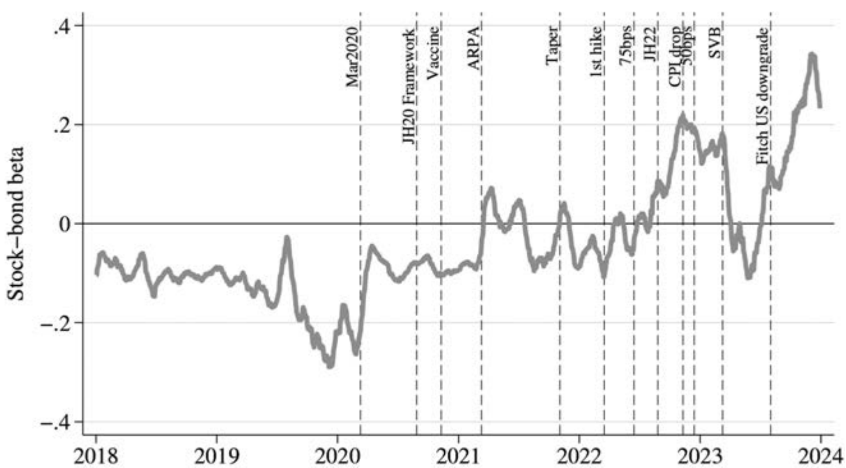
Figure 10
Good and Bad Fiscal News



Note: Panel A measures public beliefs about fiscal policy using texts from *Wall Street Journal* articles. The y-axis is the net number of articles per day indicating positive sentiment toward fiscal policy and its perceived impact on increasing inflation. The daily series is smoothed with a 20-day moving average. Panel B presents cumulative yield changes on fiscal news-heavy days, splitting those days into two groups based on positive or negative comovement between stocks and long-term bonds. The stock and bond data underlying the calculation are the same as in Figure 9. The sample in both panels runs from January 2020 to December 2023.

Appendix

Figure A-1
Stock-bond Betas



Note: The figure plots realized betas of the Ultra 10-Year U.S. Treasury Note futures returns on the S&P 500 E-mini futures returns. Daily realized betas are calculated from realized covariances and variances of one-minute log returns and are smoothed with a 22-day moving average. The high-frequency futures data are obtained from TickData.com.

Endnotes

[1]See, e.g., De Soyres et al. (2022), di Giovanni et al. (2023), Bianchi et al. (2023) for the analysis of this period and Summers (2021) and Cochrane (2023) (Chapter 21 "The COVID-19 Inflation") for warnings about the inflationary consequences of fiscal spending during the pandemic.

[2]https://www.federalreserve.gov/monetarypolicy/files/fomc_longerrungoals.pdf

[3]See Eggertsson and Kohn (2023); Meade (2023). Cieslak et al. (2024) analyze the Fed's communication surrounding the framework review and after its announcement.

[4]The model is maintained and updated by the Federal Reserve. The estimates are downloaded from https://www.federalreserve.gov/pubs/feds/2005/200533/200533abs.html.

[5]See also the analysis of this period in Bianchi et al. (2023), Mian et al. (2024), and Hazell and Hobler (2024).

[6]The macro announcements include CPI, PPI final demand, nonfarm payroll, GDP, initial jobless claims, ISM manufacturing, consumer confidence, and advance retail sales. The Fed events cover monetary policy decision announcements, Chair's press conferences, minutes, speeches, and other intermeeting communications covered by the FOMC Speak database. An event study around fiscal events is challenging, given the different types of events and lack of regular announcement timing. I, therefore, identify fiscal-news-heavy days using the Bloomberg News Trend function as the top 5% of days with the highest volume of fiscal news for topics related to "fiscal policy" and "budget" and another top 5% of days with the highest news volume based on keywords, including "stimulus package," "relief bill," "relief package," "legislative bill," and "legislative package." The event windows over which I measure respective yield changes are non-overlapping, i.e., the Fed communication windows exclude macro windows, and fiscal days exclude macro and Fed windows.

[7]The corpus contains 2,568 *Wall Street Journal* articles covering fiscal and monetary policy and is analyzed with OpenAI's GPT. A positive sentiment means that fiscal policy is seen as having a positive effect on the economy. An article indicating a positive (negative) sentiment is scored as +1 (−1). Similarly, an article indicating a positive inflationary impact of fiscal policy is scored as +1, no effect as 0, and negative effect as −1. The article-level scores are then aggregated to daily frequency by summing up the individual scores.

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General Discussion: Government Debt in Mature Markets

Moderator: Karen Dynan

Karen Dynan (Moderator): We're just going to turn to the general discussion. Now, same as before, wait for the microphone and identify yourself before you speak. And please be succinct so we can get to everyone. I'm not surprised to see Barry Eichengreen's hand up, given the important work he did last year on fiscal sustainability. So, we're going to start with Barry.

Barry Eichengreen: Thank you. We've heard about risky Treasury debt, fiscal dominance. Lucas and Stokey, and 1983, but we haven't heard about old-fashioned optimal taxation theory, where policymakers balance the marginal costs of additional deficit spending and additional taxation and additional inflation. For many of the episodes that Hanno mentioned, World War I and World War II for example, I think that is a simpler and more illuminating way of thinking about why you got the increases in taxation and the increases in inflation in the combinations that you did. I'm not so sure that old fashioned optimal taxation theory illuminates what happened during COVID, but that's a reminder that the episodes you were talking about are not all the same.

Karen Dynan (Moderator): We're going a couple of rows back to Amir and then hand the mic to Viral Acharya.

Amir Sufi: Great paper, great discussion. I just wanted to think through more on the pure fiscal side for a different way in which monetary policy may affect government yields. I think in a model, even where you have pure monetary dominance in which the monetary policymaker always perfectly responds to any of the inflation impression coming from fiscal stimulus, you still will have, even in that model, a natural effect of more fiscal spending on convenience yields. That's well shown. As Arvind Krishnamurthy's foundational work, people have followed it up, we know that unexpected increases in deficit spending in the level of government debt will raise the interest rate on government debt through just shrinking that convenience yield. I think that's important just to understand. Perhaps, Hanno, part of what you're saying is that we've reached a point now where convenience yields — if you saturate the market with anything, it can be M&Ms or whatever, you're eventually going to affect the price. Maybe we've affected the price so much that we no longer have any kind of fiscal space. My question to you is, how do you think about QE in a world in which most of this action is coming through the convenience yield? If the Fed is stepping in every time there's a fiscal shock, how does the market react in terms of how they think the convenience yield will change? My instinct tells me as a finance professor, if in expectation I know every time that there's a fiscal spending shock, the Fed will step in. There will be a level effect once I understand that, but then there won't be a marginal effect any time the Fed actually intervenes. I was just wondering what you think about that.

Viral Acharya: One, I wanted to try and reconcile the two views of Hanno and Anna, which is that it seems very robust in data that convenience yield is a function of the covariance of the bonds and the stocks. Now the convenience yield could erode because of inflation. So, high inflation will cause long duration stocks to correct, it will cause long duration bonds to correct, and that's going to lower the incentives to hold bonds. Now whether the inflation is caused by a Fed action or whether it's caused by a fiscal action, I think both will actually lead to exactly the same outcome. But I think I had a slightly theoretical point to make, which is that Hanno, for a reserve currency, I'm not sure if these two views in which it's either taxpayers or the bondholders that bear the risk from deficits is sort of the right one. For a reserve currency, the credibility of not doing "crazy things" for the taxpayers actually comes from the issuing country not passing on the losses to the bondholders. Let me just try and explain what I'm trying to say. If you think about the August 11 U.S. debt ceiling crisis, we could have had something that was not required, which is to default on the bondholders at that point, viz. the Treasury Bill holders. But ultimately what kept the U.S. government from doing that was that that would have caused a huge havoc in the economy through the repo markets. So, I think it could very well be that you do the right thing for the taxpayers by doing the right thing for the bondholders. And that is what the reserve currency status is, which is that the issuing country will not pass on losses to those who are holding its bonds for safety value. And by doing that, the country has a very long-term horizon of decision-making in its government. It doesn't need to do crazy short-term things.

Anusha Chari: A very nice paper, Hanno. And my question builds on something that Viral just brought up. In your previous work on exorbitant privilege gained and lost, you have talked about extra fiscal capacity for the global safe asset supplier. How does that play out in the context of safe versus risky, this safe versus risky regime narrative that you have presented today? And I am just wondering if there are any time-varying implications of regime switches in terms of where Treasury yields are trading, and which regime do you think is consistent with what we're seeing right now, especially with the higher tails that we're seeing in Treasury auctions?

Hanno Lustig: Let me try and take a stab at all these different comments, and then maybe in the process I'll also respond to some of the things that Anna said. So first, Barry Eichengreen, the point that Lucas and Stokey (1984) made is very similar to the point you're making, which is that in bad states of the world, it might just be optimal not to raise tax rates too much, because that's distortionary. And then in fact, if you make bondholders pay for some of the exogenous spending, that's optimal. And so, in that sense, what we were trying to say is risky debt, even though that sounds pejorative, isn't necessarily so from a welfare perspective. So, I think we're in agreement there.

The way I interpret the insights from the optimal taxation literature is that actually, if you could, what you'd want it to do as a government is issue state-contingent debt that doesn't pay off when you're in a war or you're hit by something like COVID, and issuing long-term nominal debt and having expected inflation go up does that for you. And that's not necessarily a bad thing, but of course, if that's what you're doing, if that's the regime you're in, you should expect yields to respond. And so fiscal dominance is a loaded term, but really, what we're implying there is that, any time you have unfunded spending shocks, where you increase spending today but investors don't really think that there will be future tax increases or spending cuts to offset that, then you're fundamentally, inevitably, in a risky debt regime, and something will have to give. The debt will have to be marked to market, and that can happen in different ways. It doesn't really matter whether it's demand or supply-driven inflation. If you, for example, look at, say, World War I, obviously, there's both, I would say. There's a huge fraction of the labor force that's obviously no longer available. There's a big increase in government spending, so you have all these forces operating at the same time. And let me just add that this pertains to Anna's discussion. I don't necessarily see as much of a tension between her view and ours in the sense that even when you're in this risky debt regime that is led by the government, in some sense, what monetary policy does is still very relevant for outcomes and for the way bonds are priced. And, actually, in our stylized model, we show that we're not necessarily thinking about a big regime shift by the way that occurs in 2020. We're just thinking: there's this huge fiscal shock that hit the economy. How does the value of debt respond? And I think, and this kind of goes to Viral's question as well, it's hard to argue that bondholders were protected, if you look at what happened, if you bought a claim to all treasuries in March 2020 and you held it for three years, you would have lost, in real terms, a quarter of your investment. So, you start with a dollar, in real terms you end up with 75 cents. In these other countries, because duration of debt is a bit higher, you would have lost even more. But that's completely in line with what you see when you look at the evidence from wars. I have some related work with Stijn Van Nieuwerburgh, Mindy Xiaolan, and Zhengyang Jiang where we look at all U.S. and U.K. wars and that's, you're actually better off buying stocks than bonds when the U.S. or the U.K. goes through war. And I think that's a good analogy for thinking about COVID. Amir, you brought up convenience yields. Yes, I think the convenience yield channel is a very important one and it's obviously important in the data. I think I showed you that graph where, if you look at the end of the sample and you correct for credit risk, long-dated treasuries at the 10-year horizon don't seem to be trading at a big premium relative to corporate bonds. And if you're trying to make sense of that, well then I think you think about the increase in supply. We know from Arvind's work with Annette Vissing-Jorgensen that if you increase supply, that the yield that investors are willing to forego for the safety and liquidity of treasuries is inevitably going down. And I think that is what happens. Now, how does that process work? Well that's actually in a companion paper, 'Can Treasury Markets Add and Subtract?'. With these same authors, we look at whether these CBO shocks, where they price the cost of a bill and they release these numbers, whether that affects the convenience field because it should and it does actually, quite significantly so. I don't remember the numbers off the top of my hat, but I can definitely refer you to it. So we have some high frequency evidence that speaks to that. When I say high frequency, I should point out that we don't have the exact time stamps for these CBO releases. So we're just looking at daily movements in bond yields. But I think that's a very important channel. And I would say we shouldn't just look at the narrow convenience field on treasuries relative to other safe assets, but just a broad convenience field on all safe assets. And if you think about what happened in COVID there was a huge increase in the supply of safe assets. If you add up what happened in the U.S. and Europe and other parts of the world, it's not surprising that these convenience fields declined by as much as they did. And I think that's a channel that we should sort of try and insert into these models.

Anusha, thank you for asking about the connection to exorbitant privilege. It's certainly true that because of the U.S.'s exceptional role in the international financial system, historically the U.S. has benefited from this sort of strong safe asset demand from foreign investors. And I think if you try to understand the difference between the response in 2008 and 2020, I think it's important to think about that because foreign investors, they weren't there anymore in 2020 to do the heavy lifting and buy a lot of the additional issuance. It just didn't happen. In fact, they were selling. And they were selling longer maturities. I would qualify this dash for cash interpretation. It was really selling at longer maturities. That's not what I would call a dash for cash. It's really, in some sense, a flight from maturity. So something changed. And I think it's important to think about what that is. If you look at historical precedents, obviously the U.K., say before World War I, was in the position the U.S. is in now, the world's safe asset supplier. But then World War I happened, and I think they exhausted the privilege. They had to issue a lot of debt to fight World War I and to help their allies. And after that, they were arguably in a serious fiscal crisis where they defaulted on some intergovernmental loans that were extended to them by the U.S., and they had to restructure some debt. I think that's a cautionary tale in that sense.

Karen Dynan (Moderator): We had a bunch of hands go up at the back of the room, and we haven't been back there before — so I'm going to call on Don Kohn and then Iván Werning, Agustín Carstens, and Roger Ferguson.

Don Kohn: So, I'm much more comfortable with Anna's explanation of the change in interest rates over this period than I am with Hanno's. There is huge uncertainty around the effects of COVID, around associated supply and demand shifts, and around changing perceptions of r*-- that is what the savings investment balance dictates about medium and longer term interest rates. And I think this was particularly important in 2023 when rates rose because the economy was proving very resilient to what looked like restrictive monetary policy. I's really important to differentiate between Anna's and Hanno's analysis because in Anna's world, there's no reason why the Fed can't target a 2% inflation and keep that inflation down. There's no reason why the inflation should be drifting higher as it seems to in Hanno's world. And finally, I wonder how you think about how you see developments since October 2023. long term rates are a percentage point lower now than they were in October 2023. And I would assert we've had no good news on expected surpluses in the future. Neither political party seems willing to tackle the rise in the debt to income ratio.

Iván Werning: I was going to give some praise and some critique. The praise is, I think the paper is touching on an important issue, thinking about debt is risky and thinking about the trade-offs. And I think it goes back, as was said, to Barro and Lucas and Stokey. And that's — that's very important to bring back, I think. What I, my critique is, I don't understand why that's tied up with this discussion of monetary policy being passive or active. And there's implicitly in between the lines of support for a fiscal theory, the price level type reasoning, which I think is not scientifically, you know, the inference is not very strong there. It's based on setting up two simple models. I think that ties in with Anna's comment. Like, you know, you're kind of doing this inference out of a very simple model where the only way you would have risk is if you had this passive monetary policy, but you could get risk from a bunch of other things. And so I guess coming from Argentina, I'm very into fiscal dominance, but I'm not into the immaculate fiscal dominance that some people are discussing for the U.S. And I think I'm very skeptical about that. You know, it really demands that people are imagining in the future the Treasury is going to rape the Fed if inflation doesn't go up. I really, really doubt that. So I think that's my critique.

Agustín Carstens: Thank you very much. Very interesting paper and discussion. I will make a comment coming more as a policy strategist than an economic researcher. I think when you are doing policy, you have to think not only what is going on immediately, but also what comes next, you know. And so you focused on this episode of March 20, a period that was tremendously rich in high uncertainty, where we really didn't know what was going on, what was going to follow. And my point is that at some point it might be appropriate to give the impression that in the short term you might be protecting the bondholders, but in the medium and long term you are protecting the taxpayer. Sometimes if you don't stabilize markets in an opportune moment, dynamics can turn so sour that eventually the cost of stabilizing is far higher, with a much higher cost to the taxpayer. And I think these type of intertemporal considerations you should try to capture in the models. I mean, it's a little bit — let me be very, very, very — put this in very simplistic terms. I like to grill, you know. And once in a while you have flare-ups. And of course you, most of the time you say, well, it's a flare-up, it will come down, I don't want to risk my steak, and therefore you don't do anything, you know. But there are some times when the flare-up is so high that it's better probably to use the fire extinguisher and not to wait to see if it stabilizes or not, and then if it doesn't you might have to call the firefighters. So sometimes it's better to use the fire extinguisher and not wait to have high possibilities of calling the firefighters.

Karen Dynan (Moderator): All right, thank you. We're going to go to Roger Ferguson, and then I want to squeeze in a couple of Treasury people, so Nellie Lang and Jay Shambaugh, and we'll see how much time we have left after that.

Roger Ferguson: A couple of questions. You seem to think of fiscal debt as having two kinds of risk. Either it's going to be paid for by inflation over time or it's going to be paid for by increasing taxes. And maybe some Treasury people will raise this, but we've seen a third kind, at least here recently in the U.S., which is in the so-called JOBS Act, the theory of the case being spend some money, subsidize increases in infrastructure, and over time it all gets paid for by much more productive economy growing, et cetera, reduced supply chain constraints, et cetera. So you know, and those things are often scored negatively by CBO, but in the minds of politicians and those who support them, they're meant to do something very, very different. So should we think about that as a different category? Or is it all roughly just the same because it ends up increasing the debt and deficit in at least a short period of time?

Nellie Liang: Thank you for the discussion and the paper. Very interesting. I think I'm building on some of the comments on attributing too much to the risky debt regime and not capturing the uncertainty about the uncertainty in the episode. And two empirical points. One, it seems like the downward drift from the deficit information, a good part of that is at the very beginning. And then you would have thought, and Anna pointed this out very usefully, that ARPA would have generated a bigger effect. And that's not there.

And that's just like just a data point. And also that the times, the covariation between the stock bond correlation varies quite a bit over time in this episode. And I think that's useful to point out. Another piece is the really sharp, if it's not plumbing, I know you wanted to avoid plumbing and it's useful to frame without it. But the plumbing, the announcement of the Fed interactions in March led to a very sharp decline in the Treasury yield. And I think if it was a risky debt story only that you wouldn't have seen that kind of action. And then just to mention, to add something from the Treasury market side, during this whole episode Treasury is still issuing debt. And because there's a schedule of issuing and most of the onset with the passage of the CARES Act, there's more than a trillion dollars of debt. Most of it is being issued with bills. But there's also prescheduled coupon issuance at longer maturities. And there is no sign of problems in that, even during March and April. So I just wanted to pass that on as part of the maturity story.

Hanno Lustig: Okay, I'll try to be very brief. First to Don Kohn's point, I just want to be clear here. I think the story that Anna is telling is not inconsistent with what we're seeing. What we're seeing is, look, if you have unfunded government spending shocks, and I think, I'd imagine if I do a poll here that a large fraction of the audience here would probably think that some of it is probably unfunded, not just in the U.S. but in Europe and other countries, then something has to give and debt will have to be marked down. Unless you think there's a perfectly elastic supply of gullible investors, that has to happen. And it can happen in different ways. So you don't have to be a fervent fiscal theory of the price level believer. It could be that convenience yields decline, and in fact I showed you evidence that that happened. So I'm not hanging my hat just on only the Fiscal Theory of the Price Level channel. And I'm also not using that stylized model for inference, Iván, to your second point. I'm actually just using it to illustrate these mechanisms, and we state quite clearly we need to have adjustments in narrow and broad convenience yields brought in as well in order to have a realistic model. So we're not using the model to do inference. But the bottom line is if you have unfunded spending shocks, debt will have to be marked down. I think it's hard to disagree with that, and that is what our paper's about, and that's the high-frequency evidence that we bring to bear. And I don't think that's inconsistent at all with Anna's view. Monetary policy still matters in that world, by the way. We also don't think that there's a regime shift just in March 2020. We just say, there's a really big shock. This is what happened. And if you look at history, it's actually in line with what you expect to see if you look at wars.

Karen Dynan (Moderator): I've got Jay Shambaugh and Governor Yaron as the final questions.

Jay Shambaugh: This is a really interesting paper, and I thought excellent discussion. I did want to echo what some of the other folks in the room said about not being entirely sure you want to interpret the interest rate moves as suggesting the Fed in some sense has to accommodate or is going to move, especially I wanted to just think about the international evidence. When I think of the international evidence, do I really think that the move in German yields suggests that investors think either Germany is going to default or that the ECB is going to inflate away German debt effectively? It's harder for me to see that one. Amir Sufi gave the convenience yield story. I wonder also just about the basic macro story of on a fiscal positive shock day, or negative news, but that they're going to spend more, that makes me think output is either going to be higher or we're going to push against an aggregate supply curve, and that's going to be inflationary and the Fed is going to be a bit tighter, and that leads to the bond yields going up. And then I am also just really curious about Don Kohn's question, because I had the same one, about how in your model the 100 basis point drop over the last 10 months fits. I'm just curious on that one.

Amir Yaron: Hanno, very interesting. However, I want to reiterate what Augustine Carstens mentioned. I think there is a missing regime in your model, which is sort of — we can think of it as a crash regime, where the economy really takes a hit. We arranged for that. And I think then the welfare conclusions that you sort of suggest that this has been — the intervention by the Fed and the large purchase was sort of, you know, kind of was too costly. There is a scenario where this in fact benefited the overall situation, and if you just had a Hanson-Sergeant robust control against all the uncertainties that were going on at the initial stage of March 2020, this is certainly a situation, certainly from an ex ante perspective and even an ex post perspective of a decent act. Just regarding the dash to cash, I think here, at Jackson Hole, Darrell Duffie gave a paper last year ago about the importance of, you know, the functioning of the markets and what happens when you don't have the all-to-all trading and effective netting. And I think if you're going to highlight March 2020, that's a really important point. Final point about policy, if you're going to push this, if you can save the mix on the Treasury should be between tips, maturity, and things like that regarding the way you think about the smoothing here.

Panel: Monetary Policy Implications of Market Maker of Last Resort Operations

Anil K. Kashyap

Thanks to the organizers for the opportunity to speak on this panel. I will focus my remarks on how central bank asset purchases that are motivated by financial stability concerns can have spillover implications for monetary policy. I will split the comments into three parts. I start with my explanation for why it might be appropriate to use asset purchases to achieve financial stability aims. Next, I review a pair of well-known interventions by the Federal Reserve and Bank of England that involve asset purchases. These examples are chosen to introduce some of the issues that purchase decisions create. I will close with a couple of recommendations for how to set up purchase facilities.

1. The Rationale for Financial Stability Motivated Asset Purchases

Going back to at least Bagehot (1873), it has been conventional wisdom that central banks should be willing to conduct lending operations to combat bouts of instability. Lending is no longer a limit on what central banks are willing to do. Since the global financial crisis,

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asset purchases have become an increasingly common part of the monetary policy toolkit. There is now a deep literature that explains the rationale for these purchases (Bernanke 2020) and evaluates the effects of both the purchases (Fabo et al 2021) and the sales when the policy is reversed (Du, Forbes, Luzzetti 2024).

In the last few years, however, multiple central banks have bought securities citing a financial stability rationale rather than a monetary policy motivation.[1] The Federal Reserve purchases starting in March 2020 are reviewed below. At that same time the Bank of England, the Bank of Canada and the European Central Bank (ECB) also initiated such purchases. In addition, at least 13 emerging central banks also launched similar programs at the onset of the COVID pandemic (Arslan, Drehmann and Hofmann 2020). In most cases, central banks were buying government bonds but in some cases, mortgage securities or even corporate bonds were eligible for purchase.

While the broad concern with having orderly markets for government debt goes back to the founding of the Federal Reserve (Menand and Younger 2024), I see two distinct reasons for why purchases, and not just lending, can be justified. One rationale is that if government bond prices become dislocated, the problems spill over to the rest of the financial system because the yield curve for government bonds underpins all fixed-income pricing. For instance, in the United States, the Secured Overnight Financing Rate (SOFR) now underpins many private sector rates. The calculation of SOFR is built off of government repo rates, so that makes the pass-through of problems in the Treasury market to private rates almost immediate.

Of course, if the government bond rates simply reflect concerns about the fiscal responsibility of the government, then there is nothing the central bank can do to remedy that problem. Whether or not the central bank tries to assert a financial stability motive for any purchases, bond purchases will ultimately lead to inflation if they wind up merely monetizing the debt. To take a concrete example, the Fed has correctly said that if Congressional gridlock leads to a government shutdown, the Fed cannot contain the market impact of a debt default.

In contrast, if there are technical factors causing the dislocation, then there is every reason for the central bank to try to eliminate the mispricing. In this situation, it is quite possible that the presence of a lending facility will not be enough to reverse the problems (Hauser 2021). I see no moral hazard in buying government securities to restore the normalcy of the safe yield curve in dysfunctional markets. By stabilizing the safe yield curve the central bank can allow the markets for private securities to resume functioning.

The more interesting and controversial case comes if the central banks opt to buy private securities, such as corporate bonds or commercial paper. The financial stability justification for doing so would be that there is a fire-sale that is depressing prices (Shleifer and Vishny 2010). For instance, if the natural buyers of these securities are distressed for other reasons, that can depress the private securities prices.

We care about the fire-sale because when secondary market prices for corporate securities are persistently depressed it becomes impossible for firms to issue new securities in the primary market; investors will only buy in the primary market if the expected returns are comparable to what they can get from buying existing securities. This is not just a hypothetical concern, during the first 3 weeks of March 2020 there were no high-yield bonds issued.

The threshold for making a determination that a large persistent fire-sale of private securities is underway will be high. There is some moral hazard risk to buying private securities, the central bank is likely risking taxpayer money in these transactions and drawing the line at which securities are eligible is also complicated. So there are good reasons why central banks have historically shied away from crossing this line and making these purchases. Any decision to do so would need to account for all the risks that would come with these purchases. Nonetheless, there is at least a logical case for considering purchases if a fire-sale is sufficiently crippling and stopping a fire-sale is a distinct motivation from stabilizing the safe-yield curve.

2. A Pair of Case Studies

How do purchase programs work in practice? Let me describe two well-studied cases that will help identify some of the policy challenges of conducting purchase operations.

Consider first the decisions taken by the Federal Reserve's Federal Open Market Committee (FOMC) in March 2020 at the onset of the Covid pandemic. Starting around March 9, 2020, many different parties in the financial system found themselves needing to make payments or experiencing rapid withdrawals. This episode has come to be known as the "dash for cash" (see Bank of England, 2020). The result was exceptionally large sales of U.S. Treasury securities and a commensurately big drop in Treasury prices (leading the ten-year Treasury nominal yield to rise by 64 basis points between March 9 and 18). The Federal Reserve responded with an unprecedented expansion of its asset purchases, buying more than $1 trillion of Treasury securities during the month of March (see Vissing Jorgensen 2021 for a daily analysis of the early part of the program).

The more relevant consideration for this discussion is how the purchases and the narrative around them evolved as the initial stresses subsided. The particular passages from the FOMC post-meeting statements related to the asset purchases over the next six months are presented in Table 1. The italicized text in bold highlights what I view as the key passages. At the initial unscheduled meeting on March 15 the FOMC slashed interest rates to the effective lower bound. It also announced that the additional asset purchases were being undertaken to support "the smooth functioning of markets" to assure "the smooth flow of credit to businesses and households." The statement only set floors on the size of purchases, so commitment could be viewed as open-ended. There was no definition offered for how to tell when the smooth functioning of markets would be deemed to have been restored.

When it next clarified plans regarding additional asset purchases, at another unscheduled meeting on March 23, the initial rationale was amended. The statement shifted to saying that purchases would continue in "the amounts needed to support smooth market func-

Table 1
FOMC Statements Regarding Asset Purchases

Date	Excerpts from FOMC Statements explaining purchase rational
Unscheduled Meeting March 15, 2020	***To support the smooth functioning of markets*** for Treasury securities and agency mortgage-backed securities ***that are central to the flow of credit to households and businesses,*** over coming months…
Unscheduled Meeting	
March 23, 2020	The Federal Reserve will continue to purchase Treasury securities and agency mortgage-backed securities in the amounts ***needed to support smooth market functioning and effective transmission of monetary policy to broader financial conditions.***
Regularly Scheduled Meeting April 29, 2020	… in the amounts needed to ***support smooth market functioning, thereby fostering effective transmission of monetary policy to broader financial conditions.***
Regularly Scheduled Meeting September 16, 2020	In addition, over coming months the Federal Reserve will increase its holdings of Treasury securities and agency mortgage-backed securities at least at the current pace to ***sustain smooth market functioning and help foster accommodative financial conditions,*** thereby supporting the flow of credit to households and businesses.

Source: FOMC

tioning and effective transmission of monetary policy to broader financial conditions and the economy." Thus, almost immediately, the financial stability rationale and monetary policy objectives were intermingled.

At the next scheduled FOMC meeting, on April 29, the committee's language changed again. At this point, the asset purchases were justified in part because they helped in "fostering" the effective transmission of monetary policy to broader financial conditions. The switch suggests that the purchases were now viewed as an important factor for ensuring the success of monetary policy in meeting its objectives. This language was repeated at the next two regularly scheduled FOMC meetings in June and July. Starting in June, the description of the expected increase in holdings was shifted to be "at least at the current pace."

The final important change in language comes at the September 2020 FOMC meeting. Here the language was modified to say the increase in the balance sheet was now in part needed to help "foster accommodative financial conditions."

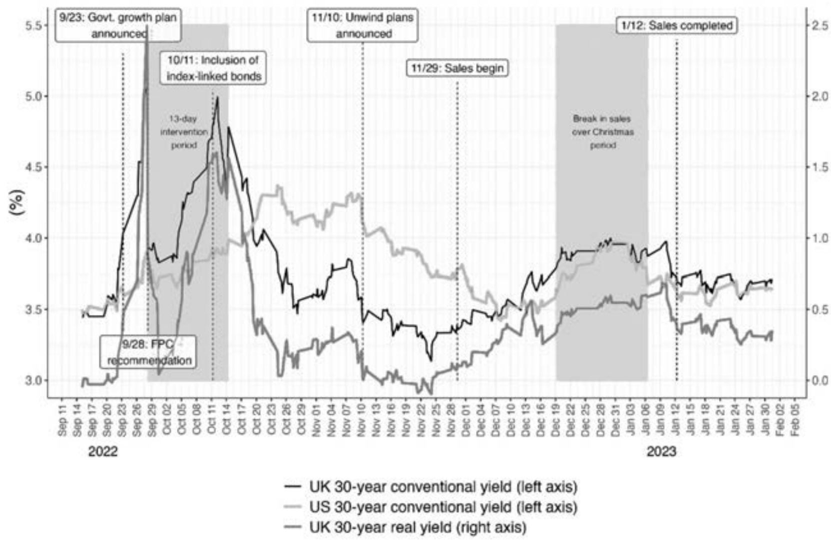
The initial purchases were undoubtedly merited on financial stability grounds, I believe that justification was long gone by the summer. Ultimately, the asset purchases continued until March 2022.[2] I suspect at least some members of the FOMC look back and question whether an earlier end might have been prudent. So one motivation for my recommendations in the next section, is whether any institutional reforms might be considered based on this episode.

As a point of contrast, consider the alternative approach followed by the Bank of England during the gilt market stress in the fall of 2022.[3] In brief, this episode started on September 23 when the U.K. Chancellor of the Exchequer gave a speech outlining a "mini-budget" that was proposed by Liz Truss's new government. Dubbed "the fiscal event" by Jon Cunliffe (Deputy Governor of the Bank of England), the budget was not accompanied by the customary independent analysis of the gap between the government's spending and taxes promises. Markets reacted badly to the proposal that appeared to imply a huge unfunded set of commitments. Over the next three trading days long-term bond yields rose by 130 basis points, a move three times larger than any prior change in such a short period.

The path for real and nominal yields are shown in Figure 1. If these moves were a reflection of concerns over debt monetization, one would have expected the gap between the nominal and real yields to open up to reflect a change in expected inflation. The fact that real yields were moving more than nominal was one hint that the simple interpretation was incorrect. The U.S. long-term yields are included as a point of contrast and to show how erratically the U.K. rates were moving.

By the second trading day after the fiscal event, financial market commentary was focusing on the impact that rising rates would have on certain special purpose vehicles, known as liability-driven investment (LDI) funds, that U.K. pension funds had established to meet defined contribution obligations.[4] The LDIs owned roughly £1 trillion in long-term bonds and were financed with some cash that was provided by the sponsoring pension fund and by using repurchase agreements to cover the rest of the funding. The spike in interest rates led to large losses in the value of LDI assets and also reduced the value of the collateral that they were using in the repurchase agreements. This combination led the LDIs to sell the bonds into falling markets.

Figure 1
Interest Rates During the LDI Episode



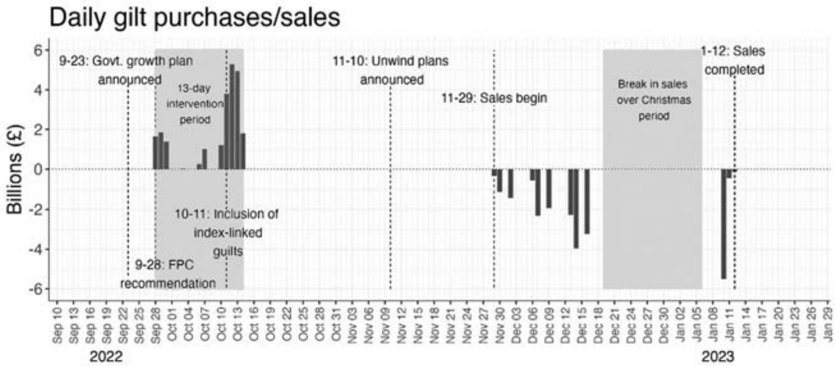
Source: Bloomberg

Thus, on September 28, the Bank of England, acting on the recommendation of its Financial Policy Committee, announced a temporary program to purchase gilts in an attempt to stabilize the market. The program was to last for 13 days with the Bank prepared to buy up to £5 billion per day. The program length and buying limit was set based on estimates of how long it would take the LDIs to obtain funding support from the sponsors and by estimates of the sales that might occur in the intervening period. Initially, only nominal bonds were eligible, but on October 11 eligibility was extended to include indexed linked bonds (aka "linkers"). Figure 2 shows the daily purchases during the life of the program.

The program ended on time and proved to be successful in buying time for the LDIs to arrange for additional funding. Ultimately the Bank purchased £19.3 billion of bonds, of which £7.2 billion were linkers. Rates also reversed their path, though the decline began when the government reversed its budget plans.

While this first part of the LDI saga has been heavily analyzed, less attention has been paid to the second part when the purchased

Figure 2
Bank of England Actions During the LDI Episode



Source: Bank of England

securities were sold. That phase started on November 10 when the Bank released its plan to unwind the purchases.[5] There were three important principles that the Bank announced in its plans. First, the sales had to be timely enough so as to honor the promise that the purchase program was temporary. If the securities were indefinitely retained, that could create confusion about why these purchases were different than the ones undertaken to meet monetary policy objectives. Second, the sales were to be conducted in an orderly manner. This meant that the sales should be structured so as to avoid triggering any renewed market dysfunction. Third, to support both these objectives, the timing of the sales would be "demand driven." This meant the pace and size the sales would depend on whether bids that were submitted were strong or weak. The Bank indicated it would use discretion in deciding on sales, with a general principle that "only bids that are deemed attractive relative to prevailing market levels will be accepted."

Remarkably, as shown in Figure 2, the sales were completed over 12 working days (spanning 4 weeks that included a two week respite for the Christmas holidays). The amounts sold varied between zero and £5.5 billion. The Bank also reported a profit of about £3.8 billion on the sales. The question of whether profits should be a necessary condition for judging the success of a program is worth debating.

3. Suggestions for Codifying Market Maker of Last Resort Facilities

The short-lived market turmoil in early August 2024 was not (ex-post) sufficiently disruptive to spur any central banks to announce a new purchase program. The speed of the events, however, serve as a reminder that instability and market dysfunction can appear quickly with little warning. Thus, I expect that sometime in the near future a major central bank will decide it needs to embark on a purchase program. With that in mind, I offer a couple of high-level suggestions about how to set up purchase facilities.

My first recommendation is that the internal central bank processes for deciding when to commence and cease purchases should be clarified. In the case of the U.K., where a formal Financial Policy Committee (FPC) exists, the existing arrangements seem adequate. Obviously, the group responsible for financial stability should have a say in when to commence a program.[6]

For many other central banks, including the Federal Reserve and ECB, there is not a formal FPC equivalent. Nevertheless, one could approximate the structure without needing any legislation to proceed. In particular, the leadership of the central bank could create a purchase facilities committee (PFC). If there are legal constraints on who formally makes balance sheet decisions, the PFC could be an advisory body that make a recommendation about financial stability actions. PFC membership should definitely include some of the people who participate in monetary policy decisions.

PFC membership should not, however, be limited to only monetary policymakers. Two other types of specialist members should be included. At least one member should be the person who oversees the central bank's market operations, for example in the U.S. the manager of the system open market account (and perhaps the deputy manager too). Virtually every central bank also has a division that monitors financial stability. The leader of the financial stability area (and possibly a deputy) should also be members of the PFC.

There are three distinct reasons why this kind of structure for the PFC is superior to a situation where purchase decisions would be decided solely by the group that sets monetary policy. First, it will improve the analytic discussions to be unambiguous in recognizing the purchase decisions are aimed at stability. The presence of the specialists will reinforce the idea that the purchase criteria are different than monetary policy purchase decisions. The fact that LDI purchases occurred just as the Bank of England was about to begin unwinding its monetary policy portfolio shows why this can be valuable.[7] New PFCs may face a similar situation and having a different set of people making the call to commence a program will be helpful. The specialists are also going to be focused on explaining why a facility needs to continue to operate and pushing discussions about when a reversal can begin.

The second reason for this favoring this PFC structure is that it simplifies external communications. Nearly every media account of the initiation of the LDI purchases noted that they were being undertaken as a result of an FPC recommendation. That allowed the Bank to clearly explain that this was not a monetary policy decision. I doubt this kind of separation is possible, if the purchase decisions are made by the exact same group of people who are making monetary policy decisions. Indeed, the communications challenges may even be bigger if purchases begin while QE is also be conducted.

Finally, the existence of a PFC will help with accountability in any ex-post evaluations of any operations. If a purchase program goes badly, the blame should be placed on the PFC and any recommendations about how to avoid future mistakes can be aimed at reforming PFC processes. I realize that because some of the monetary policymakers will be involved, the central bank cannot deflect all blame onto the PFC to absolve the central bank from any responsibility. Nonetheless, segmentation should at least partially shield the integrity of the monetary policy process.

The other suggestion is that after the PFC is formed it should quickly begin a public consultation on how the purchase facility will be structured. There are a myriad of details that need to be worked out, including the range of counterparties who can participate, the range of assets that are eligible, pricing rules and quantity limits, to name just a few. Buiter et al (2023) offer some good principles that could be used to start this discussion, and different jurisdictions will have different constraints on the governance of the central bank balance sheet and what can and cannot be purchased. In the interest of time, I cannot go into these issues today, though I do recommend that you review Logan (2023), for a great starting point for this conversation, and Kashyap, Stein Wallen and Younger (2025), for a discussion of how to detect and address instability in the Treasury market.

Beginning the discussions now, during peacetime, of what will surely be a complex set of issues is very important. Monetary policymakers routinely preach the importance of getting the public to understand their reaction function. The same principle applies with respect to the use of financial stability tools. If market participants know that a facility will be available and understand how it will operate, that information alone may help promote stability and reduce the need to activate the tool. Though conversations about a private securities facility could double-edged because they could encourage more risk-taking. So what is going to be said ought to be thought through in advance.

Endnotes

[1]The line between a financial stability justification and monetary policy motivation for purchases even in 2008 was already a little blurry, see e.g. https://www.federalreserve.gov/newsevents/pressreleases/monetary20081125b.htm As shown by Garbade and Keane (2020) and Anson et al. (2019), however, there are also much older historical precedents of purchases being explained based on financial stability considerations.

[2]Interestingly, some of the other emergency purchase programs that the Fed enacted at the onset of the pandemic were stopped soon and the acquired securities were promptly sold.

[3]For a more detailed analysis of the episode see Breeden 2022 and Alexander et al 2023.

[4]See for instance https://www.ft.com/content/4e6b89a3-a63e-49df-8a04-0488b69e84f5 (accessed August 7, 2024)

[5]See https://www.bankofengland.co.uk/news/2022/november/boe-demand-led-approach-to-unwind-recent-financial-stability-gilt-purchases (accessed August 7, 2024)

[6]The situation even in the U.K. is complicated since the Bank of England and not the FPC is responsible for the balance sheet actions, but the necessary cooperation on front is manageable.

[7]It may turn out that the harder thing to distinguish would be financial stability purchases at a time when monetary policy motivated purchases are also taking place. Even in this case, having a PFC recommendation to engage in additional purchases is likely to be helpful. Also, when it comes time to unwind the purchases the PFC would likely make another recommendation to start selling. At that time, the central bank could (and should) argue that monetary policy would still remain appropriately calibrated after the unwind is completed.

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Panel: The Monetary Transmission Mechanism

Patricia Mosser

In my day job, I train many current and future central bankers from all around the world. One of the things I try to impress on them is that the monetary transmission mechanism — how monetary policy "works", how it alters financial opportunities for financial institutions, businesses, households and governments (and thus influences output and inflation) — is not static. The global financial system is dynamic, and the ways that central bank policies influence financial conditions change frequently. Our macro models often ignore most of that as financial noise — and frankly it is sometimes noise — right up until the moment that it is not financial noise anymore. At that point, central bankers can be surprised that the impact of monetary policy is not what they predicted.

So today I want to talk about three forces that I believe have been particularly important in shaping how monetary policy works: regulation, financial innovation including digitalization and fast payments, and the impact of persistent massive excess liquidity provision by central banks since the Global Financial Crisis. I will give a few examples as I go along. I will also raise quite a few questions that I don't have answers to, but which I think are important for central bankers to consider in order to better understand how the monetary transmission mechanism has changed — and may change in the future.

Let me start with regulation.

We've known for a very long time that the structure of financial regulation is critical to the monetary transmission mechanism. Paul Volcker regularly noted that in the 70s and early 80s Regulation Q was the most effective monetary policy transmission mechanism ever invented. (Regulation Q is the former U.S. bank regulation that set caps on deposit interest rates paid by banks). As soon as the Federal Open Market Committee (FOMC) raised the policy rate above the deposit cap, deposits flowed out of the banking system, credit formation collapsed and the economy slowed down.

More recently, here is a quite sizable literature on the interaction of monetary policy and macroprudential policies. The overall conclusion is that when monetary policy and macroprudential policies are complements, rather than substitutes, that is when they reinforce each other, they are both more effective. The opposite is true if they work against each other. But many of the studies looking at this topic have taken a macro approach to measuring the impact of policies without identifying specific pieces of the monetary transmission mechanism.

I want highlight two very recent studies which directly focus on the interaction of regulation with the bank credit channel of monetary policy. Both studies look at the impact of rules which allow banks apply historical cost accounting to their securities portfolios. One study uses detailed data on U.S. banks; the other uses similar confidential data from the Euro Area (Italy). The bottom line of both studies is the same: greater allowance for historical cost accounting of securities, Held to Maturity (HTM) or Available for Sale (AFS), weakens the bank credit channel of monetary policy very significantly.

The paper on the Euro System examines the impact of European Central Bank's (ECB) asset purchase programs on individual bank lending decision using micro banking and supervisory data from the Bank of Italy.[1] In the Euro Area, the accounting treatment of sovereign bonds was used as macro-prudential tool during the European debt crisis. So, during the ECB's first asset purchase program in 2015, AFS sovereign bonds held at banks were treated like HTM to protect banks from volatility. By the time of the ECB's 2019 asset purchase program, AFS sovereign bonds held by banks were marked to market. The impact of ECB's bond purchases on bank credit in 2019 was orders of magnitude larger. The paper also looked at the impact of forward guidance on credit formation and found that it too was larger during the later period.

The second paper uses U.S. Federal Reserve Y-14 data to look at the same accounting treatment issue, but during a period of monetary policy tightening (2022-23).[2] So, it studies a different country, different banking structure, different monetary policy regime and a different monetary policy tool — but it comes to a surprisingly similar conclusion. Allowing banks to shield large portions of their securities portfolios from the capital implications of market fluctuations significantly blocks the impact of monetary policy on credit formation. So, in 2022, the FOMC's intent — that higher policy rates would tighten financial conditions — was thwarted to some extent by the very large holdings of HTM securities at U.S. banks, and by the treatment of AFS securities at some large regional banks. As an aside — this study also notes that U.S. banks (large and small) massively increased their HTM portfolios just prior to the Fed raising rates. So by 2022, the monetary transmission through banks was particularly small — and likely contributed to the relatively small tightening in financial conditions.

The results of both studies make intuitive sense. If a large proportion of bank securities portfolios are shielded from market pricing, then loosening or tightening monetary policy is unlikely to have large impacts on the banks' lending decisions, at least in the short run. Of course that's not a situation that can go on indefinitely, as we all (re)discovered in March 2023.

Another example of the importance of regulatory structure is the impact of capital regulation on dealer-intermediated fixed income markets. This is a story that everyone here is familiar with. Significantly higher capital requirements such as Basel III, and U.S.'s higher leverage ratio requirements were designed to limit risk taking behavior in the trading book — which is a desirable outcome from a safety and soundness perspective. However such regulations have consequences. They also limit the capacity and more importantly the flexibility of securities dealers and banks to use their balance sheets to intermediate and fund arbitrage in debt markets, including those for government securities. The net result is more fragile sovereign debt markets, and consequently the interest rate channel of monetary policy transmission is also more fragile and potentially more volatile. In extremis, if the interest rate channel of monetary policy breaks, as it did in 2020, central banks need to be much more aggressive with respect to their monetary policy actions, whether it is via interest rate or balance sheet policies.

I can't emphasize enough how important I think this issue is for monetary policy making. Central banks rely on sovereign debt markets to work efficiently — to be deep and liquid — in order to transmit monetary policy changes from short rates to long rates, to provide information on term premia, risk premia and inflation expectations, and to assess the impact of forward guidance. In turn all of those are key pieces of information used to determine the future stance of monetary policy. So, if the interest rate channel is more unpredictable — and prone to "breaking" — then central banks have a problem on their hands.

Now let me turn to the impact of policy stance on transmission mechanisms. For more than a decade, the global economic and financial environment was unusual by historical standards: weak economic growth, too-low inflation, near-zero interest rates, suppressed volatility and risk premia, and extraordinary amounts of excess liquidity provision by central banks. Did that affect monetary policy transmission mechanisms?

Since 2010, financial institutions, both banks and nonbanks around the world, restructured their balance sheets, business mix, risk management, and liquidity management very profoundly. Some of those adjustments were due to regulatory changes, but other changes reflect the fact that for more than a decade monetary policy intentionally pushed financial flows into riskier assets. At the same time, the long-standing trend of financial risk taking and credit formation shifting from banking and into financial markets (via nonbanks and banks) accelerated. But greater use of markets for credit formation also requires greater use of dealer/bank balance sheets to intermediate in these markets, like sovereign debt markets. This begs the question whether the broad credit channel of monetary transmission is also more fragile and potentially unpredictable in the future.

One thing we certainly know: central bank balance sheet policies have changed the structure of money markets and so altered the first stage of monetary transmission mechanism. Unsecured interbank markets are a shadow of their former selves and seem to be either feast or famine. Because of large amounts of central bank liquidity, there are very limited transactions during normal times nearly all of them near the policy rate. These periods of stability are punctuated by occasional small bursts of trading activity and high volatility in money markets. The sort of "day to day" arbitrage movements in money markets that were normal 15 years ago (noise if you like) don't happen anymore. How much does that matter for the transmission of monetary policy? In normal times probably not much. But during the short periods of extreme volatility it certainly matters because the monetary policy responses to that volatility can be very large. The U.S. experience in 2019 is an example.

Finally, I want to turn to how financial innovation may impact the monetary transmission mechanism: Again there is a long history of financial innovations — financial derivatives, nonbank financial intermediation, securitization — changing the ways that monetary policy impacts financial markets and the economy. The agency mortgage-backed securities (MBS) market in the U.S. is a classic example. Since the 1990s, the MBS market has — occasionally –caused temporary but large distortions to the interest rate channel of monetary policy. These distortions are particularly common for monetary policy changes that occur when many U.S. home mortgages are "in the money" to be refinanced (such as in 1994, 2003, 2009).

Innovations and digitalization of payments are the more recent developments that are likely to affect transmission mechanism. In the last few years, the speed with which funds can flow in and out of financial institutions, as well as in and out of countries has increased dramatically. Speeds will almost certainly continue to increase in the future. The potential for ever faster flows of funding may lead to greater volatility in asset prices, exchange rates, etc. An open question is whether faster flows/payments will strengthen transmissions via interest rates, exchange rates and credit conditions, or weaken them. My concern is that significantly faster flows may make transmission mechanisms less stable and predictable. If so, central banks may have difficulty calibrating how a particular monetary policy action will impact financial conditions and thus the real economy.

Innovations in payments, and faster speed, seem particularly important for the balance sheet part of monetary policy. Specifically, the interaction of payments innovation with liquidity regulation may significantly impact the size of reserves. Whether it is the Fed's "ample" regime — or the (smaller) excess reserves regimes outlined by the Bank of Canada, Bank of England, the ECB or the Reserve Bank of Australia, bottom line is that the amount of reserves supplied by central banks will be the same or larger than the amount banks' demand.

If I were a bank Treasurer, what would I be doing in response to faster payment flows (and the lessons of March 2023)? Well, I'd be thinking very seriously about how much intra-day liquidity my institution needs, i.e. how much do I need by 5:00 p.m. each day (T+0 liquidity)? Do I need more? Very likely. The only truly reliable way for a bank to self-insure intra-day liquidity (as required by the Liquidity Coverage Ratio) is to hold central bank reserves. Other types of high-quality liquid assets won't do. So how large a quantity of reserves will central banks need to supply in a world of real-time gross settlement of payments for everyone? Potentially very big. Relatedly this raises the issue of the effectiveness of central bank backstop liquidity facilities (lender of last resort, repo facilities, etc.) But that is an important topic for another panel.

Looking further forward: will other channels of monetary policy transmission change as the speed of financial payments and transactions accelerates, for example if central banks move toward central bank digital currencies? It seems to me that entering a world of instantaneous payments raises a host of important issues around financial structure. How and when will intraday borrowing and lending be handled. How will securities transactions settle? How will financial contracts (loans, derivatives, securities) be changed to handle real-time payments? How will international funding flows adjust to simultaneously allow for fast payments and manage across the global day? In short, how will the plumbing of the financial system — financial instruments, infrastructures and market conventions — adapt to support such a system. What does this have to do with monetary transmission? Our understanding of the monetary transmission mechanism today is predicated on a particular design (and plumbing) of the global financial system. That design is already changing and will likely change in very fundamental ways in the coming years. And it will in turn almost certainly alter how monetary policy "works."

I realize that I have taken a scatter shot approach in my remarks today. But I hope you will take my comments as a reason to explore how monetary transmission channel has changed — and likely will change. As I suggested at the beginning, I have asked a lot of questions I don't know the answers to, but I think they are worth careful consideration by central banks.

Endnotes

[1]Orame, Andrea and Ramcharan, Rodney and Robatto, Roberto (2024), Macroprudential Regulation, Quantitative Easing, and Bank Lending, June. Available at SSRN: http://dx.doi.org/10.2139/ssrn.3802634.

[2] Greenwald, Daniel, John Krainer, Pascal Paul (2024), Monetary Transmission through Bank Securities Portfolios, NBER working paper #32499, May. https://www.nber.org/papers/w32449.

Panel: The Transmission of Monetary Policy to Financial Markets

Eric T. Swanson

I will center my opening remarks today around four main observations related to the transmission of monetary policy to financial markets.

1. Central Bank Decisions Have Become More Predictable Over Time

First, central bank decisions have become more predictable over time. There has been a gradual shift from central banks being fairly secretive and focused on changes in the monetary policy instrument to central banks being much more transparent and communicating monetary policy decisions in a more forward-looking manner. This observation is already well known to everybody here, so I won't dwell on it, but I want to review the point briefly to help set up my subsequent remarks.

Research by myself and others shows that financial markets and private sector forecasters have become better able to forecast short-term interest rates at horizons out to several months or several quarters.[1] They have also become less surprised by central bank monetary policy announcements; they are more certain of their interest rate forecasts ex ante, as measured by options; and they display less cross-sectional disagreement about future interest rates when you look at panels of forecasters. Finally, there is good evidence that increased central bank transparency has been the cause of all of these changes. For example, if you look at private sector forecasts of GDP or inflation, you do not see similar improvements in forecasts of those variables, which suggests that monetary policy has been special over this period.

For example, Figure 1 reports results from my own research with Vishuddhi Jayawickrema (Swanson and Jayawickrema, 2024) that shows there is a clear decline in current-quarter Eurodollar futures rate changes around Federal Open Market Committee (FOMC) announcements over time, meaning that markets have become less surprised by the Fed's announcements over time. Nevertheless, when you look at the figure, those Eurodollar rate changes around FOMC announcements pick up when monetary policy becomes more active around 1991, 2001, 2008, and 2020. So, monetary policy in the U.S. has still been very active when needed; it's just been communicated ahead of time more often. This observation is true not just for the United States but for central banks around the world. For example, Brand, Buncic, and Turunen (2010) and Blattner et al. (2008) show similar observations for the European Central Bank (ECB), and Mumtaz, Salaheen, and Spitznagel (2024) show related results for the Bank of England. A study by the Bank for International (BIS) in 2004 found similar results for five advanced economies, shown in Figure 2.

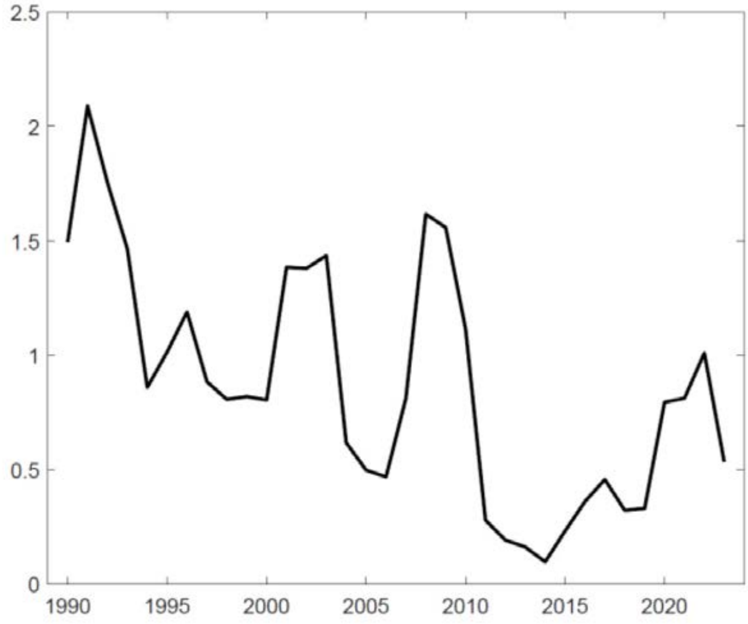
The bottom line is that central banks have increasingly communicated monetary policy decisions to markets ahead of time through policymaker communication and forward guidance.

2. Central Bank Communication Has Become At Least As Important As Monetary Policy Decisions for Financial Markets

Turning to my second main observation, the important role of forward guidance has made central bank communication as important as, or even more important than, central bank decisions themselves for financial markets.

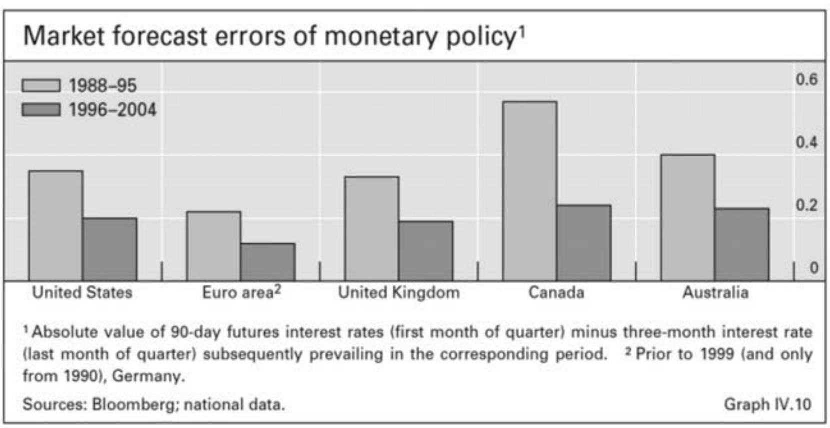
Focusing only on central bank decisions misses most of the transmission from monetary policy to financial markets in the U.S., U.K., and euro area, and probably other economies as well. A good example

Figure 1
Changes in Current-Qtr ED Futures Rates Around FOMC Announcements



Note: Three-year trailing sum of absolute changes in current-quarter Eurodollar futures rate in 30-minute windows around FOMC announcements.
Source: Swanson and Jayawickrema (2024).

Figure 2



Source: Bank for International Settlements (2004).

can be seen in Figure 3 from my own research with Jayawickrema (Swanson and Jayawickrema, 2024). The figure looks at financial market interest rate expectations three quarters ahead and shows that speeches and testimony by the Fed chair, which are depicted by the gray line, have been about as important as, or even more important than, FOMC announcements since the mid-1990s. Moreover, post-FOMC press conferences, depicted by the dashed gray line, have skyrocketed in importance and are now also as important as, or even more important than, FOMC announcements, especially in the last couple of years.

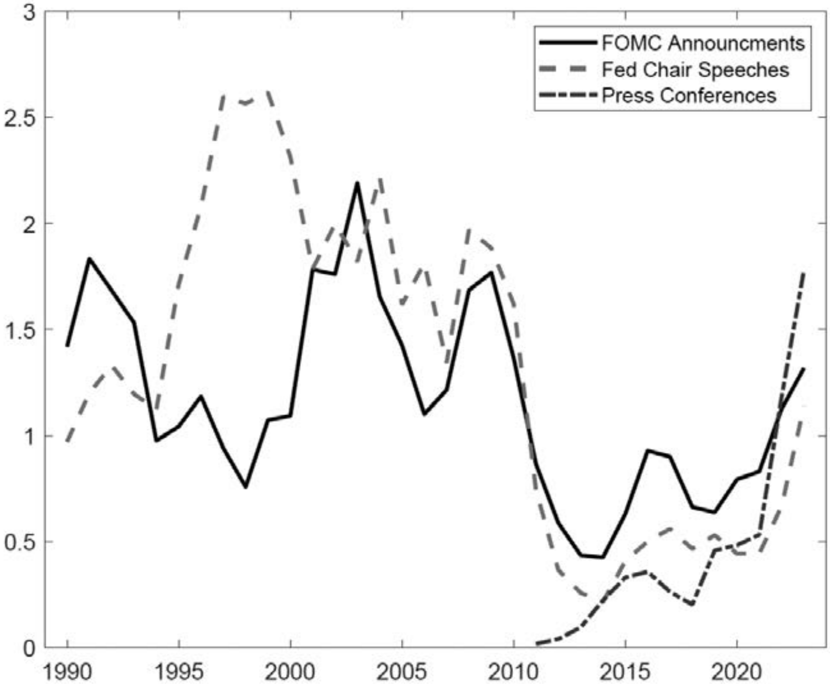
The two panels in Figure 4 report similar findings for the ECB from Istrefi, Odendahl, and Sestieri (2024). The number of significant, market-moving intermeeting communication announcements by ECB policymakers is as large as, or larger than, the number of significant market-moving announcements coming from ECB General Council meetings. Finally, Mumtaz, Salaheen, and Spitznagel (2024) report similar results for the Bank of England.

3. Central Banks Have Responded to Economic and Financial News More Aggressively than Markets Expected

Turning to my third main observation, over the past 30 years, central banks have responded to economic and financial news more aggressively than financial markets expected. This has been true for the U.S., U.K., euro area, and Switzerland, and probably other economies as well. A good way to see this is in Figure 5 from Schmeling, Schrimpf, and Steffensen (2022). The figure is a scatter plot, with each dot corresponding to a month from 1991 to 2021. The horizontal axis reports the federal funds futures market expectation of what would happen to the federal funds rate over the next six months, while the vertical axis reports what subsequently actually happened to the federal funds rate over the same period. The solid black line depicts the 45-degree line.

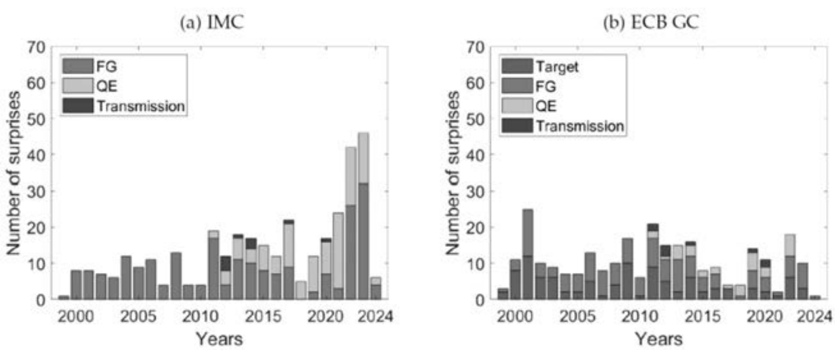
In Figure 5, when fed funds futures markets predicted an easing, the FOMC tended to ease by even more than the markets expected, as shown by the dots lying below the 45-degree line in the lower-left quadrant of the figure. Because Schmeling et al. (2022) was published

Figure 3
Changes in 3-Qtr-Ahead ED Futures Rates



Note: Three-year trailing sum of absolute changes in 3-quarter-ahead Eurodollar futures rate in narrow windows around FOMC announcements, Fed Chair speeches and testimony, and post-FOMC press conferences.
Source: Swanson and Jayawickrema (2024).

Figure 4



Note: (a) Number of significant inter-meeting communication (IMC) announcements by European Central Bank (ECB) policymakers each year, and (b) number of significant ECB Governing Council announcements each year. Announcements are further decomposed into monetary policy target changes, forward guidance (FG), quantitative easing (QE), and monetary policy transmission types.
Source: Istrefi, Odendahl, and Sestieri (2024).

in 2022, it does not include data for 2022 or 2023, but the paper by Carolyn Pflueger that will be presented here at the symposium tomorrow (Bauer, Pflueger, and Sundaram, 2024) shows essentially the same effect in those years—that is, in the upper-right quadrant of Figure 5, the dots would tend to lie above the 45-degree line as the Fed raised rates by more than markets expected. Schmeling, Schrimpf, and Steffensen also show that similar results hold for the U.K., euro area, and Switzerland.

My own research with Michael Bauer (Bauer and Swanson, 2023b) finds that the Fed has gradually responded more aggressively to inflation and output news over time. The two panels of Figure 6 report estimates from a Taylor Rule with time-varying coefficients, and those coefficients have gradually increased over time. This result echoes similar findings by Clarida, Gali, and Gertler (2000), Cogley and Sargent (2005), Primiceri (2005), and others. Quotes from Fed Chairs Greenspan and Bernanke also support this view, as they describe responding in 2001 and 2008 by more than the historical behavior of the Fed would have suggested.[2]

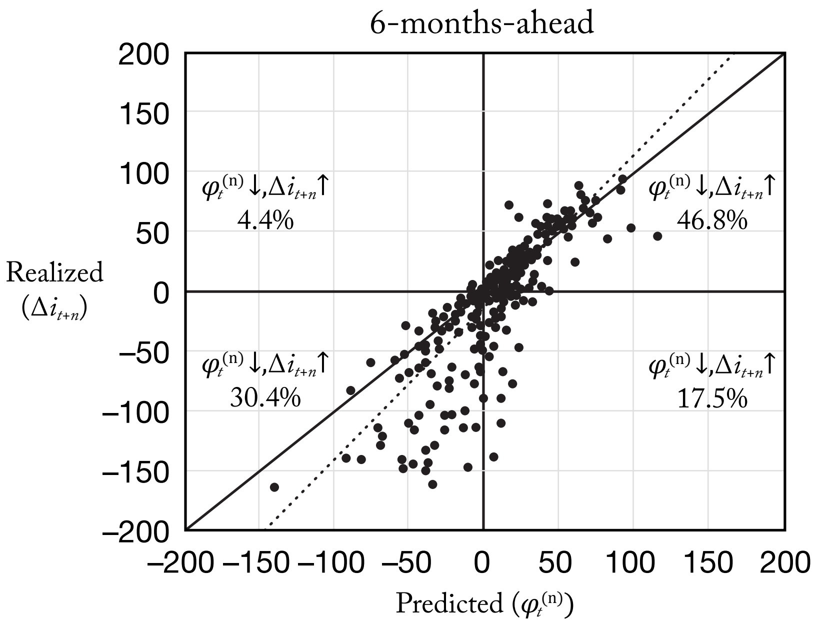
This evidence thus helps explain why markets have been surprised by the Fed's (and other central banks') actions: central banks seem to have become more aggressive over time, and the markets have had trouble keeping up with those changes.

I'll also note that this positive correlation between economic news and monetary policy surprises has often been misinterpreted in the literature as evidence of a central bank "information effect". There isn't time to cover that issue properly here, but Michael Bauer and I discuss it at length in Bauer and Swanson (2023a,b).

4. Central Banks Should Focus on Improving Communication

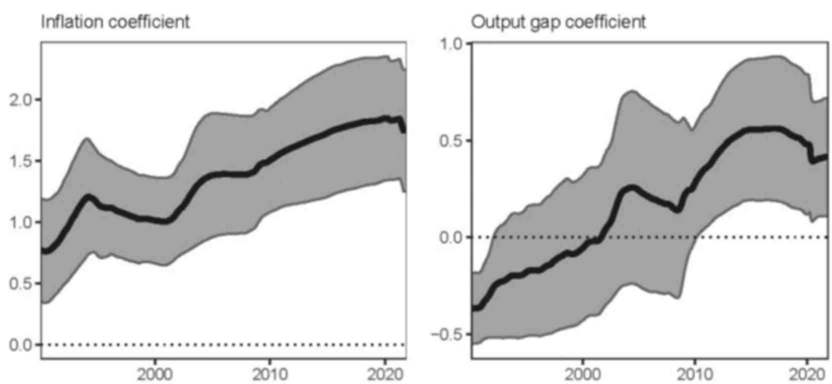
Turning to my final main observation, given how important central bank communication has become in the transmission of monetary policy, central banks should focus more on improving that communication. I'll raise several questions for thought to highlight examples where central bank communication could be improved.

Figure 5



Source: Schmeling, Schrimpf, and Steffensen (2022).

Figure 6



Notes: Exponentially-weighted recursive least squares estimate of the Federal Reserve's monetary policy rule parameters using expanding windows beginning in 1976 and ending between 1990 and 2021, with shaded two-standard-error bands.
Source: Bauer and Swanson (2023b).

First, why have markets been surprised by how aggressively central banks responded to economic and financial developments? Do markets and the private sector understand central banks' reaction functions better now? Can their understanding be improved? Carolin Pflueger's paper (Bauer et al., 2024) suggests that, as of 2022, markets still didn't fully understand how aggressively the Fed would respond to inflation. This indicates a communication problem that could be improved.

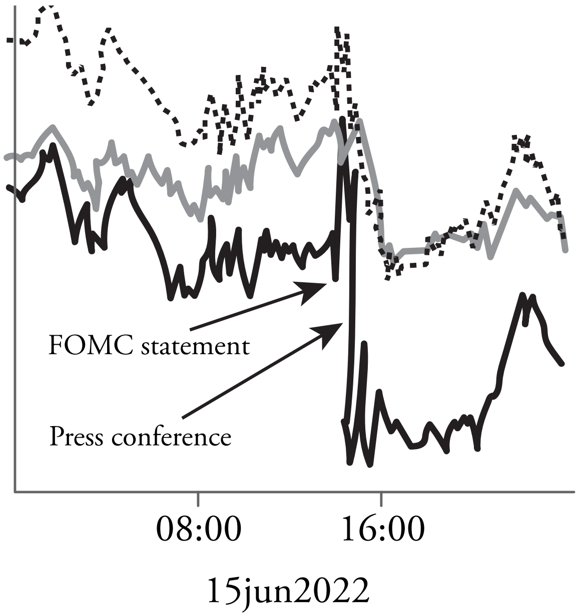
Second, did the Fed's flexible average inflation targeting framework enhance or hurt communication? Mumtaz, Salaheen, and Spitznagel (2024) found that simple communication was more effective than complex communication in the U.K., and I would argue that flexible average inflation targeting is more complicated than regular inflation targeting, which has hurt the Fed's ability to communicate effectively. A paper by Anna Cieslak, Michael McMahon, and Hao Pang (2024) also found that this framework increased uncertainty and confusion in the markets and the financial press.

Finally, in the U.S., several FOMC announcements and post-FOMC press conferences in 2022 moved markets in opposite directions. A good example is provided in Figure 7, which reports intradaily movements in the 2-year, 5-year, and 10-year Treasury yields on June 15, 2022, the day of the Fed's first 75-basis-point tightening. Markets read the FOMC statement as being about 10 basis points more hawkish than they expected for the 2-year Treasury yield (black line), but the press conference more than reversed that change and markets ended the day with substantially lower interest rate expectations than they started. In general, that shouldn't happen. My hope is that the Board has done or will do a post-mortem on days like these (June 15, 2022; November 2, 2022; and March 16, 2022, among others) to answer the question: In retrospect, how could these FOMC statements and/or press conferences have been improved?

5. Takeaways: Financial Markets and the Transmission of Monetary Policy

In conclusion, the transmission of monetary policy to financial markets used to be through central bank interest rate decisions, but it

Figure 7



Note: Intradaily values for the 2-year (black line), 5-year (gray line), and 10-year (dashed line) Treasury yields on June 15, 2022.
Source: Cieslak, McMahon, and Pang (2024).

is now primarily implemented through central bank communication (speeches, press conferences, etc.).

Economic research has lagged behind this reality: there is a tendency for researchers to focus on central bank decisions like FOMC announcements and ECB announcements. But most of the variation in advanced economy monetary policy now occurs outside of central bank decisions.

To study the transmission of monetary policy to financial markets, researchers need to look at communication events as well as central bank announcements themselves.

Finally, given how important central bank communication has become, central banks should focus more attention on improving that communication. I gave several examples where it seems like communication could be improved and should be improved.

Endnotes

[1]See Swanson (2006), Bank for International Settlements (2004), Brand, Buncic, and Turunen (2010), Blattner et al. (2008), and Swanson and Jayawickrema (2024).

[2]On March 20, 2001, Alan Greenspan stated that "The Federal Reserve has seen the need to respond more aggressively than had been our wont in earlier decades." (*Wall Street Journal,* 2001). On December 1, 2008, Ben Bernanke noted that "By way of historical comparison, this policy response stands out as exceptionally rapid and proactive." (Bernanke, 2008).

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General Discussion: Financial Markets and the Transmission of Monetary Policy

Moderator: Karen Dynan

Karen Dynan (Moderator): Before we turn to the general discussion, I want to give the panelists just a chance to talk if they have reactions or questions for the other panelists. I know we hit on a wide range of topics. Anil, for example, I know you have some questions for Eric.

Anil Kashyap: Yes, I'm curious about two things. That was a great presentation. I was not aware of some of the things you pointed out. In terms of forward guidance, what's your view on whether breaking it is wise, and whether doing so comes with a cost? And how do you trade that off? And then the second thing is I think it's true that if you'd done the dot plot in May or let's say March 2022, it wouldn't have seen 300 basis points coming either. So I wonder in that world, how they can improve the communication? Things change, and we want them to change.

Karen Dynan (Moderator): Actually, if I can just tack onto that, I mean, I think it's related to Anil's question. How do you convey uncertainty? The last couple of years have just been so tumultuous. A lot of the focus of the literature just seems to be on the base case.

Eric Swanson: I think you touched on it at the end, Karen, that it's very important to convey the uncertainty around forward guidance, around the Summary of Economic Projections (SEP). In the speeches and the press conferences, I think maybe the number one point should be that this forward guidance is very uncertain, and it's going to depend on the data. I'd like to note that I think the FOMC has done a very good job recently of saying its forward guidance depends on the data — that this is what we see happening, but of course it depends very much on the data. And as long as you emphasize that uncertainty throughout the whole process, then if you break the forward guidance, it's OK because you can say, "Look, the data didn't come in the way we thought, and so this is why we have to raise rates 500 basis points when we didn't think we had to." You mentioned the SEP in the spring 2022. I love the SEP! I'd actually encourage everyone to go look up the SEP from December 2021, and you'll see that FOMC members were forecasting that they would only tighten by, I think, 75 basis points. I think the most hawkish member of the FOMC had, I think, 125 basis points of tightening, and they thought inflation was going to go right back to 3.5 percent. It was clearly a view that inflation would be transitory. That didn't happen, and then they had to raise interest rates a lot more, and that's OK. They had to. They did the right thing. And I think just as long as they're open about the uncertainty, I think that's fine.

Patricia (Trish) Mosser: Just an observation, not a question because Karen took my question, but going from basically such a long period where things were so predictable, right, and where forward guidance and everybody could sort of agree and it was sort of easy to predict whether the Fed was going to do to a world of just massive uncertainty had to really complicate how you do this. And so I'm curious about whether anybody's done studies of before and after because a lot of those works go back further into the 2010s. And it seems to me — post COVID — that the uncertainty bands were so enormous that it had to be incredibly difficult to do this.

Eric Swanson: I agree. I mean, forward guidance was a lot easier back in 2015 and 2016, right? I still think it was correct to give forward guidance in 2020, 2021, 2022, but I think you just have to be clear to the markets that this is very uncertain, and it's going to be very data dependent.

Karen Dynan (Moderator): Thanks. I have a question of my own for — I think it's mostly Trish and Anil, which is data needs. I mean, you both come from countries, or you've studied countries that have a relative wealth of kind of data as you think about financial stability risks or risks around financial innovation. And I know this is related to what you did in your job, Trish, at the Treasury Department in the Office of Financial Research, but, as you now counsel people who maybe come from countries where the data available are not as rich, what are the most important things that people need to be watching and understanding? And where are the gaps for the countries that are on the frontier?

Anil Kashyap: Well, one thing is most countries don't have as deep a market financial system, so the U.K. and U.S., if that's what you're thinking about, are a little bit outliers. But I think the biggest thing that used to worry me when I was on the Bank of England's Financial Policy Committee (FPC) was all the cross-border flows. So the U.K. money markets are in Luxembourg and Dublin. It's a pain in the neck that the BOE can't see everything about that the way money could move. The Treasury's Office of Financial Research (OFR), when Trish was there, tried to make a funding map flow. Beth was involved in that. And getting the cross-border stuff was just a mess. You really don't know about that. So, to take up what Agustín said earlier about why you would just put out the fires, is that you have no idea what's going to happen with the cross-border part of this. So if the people in this room could just kind of make a side deal over lunch that we're going to prioritize sharing data, I think we'd all be better off. I understand that there's incentives about not wanting to show your weakest stuff to the other guys and all that, but it really is a problem.

Patricia (Trish) Mosser: It's a meta-theorem that you never have the data you need, ever. Because for one thing, all the cool risky stuff is happening in the parts of the financial system that are new and innovative and less regulated. And so you're always going to be behind the curve. I completely agree with Anil at Agustín Carsten's point that at some point you don't have a choice. You just have to put out fires and hope that on the other side whatever moral hazard you've created is going to be manageable.

The cross-border stuff is difficult for the United States and I think probably the U.K., but increasingly the rest of the world. If you look at the growth of market-based finance and a lot of it facilitated by and intermediated by non-banks, those are dark spots. The Financial Stability Board (FSB) is talking about this. The Bank for International Settlements (BIS) is doing work on it and is trying to get a little bit of information more broadly. But this is an issue everybody's going to face. It's particularly acute in the U.S. that all the cool stuff happens in the dark. And so figuring out what the financial stability implications of that are, and to the point of this panel, how monetary policy is actually impacting the credit decisions and the investment decisions in that part of the world is very, very difficult to do properly. You can sometimes get hints of it. Market-based finance helps because the market regulators do actually gather quite a bit of information. But that's about it.

Karen Dynan (Moderator): Thank you very much. I'm see a bunch of hands went up over here, so we're going to start there. If your question is directed at a particular panelist, please say so. So let's start with Arvind Krishnamurthy.

Arvind Krishnamurthy: I want to go back to Anil's comments on the market maker of last resort and expand on a point he made, which is about moral hazard and about how there may be no moral hazard for safe assets. Safe assets are used for purposes other than just investment, such as payment, liquidity, collateral, which then leads these assets to carry a convenience yield. Assets such as money, bank, debt, reserves, treasuries, all fall into this convenience category. If you look deeper and ask what theories explain why these assets offer convenience services, almost every theory involves complementarities. In particular, the more I use the asset, the more others use the asset, and that's what creates liquidity or safety. With a complementarity-based theory there is less moral hazard from government action. The government purchases assets and, with complementarities, the asset's convenience properties increase and the private sector also steps in to purchase. So it's the opposite of moral hazard. Now if I apply that theory to the set of assets that Anil brought up, I feel like there's a significant distinction between short-term and long-term assets. For example, the repo market and the repo spike that we had in 2019, can fit well into the complementarity and no moral hazard theory. With long-term debt, it's less clear. The LDI example looks like an investment in a long-term bond that went badly rather than rather than holdings of a convenience asset that lose liquidity. So moral hazard has got to be important there. And then thinking about long-term Treasurys in the U.S., Hanno Lustig showed us data that the convenience yields on those are quite low currently. So I suggest that there less moral hazard in the market maker of last resort for assets are used for convenience purposes and more moral hazard when this is not the case. Measuring convenience yields is a great way to distinguish these cases.

Francesco Bianchi: First, thanks to the panelists. I have a question for Eric and also for Anil. For Eric, you showed this result that the federal funds rate became more predictable. I was wondering if you have a sense of how much of that is due to the fact that the macro environment has been more stable in recent years, because that might be relevant about what we should see going forward. We also had a prolonged period at the zero lower bound. So, I was wondering if you could elaborate on that. And for Anil, with respect to the mini-budget in the U.K., I understand that it can be interpreted as a "plumbing" issue. The question is why it originated at that time, and what would be the perception if central banks started to systematically intervene in response to fiscal decisions of some sort.

Guido Lorenzoni: I have a question for Anil about the facility—the purchase facility committee. I wonder—I mean, natural question, how do you envision that working in a context like the European Central Bank (ECB), where, you know, like I think that this notion of transmission protection, it's a bit of a vague notion. It's not so much financial stability, but it's more like, I want to make sure that monetary policy acts the same in all countries of the Euro area. But if you create that facility, would that go in there? Would it stay in?

Markus Brunnermeier: I have two questions, one for Anil and one for Eric. About the ambiguity question you raised, should it be ambiguous whether you have this market maker of last resort feature active automatically or not? There would be huge differences in the

LDI case because of LDI, the trust government was thrown out or not. But if there's a standing facility there, then actually the implication for the fiscal side or for the government would be very different. So in this sense, ambiguity makes a huge difference, whether it's ambiguous or it's a standing facility. And then for Eric I have a question. There's this paper by Sebastian Hillebrand who shows that the 10-year yield only moves during FOMC meetings or primarily moves during FOMC meetings. You show exactly the opposite, that it moves by speeches before the FOMC meetings. That refers to the policy rate. Why is there this disconnect or do you have an explanation for this disconnect?

Anil Kashyap: There were a bunch of questions about the LDI, and I spent a lot of time on this, so you asked, and you're going to get it. First of all the LDIs were weird because they had this very, very long duration debt that wouldn't have even existed were it not for their needs. So the U.K. Government Debt Office was issuing this stuff. They were the only buyers, especially long dated inflation protected securities. Nobody else would want to have that kind of real rate duration risk. So there was a plumbing problem there because it became clear by probably Monday morning people knew that the LDIs were going to be insolvent and were starting to work out when's the fire sale going to start. I think that was a technical thing. An important part of all of this was the yields by the end of the program weren't that much lower. I'll just point that out in my slide. The yields really come off when the government gets fired. I don't think there was fiscal dominance in what the bank was doing. In fact, Andrew (Hauser) used to say, it's not our job to cap yields, and in fact there's this funny two-day period where the first day the bank bought yields shot down like it looked like it was QE and then there was no buying for a couple days and they started rising again and ended up pretty high. So I think that was actually a technical problem and the way it was scaled was to give them enough time to work out how much they were going to have to sell before they could recapitalize. If you look at the stuff in my written remarks, I point to a bunch of speeches that were given when this was all being working out. So there's lots and lots of information about that.

I think Guido's question is the hardest one because the ECB kind of purchases are tied to [monetary policy] transmission protection. I've never understood what market price you can look at to tell what the difference between when Italian sovereign yields and German sovereign yields are elevated based on fundamentals and when it's because Italy's going to misbehave. And so I've been surprised that there hasn't been a calling of the bluff to see if the ECB gets in whether it could ever get out. I think though you would have to look at this as to whether or not it's really a plumbing problem. If it's because the governments just fall or they can't form a government in France, you can call that a plumbing problem and maybe you can do a little bit about that, but at some point I think that's a harder call.

So I'm down with everything Arvind said about the collateral, and that's what's important, and that's what you'd largely be doing. And I do think in the U.S. you probably wouldn't need to be buying a lot of long-term government debt. You'd be using the stuff that's used as collateral, and as you say, that's disproportionately short maturity.

Eric Swanson: Francesco asked whether the macro environment and the zero lower bound explain why monetary policy was less surprising and the trend in uncertainty is lower. The zero lower bound of course would be a concern that, of course, monetary policy is more predictable during the zero lower bound, but the trend is much longer than that. If you look at the figure I showed, it goes from 1988 to 2024. There's a long period from 1988 to 2008 where there is no zero lower bound, and if you look at the GDP and inflation forecast data, tthose are about equally uncertain throughout this time, and yet the decline in monetary policy uncertainty goes on despite GDP and inflation data being about equally uncertain over this time. So that's evidence that monetary policy transparency has been a large part of the story.

Turning to Markus's question about the Hillenbrand finding, I'm not trying to contradict what Hillenbrand said. If you think about his paper, there's sort of this long-term downward trend in interest rates, and he says essentially all of that trend can be explained if you just look at these narrow windows of time around FOMC announcements, and it's a puzzle why that is. But I'm talking here about total variation in interest rates, which is more than just the trend. There's cyclical variation as well, there are monetary policy cycles. I don't have anything to say about trend versus cycle, just the total variation. Most of that total variation is coming, not in the FOMC announcements themselves, but around speeches by the Fed chair and press conferences by the Fed chair.

Karen Dynan (Moderator): All right. I'm going to take some questions from the middle of the room now. I have Kristin Forbes, Jan Eberly, and Governor Macklem, and Alan Blinder.

Kristin Forbes: Questions first for Anil on your specific proposal, and then for the broader panel. Anil, you argued that asset purchases of government bonds are okay, but not purchases of private sector bonds. Where do MBS and ABS fit in that? Should the Fed treat them roughly symmetrically? Getting ahead of a discussion for tomorrow, you implied that when countries buy bonds for market stability reasons, they should get out of that quickly, like the U.K. did. So are you suggesting that the U.S., when they bought bonds in the spring 2020, should have sold them right away and then restarted QE programs through a separate facility when QE was needed to stabilize the economy, meet inflation targets, etc.? That will be really tricky to explain to the public, but is that what to take from your proposal? Hoping you could expand.

Then for the broader panel, what struck me about all of your comments was there was almost no mention of the international environment until the very end. So I was hoping any of you who dared could talk a little bit about how the international environment matters for the transmission of monetary policy. Specifically, if other countries are lowering interest rates, does that take pressure off individual countries to lower rates because there's a broader easing of financial conditions? Or does only the U.S. matter for the international environment? And then finally, there have been some really important shifts in global capital flows over the last couple of years, some which are likely to continue given geopolitical fragmentation. It's the whole host of issues we all know about. Concretely, when the U.S. has traditionally done QE or QT, on the other side an important group that has absorbed changes in Fed demand for government bonds was foreign purchases and sales. That has not happened this time. As the Fed is doing QT, the foreigners are not on the other side of the trade as they used to be. So how will these changes in global capital flows affect the transmission of monetary policy?

Jan Eberly: My question is for Eric. You made a convincing — even a compelling — case that much more information comes out of the Fed regarding its feedback rule outside of decision-making moments, and that that has reduced uncertainty and reduced surprises. The paper that's coming tomorrow morning that you also mentioned from Bauer, Pflueger, and Sundaram — maybe this will be a transition to the discussion we have tomorrow — in looking at the last 10 years of data emphasizes the opposite: that markets really reacted to the decisions that were made. And I wonder whether you agree with that and, if so, do you think that there's a fundamental change or that this is episode-specific because of the uncertainty and the change in the monetary policy framework that you also mentioned? We can also discuss this tomorrow.

Tiff Macklem: Well, first of all, three excellent presentations. I learned a great deal. I could ask you all a question, but I am going to limit myself to one, and I'm going to pick on Anil. In Canada, similarly to the United States, we embarked on a large-scale asset purchase program in March 2020, very much to restore market functioning, but that did evolve into a QE program to provide monetary policy stimulus. And somewhat remarkably, the amounts were the same. Now, it's easy to forget just how much uncertainty there was at the time, but with the benefit of hindsight, I agree with you that we could have been clearer about the changing objectives. And you're right, your suggestion to have a different committee to take those decisions is interesting, but of course if the committee doesn't do anything different, it's not going to be different. You flicked at this idea of exit conditions. It's easier to start things than stop them, and the clearer you can be about exit, the better. Maybe you could just say a little bit more about what — would you have very different exit conditions for market functioning versus QE? What would those look like? How prescriptive can those really be when you're taking these decisions in a state of very high uncertainty?

Alan Blinder: I want to raise very briefly two very obviously important things that weren't mentioned. The first is for Eric, and I'm pretty sure he's not going to disagree with this. A major part of the case for forward guidance and related things is shortening the lag in monetary policy. And I think one of the things that strikes academics that come to the Federal Reserve, or any central bank, is how important those lags are. It's like you go to bed praying every night, "I wish the lags were shorter so we could actually see what in the world is going on." I'm sure you don't disagree with this point, but it just didn't come up. My other question is for Anil, and here I don't know the answer. Kristin just touched on it briefly. It's in the distinction between restricting yourself to government debt and moving over to private assets. When this was done in 2009, the switch was pointed at what was then the big hole in the financial system — a gigantic hole that was sucking the rest of the financial system into the maw. And while I don't think you want to rule that out, I don't want to answer the question for you.

Karen Dynan (Moderator): Okay, panelists, briefly respond, because I'd like to get another round of questions in if we can. Let's start with Anil.

Anil Kashyap: Okay, so on MBS, I think anything that's got the full faith and credit of the government is being used as collateral and all that so you're going include that. The ABS stuff, I think, is trickier, and it's not as clear to me. I don't think I would have done the high yield facility that the Fed announced. That would have been a bridge too far for me, but, you could make a judgment on that.

I think the one thing that both Tiff Macklem and Kristin Forbes pointed out is when you're doing QE and PFC purchases in the same direction, it's probably harder than when it's in opposite directions. The counterfactual that I imagine Tiff is if you've done this stuff, you would have slowed it down greatly, probably in April or May. And then the FOMC would have come in and said, we don't want you to sell this. The Bank of England has used knockout clauses. In fact, the MPC at one point said we want to do this unless the FPC suggests to us that it's going to be counterproductive. So I think you could have a knockout clause discussion that essentially would have made a handoff sometime over the summer to say, okay, this is now QE, and the FOMC is going to own the disposal of the stuff that we bought for the other reason, and it's off the table because I agree if you try to say I'm doing red QE and blue PFC, nobody's going to understand what the hell it means. But it is interesting that the Bank of England was able to get out of when they were going to go in the opposite direction. So I think that was important.

On Alan Blinder's question, I was thinking of private assets mostly being like commercial paper, corporate bonds, or high yield bonds, and there I guess the question is how long a fire sale would I tolerate and could I convince myself that it's something to do with the plumbing and not the uncertainty in the economy? So if you were going to do that, I see that as more monetary policy decision than a financial stability decision.

Patricia (Trish) Mosser: So to Kristin's question about global capital flows — absolutely critical. Any small economy governor is saying this, and I'm going to tell you the number one way, the number one transmission mechanism often is basically whether capital is flowing in or out and where you're — sometimes that's about where your interest rate is relative to everybody else's. Sometimes it's more complicated about your fiscal position, etc., etc., but whatever it is, it drives almost everything. The really large advanced economies, so the Euro area, the U.S., Japan, have had the luxury for a long time to not have that be a particularly important transmission mechanism. I think all you have to do is look at what's happened to Japan in the last few weeks to know that that is not true anymore. And I think it's part and parcel of the fact that the way that funds move around the world is so fast and so big now that every economy in the world needs to be prepared for exactly what you highlighted. I think this is going to be a really big sea change, and it's going to get bigger over time — potentially gets bigger — and it's not about how quickly things reprice per se. It really is about how fast the quantities of funding move around, which of course will ultimately impact the price.

Eric Swanson: Jan Eberly asked about the Taylor rule and the paper to be presented tomorrow. I don't want to front-run tomorrow's paper, but I will mention that I didn't mean to suggest that

FOMC announcements themselves are unimportant. It's just that the speeches and the testimonies and the press conferences seem to be, all in all, more important. The press conferences come on the same day as the FOMC announcements as well, so if you're looking at the day of an FOMC announcement, it includes the press conference too, and those have been becoming more and more important. So I'm not contradicting what Carolin Pflueger is going to talk about tomorrow.

Alan, the idea is that we can move long rates a little more directly now with forward guidance? Yes, absolutely, I agree.

Patricia (Trish) Mosser: Sorry, I forgot to respond to that. I think all of this should get faster. Again, pricing, re-pricing things has happened faster, but if you think ultimately that, for example, credit channels are about the quantity, not just the price, of how monetary policy impacts economic behavior, then if that's faster, and I think there's a case to be made that it's already faster now, and potentially going to get even faster in the future. That should be happy. I'm concerned about the overreaction the other way, right? As you go way too far, and then it's much harder to understand what, you know, what's the result going to be, you know, two quarters from now as opposed to what happens in the first week. I think that's the confusing when I say I'm worried about the volatility of the transmission mechanism, that's exactly what I'm worried about.

Karen Dynan (Moderator): Okay, we're going into the lightning round because we do have a hard break for lunch in a few minutes, but there are a few people who have been waiting patiently in the back, and I do want to get to the question over there. Yeah, back there, and then we're going to head over to the other side of the room. Yiming Ma has had her hand up.

Olli Rehn: My question goes to Anil, and that's actually related to what Kristin posed as a question and concerns your slide number three, Market Maker of Last Resort. Namely, I would add one important element to this, and that's the global dimension of crisis management. I'm referring especially to the March 15, 2020, decision of coordinating the provision of U.S. dollar swap lines to banks.

That was an agreement of the Fed, the ECB, and four other central banks, in order to secure dollar funding in the global financial system at a very critical moment. So, in my view, this decision was a crucial step in preventing a liquidity crunch and stabilizing the global financial markets. So, what importance would you, Anil, give this in your overall crisis management which you so elegantly outline in your presentation?

Yiming Ma: I wanted to connect a little bit with what Trish said and what Anil said. Trish, you mentioned there's been a rise of non-banks, and I wonder whether that begs the question of not only how many reserves do we need, but also who should have access to these reserves? Because one defining feature of non-banks is that they do not have access to central bank reserves, and of course that wouldn't matter if banks can frictionlessly just lend to non-banks or if non-banks just keep deposits that are then invested in reserves, but we know that's not true, right? So in March 2020, we know that a lot of non-banks actually had a lot of treasuries that then they sold because that was their liquid asset buffer, which, in response, as Anil mentioned, central banks came out and had to purchase. So I wonder whether, you know, one alternative or, you know, another way to help the institutions that are increasingly dominated by non-banks is also to have, you know, access to reserves by not only commercial banks, and I think the U.S. Federal Reserve has done some of that in the direction with the overnight RRP facility, but I wonder what you think about doing this a bit more broadly.

Karen Dynan (Moderator): Okay, I've been told we're in overtime now, so panelists, can you just give us, if you want, a word or two, and then we're going to end. I'm going to start with you, Trish, on Yiming's comment.

Patricia (Trish) Mosser: I'm in complete sympathy. Of course, she probably knows that already. You know, the liquidity provision to the U.S. financial system is just, like, not fit for purpose, and it's a legal problem for the most part, not completely, but partly a legal problem, just legal and a stigma problem. Not having given how that two-thirds of the U.S. financial system is basically non-banks, who have no access to the central bank in any way, shape, or form, except in a huge crisis, makes a crisis more likely, first of all. And so I have always been in favor, up to the legal limits of the Fed's authority, of them figuring out a way to, perhaps taking only treasuries and MBS as collateral, to massively expand the ability of, and to create a liquidity facility that's basically for the non-bank sector. It doesn't have to be available constantly, but it would be very easy to turn on. There are other central banks who've done this, by the way. The Bank of England is one of them, for example. So that has always been my longtime view, but it's hard to get that built in, given the legal restrictions that the Federal Reserve faces.

Anil Kashyap: I'm even more radical than Trish. I would like the Fed to join FICC and then they face anybody they needed to, and they would have a clearinghouse that's got a triple-A rating standing in between them, and I think that would be way better. Broader access—I've been on a jihad about this for about five years, getting nowhere, but I still think it's the best way to solve the problem she talked about. On the swap lines, I guess the hard question is what about the central banks that wanted them and didn't get them? And I don't really know how you decide this, and this is probably going to get worse over the next 10 years because if some countries in China's orbit, not our orbit, but they're a financial center, I don't know how we're going to make those judgments. That could be a pretty nasty problem, but I see that as a distinct thing, and it wouldn't be the PFC deciding that.

Luncheon Address: Reflecting on Recent Times

Andrew Bailey

I want to use my time to look behind the latest state of monetary policy, at issues that have arisen from the experience of recent years, but with some reflections on where we are now.

The pandemic caused a sudden, coincident and precipitous fall in global demand and supply — one of these did not obviously lead the other. Moreover, in March 2020 we faced monetary policy and financial stability issues arising from the same source, namely the pandemic. Taken separately, the responses should be different, with a more exceptional temporary, targeted and typically maximum force intervention better suited to dealing with a financial stability problem. In contrast, a monetary policy response of the sort used in 2020 is typically undertaken over time.

But when monetary policy and financial stability issues coincide, the judgement becomes more complicated. By engaging both of the core central bank objectives, the pandemic posed an unusual but not unprecedented challenge.

I am grateful to Nat Benjamin, Fabrizio Cadamagnani, Jonathan Haskel, Karen Jude, Clare Lombardelli, Katie Martin, Rhys Phillips, Huw Pill, Vicky Saporta, Martin Seneca, Fergal Shortall and Paolo Valenziano for their assistance in preparing this speech.

As economies started to adjust to the consequences of the pandemic there was a substantial increase in global demand for goods rather than services, at a time when the supply of goods remained disrupted and restricted. This was an asymmetric demand shock. Global goods prices rose as a result, akin to a cost-push shock for open economies like the U.K. This was the context of the so-called transitory assessment of monetary policy, namely that such shocks should be short-lived in impact because supply chains should recover and inflation expectations should remain anchored in anticipation of that recovery. That's the theory. The evidence suggests that, taken on its own, the global supply chain shock had run its course by the end of 2022. But a key question at that time was whether and to what extent there would also be catch-up effects in wages and services prices, and over what time period?

In the U.K., the labour market did begin to tighten but it was hard to discern at the time by how much. In mid- to late-2021 the U.K. Government's furlough scheme — a sensible policy in its own right — was creating uncertainty around the state of the labour market. We can now use tools such as the Bernanke-Blanchard approach to assess the timing and scale of this labour market effect.

Using this approach, and based on work done on the U.K. case by my colleague Jonathan Haskel, it became evident economy-wide in late 2021 and early 2022, putting further upward pressure on inflation. We started to tighten monetary policy from late 2021.[1]

Then, starting in February 2022, came the impact of the Ukraine War and Russia's illegal actions. This created large supply shocks, in particular to energy and food prices. It substantially increased the risk of de-anchoring of inflation expectations and created the potential for larger second round effects in the form of more persistent higher inflation. As shock came upon shock, so to speak, the transitory judgement looked less appropriate.

Our response in terms of both the pace and scale of tightening was progressive but measured. Why? Four reasons stand out for me.

First, unlike in March 2020, in 2022 there was not a coincident financial stability shock. It could have happened, for instance in commodity finance markets, but in the event such a shock did not occur.

Second, the scale of the indirect or second round monetary policy effects was unclear at the time. There were several sources of such uncertainty. One was the transmission mechanism of monetary policy. Looking again at the U.K. case, in terms of the impact of a tightening phase on economic activity and inflation, the channels of transmission have changed over time. This no doubt reflects underlying changes in the economy since the previous tightening phase which was prior to the Global Financial Crisis, most obviously the shift from variable- to fixed-rate mortgages. But it most likely also reflects specific features of the latest tightening phase. One such feature is that it followed an extended period when interest rates were near the lower bound, along with the use of unconventional policy measures, both of which contributed to a relatively fast increase in longer-term market rates when the tightening came. A second feature of this tightening phase has been the size of the shocks we have witnessed and the potential non-linearities and asymmetries that have arisen in the monetary transmission mechanism. When we are dealing with relatively small shocks which stay within the locality around the inflation target where the linear approximations we normally make in our models hold, then these issues do not arise. That was the experience during much of the inflation targeting era.

But when there are big shocks that move outside this locality, such as those of recent years, then non-linearities and asymmetries can emerge. But, at the time, the impact of this was more uncertain.

The third reason for a measured response was that a very fast and large response of interest rates would have risked creating a severe economic shock of its own (a trade-off). I will come back to this point.

Fourth, while in Europe — and here I refer to Europe in a geographical sense — demand was recovering faster than supply, levels of activity were well below actual and potential levels pre- Covid, leaving substantial questions around how much slack there was.

To bring the story up to date. Headline inflation has since fallen sharply as energy and food price shocks in particular have fallen away. Global goods price inflation has also fallen back sharply, with supply chains restoring themselves and with signs of strong disinflation emerging in some key supplier countries most obviously China.

Meanwhile, monetary policy has been leaning heavily against the indirect and second round inflation effects and the persistence thereof. The job of monetary policy — which it has been doing — is to squeeze the persistent element of inflation out of the system in a way that is consistent with returning inflation to its target on a timely and sustained basis.[2] When we think about inflation persistence, I would distinguish between extrinsic persistence (the duration of external shocks) and intrinsic persistence in the sense of capturing the impact of the echo effects of those external shocks owing to domestic responses (second round effects). Extrinsic inflation persistence is a setting where price and wage setting behaviour remains unchanged, but a succession of external inflationary shocks cause inflation to be above targe for a sustained period. Since the lags in the transmission of monetary policy are typically longer than the lags in the transmission of these shocks to inflation, some volatility of inflation is inevitable, and with the type of big shocks we saw, all going in the same direction, the impact will be large. Contrast this with intrinsic inflation persistence where price and wage setting behaviour does change, including in response to the unusual character of the external shocks. Here, the nature of the response of monetary policy needs to be different. The reality is that we experienced both types of persistence, though the scale of the intrinsic persistence has — almost of necessity — been harder to judge and therefore more subject to revision.

I think we are now seeing a revision down in our assessment of that intrinsic persistence, but this is not something we can take for granted. Important questions remain which in many ways set the framework through which we now view monetary policy.

On current evidence, and speaking of the U.K., I would say that the persistent element is still with us but it is smaller in magnitude now than we expected a year ago, and considerably smaller than the type of persistence that was seen in the 1970s. However, that is not the end of the story. We still face the question of whether this persistent element is on course to decline to a level consistent with inflation being at target on a sustained basis and what it will take to make that happen. Is the decline of persistence now almost baked in as the shocks to headline inflation unwind, or will it also require a negative output gap to open up, or are we experiencing a more permanent change to price, wage and margin setting which would require monetary policy to remain tighter for longer? This framework is now prominent in our thinking on the MPC.

The first of these cases is the more benign — the persistence is essentially self-correcting with the degree of restriction we have in place today easing off over time. "Self-correcting" is the key phrase here: it depends on the credibility of monetary policy, which depends on the willingness of policymakers to act, and the best evidence to support this mechanism is well-anchored longer- term inflation expectations.

The second case is the intermediate one. Here we would need to maintain restriction for longer and thus open up more of an output gap.

The last case is least benign and would require more restrictive policy than the first two cases. It would suggest that there are structural changes in product and labour markets going on which are causing the supply side of the economy to change as a lasting legacy of the major shocks we have experienced. To be clear, as policymakers we can have all three of these cases in our expectations, with different weights attached.

Tentatively, it appears to me that the economic costs of bringing down persistent inflation — costs in terms of lower output and higher unemployment — could be less than in the past. This is consistent with a process of disinflation which is steady and more in keeping with a soft landing than a recession induced process. For the U.K., this is consistent with how we have revised our outlook for growth, and the numbers themselves so far this year.

Inflation expectations appear to be better anchored, which I put down in good part to the presence of independent central banks with clear mandates and nominal anchors, usually in the form of inflation targets. But, crucially, policy does have to respond to ensure credibility is maintained.

Moreover, while second round effects may be smaller that does not tell us how much smaller and less persistent they will eventually end up being than in the past. On this basis, at the moment I put more weight on the first case — self-correction — but some smaller weight on each of the other two. These weights can of course change over time.[3]

This is an important issue of the moment for monetary policy. It is directly relevant to the question of how challenging the last mile of returning to our inflation target level on a sustained basis actually will be. The well-known argument goes that an independent central bank operating a transparent low inflation target successfully over time will anchor inflation expectations more consistently. In this world, in the short-run monetary policy can respond to shocks with suitable flexibility, acting consistently but not always identically, to return inflation to target. In the U.K. case, the evidence suggests this may have worked insofar as we are seeing a lower level of inflation persistence than we expected a year ago. But, we need to be cautious because the job is not completed — we are not yet back to target on a sustained basis. Policy setting will need to remain restrictive for sufficiently long until the risks to inflation remaining sustainably around the 2% target in the medium term have dissipated further. The course will therefore be a steady one.

Before considering challenges going forward, I want to pull out one further point from recent experience. In an effective monetary policy regime we should have flexibility in the short term on how quickly we return inflation to target. Looking back over recent years, I think it is common ground that the Covid and Ukraine shocks could not have been anticipated, and certainly not in sufficient time for any consequent monetary policy actions to have had an effect on monetary conditions. But there are two follow-up questions that I get asked. One starts with the words "with the benefit of hindsight" what would you have done. The second, asks about actual policy choices once the shocks took effect.

This is where so-called trade-offs come into the picture. The language of the Bank of England remit states that "the inflation target holds at all times", which is essential. But it also states that "the actual inflation rate will on occasion depart from its target as a result of shocks and disturbances".

It further adds that "attempts to keep inflation at the inflation target in these circumstances may cause undesirable volatility in output". In 2013 the remit was amended by adding that where shocks are particularly large or the effects of shocks may persist over an extended period (or both) then"the Committee is likely to be faced with more significant trade-offs between the speed with which it aims to bring inflation back to target and the consideration that should be placed on the variability of output".

This is what we call the trade-off language. We are not alone in having this type of language in our remit. The language applies when the economy is hit by temporary cost or supply shocks. In these circumstances we have to judge the appropriate balance of inflation and output volatility, when judging how quickly to bring inflation back to target. Moreover, such judgement must ensure that, again using the language of our remit, "inflation expectations are firmly anchored in the medium term".

Applying this framework over the Covid and Ukraine period has not been easy. As policymakers dealing with the here and now, balancing the objectives of applying the inflation target at all times and dealing with trade-off situations requires us to decide whether to look through a transitory shock or respond because it could have quasi-permanent features. In doing so of course we must distinguish between these two shocks in real time. Good luck with that as they say. It has required judgement on whether the shocks were temporary or not, and whether they were expected to be so or not by participants in the economy. The further complication is that the configuration of shocks — with no gaps between them — effectively meant that the judgements had to be reached on the shocks as a collective more than individually.

The U.K. was hit by a severe terms of trade shock, raising the rate of inflation in imported goods and services relative to domestic prices, leading to a sharp fall in household real incomes, something that could not be offset by monetary policy. But let us say we had seen all of this coming in sufficient time to act given the lags in the transmission of monetary policy. In that case, the remit trade-off language would have to be taken into consideration. A negative terms of trade shock involved a sharp fall in real incomes and wages.

If monetary policy had acted to offset this shock, it would have required a much larger fall in domestic prices and wages in order to counteract inflation in import prices. It would have required domestic prices and wages to fall in nominal terms. Achieving this effect would have called for a substantial rise in interest rates creating a strong probability of a deep recession and a steep rise in unemployment. Moreover, it would not have led to inflation being at target on a sustained basis — which is our objective. Rather, as energy and food prices fell back, inflation would fall below target.

Put simply, responding in this way to short-lived shocks is not consistent with our remit nor is it the way to ensure the policy framework remains robust. That said, the trade-off element of our remit leaves us with the judgemental challenge of how to assess and respond to the impact of supply shocks on inflation, particularly when they are accompanied by demand pressure.[4] What is the best way to make sure inflation expectations are anchored, and how do we judge in real time whether they are anchored, accepting that short-run expectations will move with headline inflation measures? The judgement therefore remains one of to what extent central banks can look through such shocks, or not, all of which will be state contingent.

So, let me draw out what I see as key challenges for central banks arising from these experiences. Modern monetary policy with its emphasis on independent responsibilities, clear policy objectives and nominal anchors typically in the form of an inflation target is the product of tackling the great inflation of the 1970s. More recent experience defines at least three challenges to that orthodoxy.

First, how to operate monetary policy near to the lower bound of interest rates when the challenge is to raise not lower inflation. Moreover, if the response has to go beyond moving the official short-term interest rate, the policies adopted to counter disinflation will take longer to wind down and have implications that are more spread out and open to contestation.

Second, in a more uncertain and volatile world, how to set policy in an environment where shocks may or may not be short-lived — either individually or collectively — and where they may create conditions where judging trade-offs between inflation and activity play a large part.

Third, how to ensure that we can at all times meet both our monetary policy and financial stability objectives, including when they may be pointing in opposite directions, and in particular that central banks have the necessary operational tools and can use them at all times if required.

Recent experiences indicate the larger role of the financial stability objective in modern central banking in contrast to the orthodoxy of the post-1970s era when monetary policy alone came to the fore. This rebalancing in some ways takes us back to the earlier classical gold standard era of central banking. But in modern central banking, the separation principle is much more important than it was in the classical era. By this I mean distinguishing between, and communicating the distinction between, monetary policy and financial stability actions.

Looking at recent experience in the U.K., the so-called LDI event was clearly a financial stability not monetary policy one, and the challenge was to structure the intervention and communicate it in a way that reinforced this point. The March 2020 "dash for cash" was more complicated because it arose in the context of both financial stability and monetary policy events (the latter in the sense of the severe and unexpected recession). How to structure and communicate the policy response by central banks in this — hopefully highly unusual — situation deserves more attention. That said, in the normal state of affairs we are moving to a world where our standard operations meet the system's demand for liquidity in normal times, and not more than that. Against this backdrop, monetary policy can most effectively set the official interest rate. In normal conditions, meeting the demand for liquidity — most obviously through the level of reserves banks choose to hold — should also support financial stability. Beyond that, we must then have a set of effective and usable exceptional tools for financial stability stresses including when they arise in the non-bank part of the financial sector.

The classical gold standard was an era of prolonged monetary stability punctuated by the need to respond rapidly and forcefully to financial stability shocks, and in doing so preserve monetary stability. Walter Bagehot's critique of the Bank of England in the classical gold standard era was for not responding in a timely and forceful way to financial stability shocks. In the Covid-Ukraine era central banks did respond rapidly and forcefully. Some would still say we did too much. I disagree with that assessment. But I do think that going forwards — and as we experienced positively with the LDI crisis — rediscovering the distinctive roles of monetary and financial stability actions will help us. Financial stability issues themselves create macroeconomic trade-offs which can affect monetary policy.

But these will naturally fit within the framework of monetary policy. This is what we did in March 2020. That said, distinguishing the handling of primary monetary policy and financial stability shocks, and having more targeted tools in our boxes, will I am sure assist with the inevitably hard job of policy making.

To conclude, the challenge for monetary policy of the Covid-Ukraine era could not have been to prevent the inflation happening. To attempt to do that would have been to ignore the trade-off element of our remit. Put more directly, as Ben Bernanke did in his report, it would have led to a depression and thus a repeat of the errors of the 1920s.[5] Rather, the task for central banks was to produce an orderly return of inflation to target, with expectations anchored.

Recent experience leads me to be cautiously optimistic that inflation expectations are better anchored as a result of the regimes we have in place. The second round inflation effects appear to be smaller than we expected. But it is too early to declare victory. Policy does have to react — the regime works because we use it.

Economies — and the U.K. is a good example here — are in a stronger and more resilient position as a result of the actions taken over recent years. A key point here is not to do with the immediate situation and prospects. It is that the underlying resilience of economies and financial systems should be sufficient to enable sizeable market movements and risk asset price corrections to occur without threatening stability. This is the lesson from Bagehot in the nineteenth century. His diagnosis was that flaws in the response to financial stability events undermined monetary stability, at that time in the form of the classical Gold Standard. Similar diagnoses have been made around the Great Depression and the Global Financial Crisis. This explains why we have done so much to build stronger financial stability buffers over the last fifteen years since the GFC. This is the best way to support resilient and competitive financial systems and strong economies. Market events like those of two weeks ago or so will happen; the test is not whether they happen but whether they trigger wider instability. As central banks we operate within systems that are framed by law and institutions to create and preserve stability and prosperity in the public interest.

All that said, communicating policy is harder in uncertain conditions with large shocks. Communication is complicated where we have to operate to achieve both our monetary policy and financial stability objectives, with the latter typically being a matter of operating in an emergency in such conditions. Likewise, communicating when we decide to accommodate short- run shocks and/or there is a trade-off between inflation and activity involved is essential but difficult. These are all areas that will benefit from further assessment.

Endnotes

[1]U.K. inflation: What's done and what's to come - speech by Jonathan Haskel.

[2]Transformation and conjuncture — remarks by Huw Pill.

[3]I am very grateful to my colleague Huw Pill for the insights on this framework.

[4]See speeches by my former colleagues Ben Broadbent and Silvana Tenreyro: Lags, trade-offs and the challenges facing monetary policy — speech by Ben Broadbent, Bank of England and The economy and policy trade-offs — speech by Silvana Tenreyro.

[5] Forecasting for monetary policy making and communication at the Bank of England: a review.

General Discussion: Luncheon Address: Reflecting on Recent Times

Agustín Carstens: Thank you, Andrew, for a really illuminating speech. Thank you very much for all the actions you have undertaken in the Bank of England, showing the way in many different respects. I think the fact that you have been thinking so much about how to organize policymaking is really a sign of leadership.

Now, in your speech, there are two, I would say, big elephants in the room that you didn't talk much about. One is fiscal policy and the other is regulatory aspects. I mean, basically what you gave to us, at least the way I understood it, is how the central bank can organize itself with respect to monetary and financial stability policy objectives. But, at the end of the day, those objectives also depend a lot on fiscal policy and on the regulatory environment.

Now, a perennial concern of central banks is how to manage the interactions with those two dimensions. So, from your experience, what are the principles you follow in terms of dealing with fiscal uncertainty and the regulatory aspects?

Andrew Bailey: Yes, it's a great question. Thanks, Agustín.

I think, first of all, stability — monetary and financial stability — obviously operates independently from fiscal policy. But I think, if we achieve them and maintain them, they underpin the operation of fiscal policy. In a sense, it's not agile, but it is easier to operate fiscal policy in an environment of monetary and financial stability.

For what it's worth, and I don't pronounce on fiscal policy, I think it is easier when fiscal policy is transparent, predictable, and well understood, rather like monetary policy. The problem with the fiscal policy that caused the Liability-Driven Investment (LDI) crisis was that it was such an unpredictable surprise. That was the problem. So, I think monetary policy and financial stability are an important backdrop for governments to operate fiscal policy within the rules they choose, which, of course, in their own right, need stability.

On the regulatory aspect, obviously, it's tightly connected with financial stability. We draw the distinction between macroprudential and microprudential regulation, and we do so rightly because they are different. I don't think macroprudential gets enough airtime.

One of the things we find — and Anil was very good in setting out the institutional structure we've got in the U.K. and the fact that we've got the Financial Policy Committee (FPC), which I think is a great asset — is that the Monetary Policy Committee (MPC) gets far more airtime. Now, it always will, of course, as it's making a decision that affects everybody directly, whereas what the FPC is doing is in the background, ensuring stability.

But, even when you've got an FPC, it's a constant challenge to make sure that people who should understand it do understand it. One of the challenges in the regulatory field is that it's less well understood. And the second thing I would say is that regulation, particularly on the microprudential side, is still more subject to political intervention than monetary policy. We've achieved a great deal on that front, but what I still find is that governments feel they have more of a right to intervene on regulation and financial stability issues than they do on monetary policy.

Barry Eichengreen: My question is, in a sense, the same as Agustín's. The Bank of England's response to recent financial instability has been very different from the response 16-odd years earlier to the run on Northern Rock. There are a number of hypotheses that could explain the contrast. Thinking about it for a minute: the change in institutional arrangements is one, the change in personnel might be a second, and the lessons drawn from recent historical experience might be a third. How would you go about thinking about that?

Andrew Bailey: Well, I have to put my hand up and say I was involved in both, so I don't know whether or not personnel is a factor—so let's leave that to one side.

Honestly, I think we all learned a huge amount in the financial crisis. The big lesson from Northern Rock, having had the painful experience, was, at the Bank of England, we always used the phrase: if you're going to intervene, and if you're going to lend, if you're going to do some form of central bank lending, it's got to be a bridge to somewhere.

Now, the problem we had at the time was that we didn't have an effective bank resolution regime. We didn't have the regime that the U.S. had at that time. So it was a bridge to nowhere. So, when we came out and announced, "Good news, the Bank of England has lent to Northern Rock," everyone said, "And what are you going to do next?" That's what caused the problem, and what we learned very quickly was that central bank emergency lending is a critical part of the toolkit, but unless you've got an answer in terms of where you're taking it and what the endpoint will be so that depositors can understand, it doesn't produce confidence. That was a hard lesson.

Nela Richardson: I'm asking a question from the vantage point of a private sector company. So you made a few really nuanced points that I really appreciate. One, that inflation was triggered by these events that no one could have predicted and therefore central banks couldn't avoid them, and that the mission was to keep expectations anchored and inflation down using an emergency toolkit.

So here's my question: has central banks, in doing exactly what they needed to do in this extraordinary time period, set up a set of precedents that will make the response more aggressive for more minor shocks than it would have been absent this episode?

Andrew Bailey: That's a great question. Let's go back to what Anil was saying. March 2020 is the most difficult but also best case study, because as I said at the beginning, you had financial stability and the monetary policy shock operating coincidentally.

The LDI, I think, is different because that was clearly a financial stability shock. The complication for us, which we confronted, was how to explain it as such, because we hadn't been in that territory before. I had people saying to me, "Well, as soon as anything like that happens, just do more QE."

This is Anil's point about getting out quickly. It's why we were so determined to get QE both to end it and to sell it so quickly — to prove that, no, this is different. I think the answer you want to use is that we've got to draw out the difference between when we're doing one and when we're doing the other. But that still leaves us with the challenge of what to do when both shocks coincide, as they did during COVID. When something so massive coincides, you've got to go in for the sake of the financial system.

So, people sometimes say to me, "Well, is the lesson from this that what you should have done in March 2020 is go in quickly and then come out quickly, like in an LDI situation?" And I say, "Well, it's just not that simple." If you go back to that time, the idea that we would have started selling gilts on that scale in the middle of COVID, when the economy was coming off a cliff, it's just not going to happen.

So that challenge — and I would encourage all who are working on these issues — remains with us: how do we deal with that sort of situation? It's very nice, ex post, to intellectually separate them, but at the time, we didn't have that luxury.

Jacob Frenkel: In the question of how to balance the monetary policy and financial stability objectives, you mentioned, very sensibly, that much depends on how well inflation is anchored in that country. Now, the answer to this depends, of course, on the past track record and the history of that situation, which differs across countries.

Now comes my question. Suppose there was, there is, an external global shock, as we've had. The degree to which inflation is well-anchored is very different across countries, which means that the choices of policy response in balancing the two objectives would be different. Would that generate a second-round shock because you are going to create diversity in policy responses and the reactions to those policy responses?

Andrew Bailey: That's a great question, Jacob. I think it will generate different second-round effects across regimes. I think that's true. And I think, in many ways, the response we've made to the shocks of the last few years has exactly leaned on the credibility that has been developed in the preceding period.

That's why, you know, I get this question quite often in Parliament where people say, "Well, you failed to control inflation." And I say, no, the test is whether the regime failed. No, the test of the regime is not that we will never have inflation. The test of the regime is, when you get hit by these shocks, how quickly do you bring it back to target? How quickly, what are the effects of bringing it back to target? That's the test of the regime.

The regime is about sustained inflation over the medium term; it's not about what happens tomorrow. I think we benefit from everything that happened in the wake of the 1970s in that sense, and we've put that to work. Our job, then, as I said, is to use the tools and to be prepared to actually raise rates. Anybody who says, "Well, that means you don't have to raise rates," no, that's wrong.

Because, A, I don't think you'll control inflation in that case, and B, of course, you will undermine the regime. People will start to ask, "Do these people actually believe in the regime?" So, I think you're right; you will get different responses because there are different degrees of credibility, and those change over time. I underline, as you rightly said, that those regimes are important.

But I'm not sure that will lead to different global second-round effects. I think it will lead to different national second-round effects, certainly.

Kristen Forbes: So I want to push you a little more about your comments on tradeoffs. From the viewpoint of economists, central bankers, we think about inflation. It really has been a remarkable success how inflation went up and has come back around target. But from the viewpoint of households, it has not been so successful. The viewpoint of households is that many have taken a big hit to their real wages. Many are looking at the basket of goods they buy, which is now much more expensive. Households think more about price levels, not inflation. This is very different from the way economists and central bankers are trained to think. So, that has led to a big backlash against central banks and governments, which could have longer-term implications.

Knowing that, does that make you think differently about tradeoffs? Looking forward, if there is another big inflation shock — and you know it will be temporary but long-lived — does this suggest that you should be more aggressive so that the price level doesn't go out of line for too long, even if it's more costly to bring inflation back to target?

Andrew Bailey: Well, I mean, I would say you're right. I think it's important—what is certainly called the "cost of living" in the U.K. is, of course, a price level issue, and it's a real wage issue in many ways. I'll come back to that point.

I don't think that we should, in any sense, overdo what we can do about price levels in the sense of when you get a shock, like the one we saw with Ukraine, particularly in the European context. Could we do anything about imported food prices in the face of what happened in Ukraine? No. We shouldn't assume that we can, because we're heading for trouble if we do that.

But the second point, and this is where I come back to your very valid point, is the framework I laid out about inflation persistence. Are we now at a point where we think it's going to be more self-correcting with the given level of restriction? Do we have to create more of an output gap? Or, I'll come to the third one, do we have a structural issue?

Let me illustrate that in two ways, one of which directly relates to what you said, Kristen. So, the first way I would illustrate that is by asking: Has COVID changed the Non-Accelerating Inflation Rate of Unemployment (NARU)? If you'd asked us this question a year ago, we were more of the view that it probably had, and that the

NARU had increased. Now, we're a little less certain about it, but it's still a question.

The second part of this structural story, which may not be a long-term story but is very relevant to the moment, is: Are we seeing a process where we have a tight labor market, one that is loosening gradually but is still tight? Are we seeing a process by which people want to, in a sense, reclaim that level of real earnings — going back to your point about price levels — and will that be a structural feature for the coming period that we will have to deal with?

We don't know. But I think it's right to have a framework that forces us to sit down and ask ourselves: What have we learned about this?

Nellie Liang: Thank you, Governor Bailey, for the question. I wanted to follow up on the central bank as a market maker of last resort, which I think probably makes many central bankers around here cringe. Given the idea that non-banks have grown significantly, perhaps regulations, such as Trish Mosser mentioned, may have made banks less flexible in adjusting to stress and intermediate.

One step short of a market maker would be expanding access of non-banks to lending facilities. As I understand it, the Bank of England has done some of that, and there's some cost that would be imposed on non-banks to have access. I just wondered if you could speak to that a little bit.

Andrew Bailey: So, I think we face two challenges at the moment in the world we're in. One, as you rightly said, is that the scale of financial intermediation in the non-bank sector has grown relative to the banking sector post-financial crisis. By the way, we should not be surprised at this because we re-regulated the banking sector. So we should not express any surprise that the non-bank sector is now much bigger.

Secondly, and this is possibly a corollary of the first point, we are much more doubtful that the old sort of theology — that if the central bank puts liquidity into the banking sector, it will find its way to everywhere it needs to go — actually works as we need it to work in the current environment. Maybe that's just a corollary of the first point, but I think it's important to keep both in mind.

Now, on the point about what we've done at the Bank of England, one very important point here is that we have not—and have no plans to—introduce what I would call standing facilities for non-banks. That's the sort of line that we're not prepared to cross. Somebody wrote an article today saying, "Bagehot would be turning in his grave over what we're doing." Actually, no, that's wrong. We're not prepared to go to standing facilities for non-banks for various reasons. But we think that's a line.

What we have done, and Anil touched on this earlier, is say that because of the first two issues you raised, we think it's right to have what I would call facilities that we can put into effect, where we would prefer to do that on the basis of repoing with some non-banks anyway. But if the repo route doesn't work—and the LDI issue was a problem here because the LDIs didn't actually own the assets they needed to sell—it wouldn't have worked anyway, even if we'd had facilities. You have to have an outright market purchase facility as a backup.

But I would stress that we are not — in any sense — contemplating standing facilities for non-banks.

Chris Waller: I wanted to bring up a point in the discussion with Anil this morning, about what you were talking about regarding the interaction between monetary policy and financial stability. Anil's idea of "get in and get out" was discussed, and we kind of got criticized this morning. I just want to bring up an example that maybe people have already forgotten.

But in March 2023, we were staring at a banking crisis. It was about as much of a financial stability crisis as you could run into. What we did was we set up facilities—the Bank Term Funding Program, gave it a fixed life of a year—it wasn't like it was going to go on forever. At the same time, people were telling us we needed to stop raising rates, stop quantitative tightening (QT) because of this situation.

What we did was, we didn't stop. We raised rates. We continued on, and we let the facilities do the job. There was never any confusion about QT and the fact that we were also lending out through this facility. So I personally congratulate Jay Powell for leading us on this. This was a very good example of how you separate monetary policy from dealing with financial stability, and how you do all the things that were mentioned earlier about getting in and getting out.

Andrew Bailey: I agree with you, Chris, and I think you're right. Going back to the point about the interaction between monetary policy and financial stability, we've got to have the tools to keep those two separate. We don't want to stop QT. We had to delay the introduction of QT with the LDI point, but we only delayed the start—we didn't stop QT.

I think the challenge we all face, and you may have observations on this, is that in the situation we found ourselves in March 2023, we've all got discount window facilities, which are very old facilities, but they are often stigmatized. Banks say to me, "We can never use that facility because if we have to disclose that we've used it, or we actually have to disclose it ourselves, we're dead at that point."

I think that's a challenge because we've had similar situations where, then, you end up having to set up special facilities in a crisis. We've developed this big sort of menu of facilities, and then we find that some of them are not actually available when we need them. That's a challenge we still face, I think.

Pierre Wunsch: Great speech, Andrew. Thanks for that. We are fighting inflation now, but before this, we were fighting inflation being too low. What do we do if we're stuck at 1 percent again? Do we do Quantitative Easing, do we do forward guidance? Because, I mean, Christine Lagarde said people have been hit by inflation, but nobody cared when we were at 1 percent except for us. We tried to do things to bring it back to 2 percent. Was it successful? I'm not sure. So what would you do if we were stuck at 1 percent?

Andrew Bailey: I don't have a magic answer to that question, Pierre, because I think we've got to go back to that question. QE, frankly—I'm not saying we never do it—but I think it's tarnished as a tool. I have to be honest.

We had a long, long debate in the Bank of England's MPC going back into 2020 about negative rates. And, to be honest with you, we never concluded it before inflation took off, so we sort of got—we got the escape route the easy way. I remain quite concerned about it. Maybe this is just the U.K. context, but obviously, others have done it, so I take my hat off to you.

But I've always wondered how well we would be able to explain negative rates in the context of the U.K. setting to the general public. The problem with QE is almost the opposite—it's so obscure that nobody understands it. We did it for years, paying cash over to the government for years, and no journalist ever wrote an article about the Bank of England paying money over to the government. But then the cash flow turned around, and they all started writing.

But QE is obscure. Negative rates, I must say, there was a very, very wide dispersion of views in the MPC on the subject, but we remained very cautious about it, and in the end, the question went away, actually.

Changing Perceptions and Post-Pandemic Monetary Policy

Michael D. Bauer, Carolin E. Pflueger, and Adi Sunderam

Abstract

We document that the Fed's perceived monetary policy response to inflation shifted materially over the post-pandemic period. In forward-looking policy rules estimated from surveys of macroeconomic forecasters, the inflation coefficient rose significantly after liftoff from the zero lower bound in March 2022. Consistent with a shift in the perceived policy response, event studies show that interest rates became significantly more sensitive to inflation data surprises following liftoff. The increase in the perceived inflation response likely aided the transmission of monetary policy to the real economy and improved the Fed's inflation-unemployment tradeoff. The timing of this shift and additional evidence from surveys and financial markets suggest that forecasters and markets were highly uncertain about the monetary policy rule prior to liftoff and learned about it from the Fed's rate hikes.

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1. Introduction

The aftermath of the Covid-19 pandemic has presented serious challenges for monetary policy. The Federal Reserve responded to the ensuing inflation surge with the fastest increase in the federal funds rate in 40 years. The effectiveness of any such policy response depends crucially on the public's understanding of the monetary policy framework and strategy.[1] To understand this episode and the effectiveness of the Fed's tightening, it is therefore important to address the following question: How did public perceptions of the Federal Reserve's response to inflation evolve over the post-pandemic inflation episode?

In this paper, we address this question using both surveys of professional forecasters and financial market data. We use the methodology we developed in Bauer, Pflueger and Sunderam (2024) to estimate the perceived monetary policy rule from individual forecaster responses in the Blue Chip Financial Forecasts (BCFF). By relating policy rate forecasts to output gap and inflation forecasts, we obtain a forward-looking estimate of how the Federal Reserve is expected to react to incoming economic data. We can estimate this relationship in each monthly panel of survey forecasts, which allows us to detect changes in the perceived rule over the course of the monetary policy cycle.

The main result from this survey-based analysis is that the perceived inflation response coefficient was close to zero for many years but then increased substantially and rapidly during the Fed's monetary tightening. It reached a level around one in 2023, in line with the Taylor principle. During periods when inflation is low and stable, the inflation coefficient in any estimated policy rule may well be low regardless of whether the central bank is credibly committed to price stability (Clarida, Gali and Gertler, 2000). However, episodes of high inflation reveal whether a central bank is indeed committed to fighting inflation, and whether this commitment is perceived as credible. The significant increase in the Fed's perceived responsiveness to high inflation confirms that this is indeed the case: Monetary policy perceptions are consistent with the Fed's strong commitment to price stability.

Bond markets provide a second source of evidence on perceptions about a central bank's responsiveness to inflation. When investors anticipate a stronger policy response to inflation, then interest rates should move more in response to news about inflation. For example, if an inflation print comes in higher than the consensus expected prior to the data release, a higher perceived inflation coefficient should lead to larger upward revisions of investor forecasts of future policy rates, and thus to a stronger interest rate response.[2]

To test this idea, we estimate event-study regressions of interest rate changes on core CPI surprises, calculated as the released core CPI inflation minus consensus expectations before the announcement. The rate changes are taken over narrow windows around the inflation data releases, so that the regressions arguably identify the causal effects of inflation news on interest rates. We find that Treasury yields as well as money market futures rates became significantly more responsive to inflation news after the Fed's liftoff from the zero lower bound (ZLB) in March 2022. For example, a core CPI surprise led to essentially no change in the two-year yield over the period from January 2014 to March 2022, despite the fact that there were several large core CPI surprises in 2021. But a core CPI surprise of 10 basis points (bps) led to a highly statistically significant 9.6 bps increase in the two-year yield over the post-liftoff period from April 2022 through May 2024. In other words, yields responded roughly one-for-one to news about inflation. Our finding of a flat relationship between bond yield changes and inflation news surprises pre-March 2022 is not a mechanical result of the ZLB, as we find that the sensitivity of the 10-year Treasury bond yield to inflation also significantly increased after liftoff. This evidence from inflation surprises corroborates our survey-based evidence of a substantial increase in the perceived inflation coefficient using a completely different methodology in different data.

Our finding of a substantial increase in the perceived monetary policy response to inflation is relevant for policy for at least two reasons. First, the perceived policy response shapes the key asset prices that transmit monetary policy to the real economy. As argued by Woodford (2005), markets can "do the central bank's work for it" provided that market participants understand how policy will react to changes in the economic outlook. In this case, expected future short rates, long-term rates, and broader financial conditions became more responsive to macroeconomic news.[3] Second, perceptions about the policy response to inflation can matter for the inflation-unemployment tradeoff faced by a central bank. We show that a stronger perceived inflation response can help lower inflation at a given output gap in a simple New Keynesian model with distinct actual and perceived monetary policy rules.[4] Given its importance for monetary transmission and monetary tradeoffs, the shift towards a strong perceived inflation response may help explain why the recent disinflation had low output and unemployment costs, particularly compared to the Volcker disinflation of the 1980s.

The timing of the shift in policy perceptions we document is noteworthy and somewhat puzzling. Our evidence suggests that it only happened after liftoff in March 2022, and some estimates suggest it came well after that point in time. For example, the inflation coefficient in our simple perceived policy rule only increases in early 2023. This is puzzling because one might have expected the perceived policy rule to start changing in 2021, when markets and forecasters were repeatedly surprised by large, positive inflation announcements and the public likely expected the Fed to respond to the inflation surge. We consider three potential explanations for the relatively late change in perceptions.

The first possibility is that the public thought inflation was transitory and would come down even in the absence of a monetary policy response. To assess the relevance of this explanation, we examine heterogeneity across forecasters. While the average forecaster in our survey data believed inflation would be quite transitory, there was substantial heterogeneity. In December 2021, 25% of forecasters believed CPI would average 3% or higher over the next four quarters and 10% believed it would average over 3.75%. We find little evidence that forecasters who expected higher inflation anticipated a different policy response than the average forecaster prior to liftoff in March 2022. Prior to liftoff, even forecasters who thought inflation was likely to persist believed that the Fed's response to inflation would be limited.

The second possibility is that the public may have believed the FOMC was following a well-understood but nonlinear or state-dependent monetary policy rule. For example, average inflation targeting (AIT) may call for the Fed to remain "behind the curve" after under-shooting its inflation target for an extended period of time.[5] This type of mechanism could generate a substantial increase in the perceived monetary policy inflation coefficient with a lag after an inflationary episode.[6] To study this hypothesis, we examine the sensitivity of yields of different maturities to inflation surprises. Even if the FOMC followed a deliberate and well-communicated strategy of remaining "behind the curve" for some time, long-term interest rates should still be sensitive to inflation surprises early on. But we find little evidence for such interest rate sensitivity. Prior to March 2022, long-horizon Eurodollar futures rates were only slightly more responsive to inflation surprises than short-maturity rates. Furthermore, the sensitivity of long-maturity rates to inflation surprises was small even during the significant inflation surprises of 2021, and only rose following liftoff. This evidence is inconsistent with the view that markets expected the Fed to respond strongly to inflation but simply with a lag, until previous inflation shortfalls had been made up. Instead, it suggests that even in late 2021 and right up until liftoff in 2022, markets expected a moderate Fed policy response to inflation, and only updated their beliefs after observing liftoff and major rate increases.

We also examine survey data from Europe. We find a similar pickup in the perceived monetary policy inflation coefficient for the ECB. If anything, the increase in the perceived inflation coefficient was somewhat later and less pronounced in Europe than in the U.S. Since the ECB did not have an AIT framework in place, this comparison between the Fed and the ECB further suggests that complex monetary policy rules cannot explain our results.

The third possibility is based on the notion that knowledge about the Fed's policy rule is incomplete. Under this plausible assumption, forecasters and markets take cues from FOMC interest rate decisions and update their beliefs about its inflation coefficient from observed rate hikes. The idea that the monetary policy rule is partly unknown and even experts update their perceptions about the rule from policy actions is consistent with our findings in Bauer, Pflueger and Sunderam (2024) over a much longer sample period, as well as with evidence in Cieslak (2018), Schmeling, Schrimpf and Steffensen (2022), Bauer and Swanson (2023*a*), Bauer and Swanson (2023*b*). It appears that the data are most consistent with this third explanation for the delayed shift in perceptions. Interest-rate options show that uncertainty about future interest rates and the Fed's policy response was elevated during this episode. Monetary policy surprises — the reactions of interest rates to monetary policy announcements — were small in magnitude in 2021, but large and volatile with the onset of rate hikes in 2022. If the policy rule were fully understood before policy actions, then such large monetary policy surprises would have been unlikely. A rough back-of-the-envelope calculation suggests that learning from policy actions likely played a quantitatively significant role in the shift in public perceptions we document towards a stronger policy response to inflation.

Taken together, our results suggest that the recent pivot in monetary policy seems to have been broadly successful. Our findings from surveys of professional forecasters and financial markets show that public perceptions shifted towards a strong systematic inflation response during the Fed's recent hiking cycle, and within standard models this shift would have helped generate a larger disinflation for a given decline in output. However, our results also indicate that substantial rate hikes were apparently necessary for perceptions to shift, and that the public did not fully understand the Fed's strategy and policy rule prior to liftoff.

We highlight three policy implications of our findings. First, policy makers may want to track the perceived monetary policy rule via the survey- and market-based methodologies shown to be useful in this paper. Second, policy rate actions contribute to, and may even be necessary for, the effectiveness of communication, particularly when uncertainty about the monetary policy framework is high. As our evidence shows, a timely policy rate response to inflation matters not only for influencing immediate financial conditions, but also for signaling that policy makers are serious about responding to future inflation news. Third, innovations that allow for clearer communication of the intended monetary policy rule may be helpful. For instance, the Summary of Economic Projections could link macroeconomic and policy rate forecasts, allowing the public to more easily learn about the Fed's reaction function.[7]

Our paper is related to other recent work that has studied links between monetary policy and financial markets in the post-pandemic period. Cieslak, McMahon and Pang (2024) also document increased uncertainty about the monetary policy framework in 2021, and an increased sensitivity of Treasury yields to core CPI news since liftoff in March 2022. They emphasize the role of term premia in this context and provide a detailed, critical analysis of the Fed's policy response to the recent inflation surge. Arnaut and Bauer (2024) show that broader financial conditions have become more responsive to inflation news over this period. Bocola et al. (2024) document a substantial decline in the correlation of daily changes in nominal Treasury yields with inflation compensation in the 2020–2022 period, consistent with our finding of a low perceived monetary policy response to inflation before liftoff. Haddad, Moreira and Muir (2023, 2024) argue that unconventional monetary policy announcements convey information about asset purchase rules, as revealed by options and term premia. Pflueger (2023) analyzes the comovement of nominal yields, breakeven inflation, and stock returns within a quantitative New Keynesian asset pricing model. Her evidence is also consistent with a low inflation coefficient in 2021 and into 2022, and a late change in financial market perceptions of the monetary policy framework.

The remainder of the paper is organized as follows: Section 2 presents our main empirical results, including estimates of the perceived monetary policy rule and event-study evidence of interest rate sensitivity to inflation news, and discusses the economic relevance of the shift in perceptions. Section 3 investigates the drivers of changes in the perceived inflation response and evaluates the three possible explanations for the late timing. Section 4 explores policy implications, and Section 5 concludes.

2. Policy Perceptions During the Recent Inflation Episode

In this section, we show that the perceived response of monetary policy to inflation increased significantly after liftoff in March 2022, based on data from both surveys of professional forecasters and financial markets. We then discuss why this shift in policy perceptions is economically significant for the monetary transmission mechanism.

2.1 Perceived Monetary Policy Rule From Survey Data

We apply our methodology from Bauer, Pflueger and Sunderam (2024) to estimate the perceived monetary policy rule through the recent inflation experience and liftoff. The data is from Blue Chip Financial Forecasts (BCFF), a monthly survey of professional forecasters, and we include survey waves up to and including April 2024. The BCFF survey asks participants for forecasts of interest rates, including the federal funds rate, as well as their *assumptions* about output growth and inflation underlying their rate forecasts, effectively asking forecasters for their perceived relationship between macroeconomic variables and interest rates. Forecasts are for quarterly horizons from the current quarter out to five quarters ahead. See Appendix A for further information about the data and summary statistics.

We estimate the relationship between forecasts for the federal funds rate, inflation, and the output gap using panel regressions according to a standard Taylor-type monetary policy rule (Taylor, 1993, 1999). In contrast to the standard macroeconomics literature, which typically obtains backward-looking estimates of the Fed's policy rule using macroeconomic time series (Kim and Nelson, 2006; Boivin, 2006; Orphanides, 2003; Cogley and Sargent, 2005; Clarida, Gali and Gertler, 1999; Rudebusch, 2002), our estimates from BCFF forecasts should be interpreted as forward-looking. We estimate

$$E_t^{(j)} i_{t+h} = a_t^{(j)} + \hat{\beta}_t E_t^{(j)} \pi_{t+h} + \hat{\gamma}_t E_t^{(j)} x_{t+h} + e_{th}^{(j)} \tag{1}$$

for each survey month *(t),* where horizon *(h)* and forecaster *(j)* are the two panel dimensions. Here the expectations operator $E_t^{(j)}$ denotes the forecast of forecaster j in survey wave t, i_t is the federal funds rate, π_t is year-over-year inflation in the consumer price index (CPI), and x_t is the output gap, derived from real GDP growth forecasts as described in Appendix A. We include forecaster fixed effects $a_t^{(j)}$ to absorb forecaster beliefs about long-run inflation and the long-run real interest rate, which may be correlated with inflation and output gap forecasts. Since we estimate a separate panel regression in each monthly survey, we can allow all parameters to vary over time in a completely unrestricted manner.

The coefficients $\hat{\beta}_t$ and $\hat{\gamma}_t$ in (1) capture the *perceived* policy responses to inflation and the output gap, respectively. These perceived response coefficients may well differ from the true, time-varying response coefficients in the Fed's policy rule, β_t and γ_t, which are difficult to estimate and we treat as unobserved.

In addition to the simple rule above, we also estimate a perceived inertial rule, which allows for interest-rate smoothing by including forecasts of the policy rate one quarter earlier, that is,

$$E_t^{(j)} i_{t+h} = a_t^{(j)} + \hat{\beta}_t E_t^{(j)} \pi_{t+h} + \hat{\gamma}_t E_t^{(j)} x_{t+h} + \hat{\rho}_t E_t^{(j)} i_{t+h-3} + e_{th}^{(j)}. \tag{2}$$

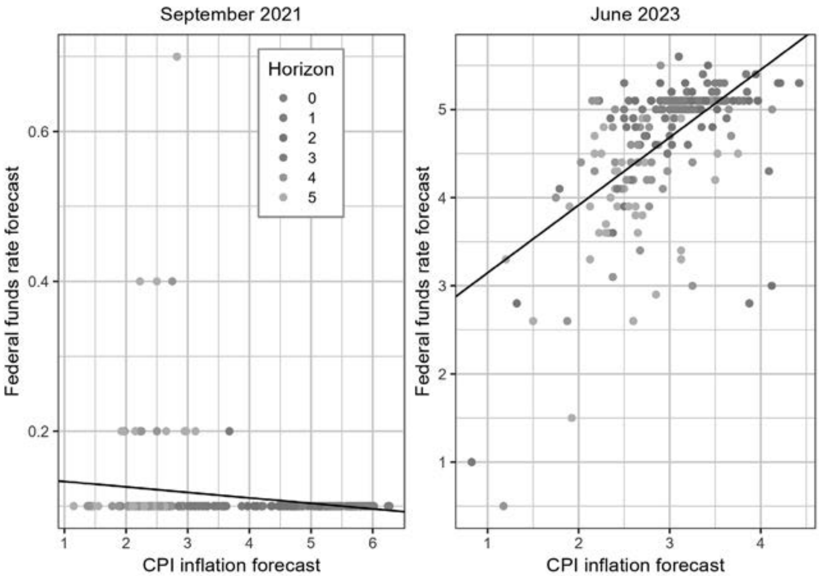
The estimates from the inertial rule should be interpreted as the perceived short-run monetary policy response, which can cumulate over time with monetary policy persistence. By contrast, the estimates from the baseline rule should be interpreted as the perceived medium-run response over the forecast horizon.

In Bauer, Pflueger and Sunderam (2024), we described four assumptions for these panel regressions to recover the true perceived monetary policy rule of professional forecasters. First, forecasts must exhibit some disagreement about future output and inflation. Second, forecasts for future output and inflation must be uncorrelated with forecasts of future monetary policy shocks. Third, our panel regressions must capture the correct specification of the policy rule, including homogeneous beliefs about its parameters. Finally, expectations about the parameters of the rule must be constant over the forecast horizon.

These identifying assumptions are likely to be satisfied in practice, at least to a first approximation, and some of them can be relaxed without affecting the results, as discussed in our earlier work. For instance, alternative specifications that allow for a policy response to financial conditions lead to similar estimates of the perceived response to economic activity and inflation. And while beliefs about the monetary policy rule are likely heterogeneous — see, for example, Carlstrom and Jacobson (2015) — our methodology is robust to allowing for such heterogeneity, and should be viewed as estimating the average perceived rule across professional forecasters. While the second assumption — the exogeneity of macroeconomic forecasts — strictly speaking requires that forecasters do not take into account the impact of monetary policy shocks on inflation, our main finding is unlikely to be driven by violations of this assumption. First, both the level of and changes in such a bias would work against finding an increase in $\hat{\beta}_t$, as we do. Forecasters who expect a positive monetary policy rate shock should forecast lower inflation, leading to a negative bias in the relationship between inflation and policy rate forecasts. This bias is likely to have become more negative over our sample period, as the perceived volatility of monetary policy shocks increased. Second, our evidence from financial markets in Section 2.2 does not require this assumption and corroborates our main findings. Moreover, the explanatory power of our estimated perceived policy rules for the federal funds rate forecasts is quite high, with an average R^2 (including fixed effects) of 0.70 for the simple rule and 0.90 for the inertial rule. This suggests that omitted variables not captured by fixed effects, heterogeneity across forecasters, and misspecification of the perceived rule are unlikely to be significant.

Figure 1 illustrates our main finding in the raw BCFF survey data. The left panel shows a flat relationship between forecasts of the federal funds rate on the y-axis and forecasts of CPI inflation on the x-axis in the September 2021 survey wave. Different forecast horizons are depicted in different colors. We see that there was significant variation in inflation forecasts both across and within forecast horizons in September 2021. However, this variation is uncorrelated with forecasts of the funds rate. As a result, our estimation methodology recovers a perceived monetary policy inflation coefficient, $\hat{\beta}_t$ that is close to zero in September 2021.

Figure 1
Forecasts in September 2021 and June 2023

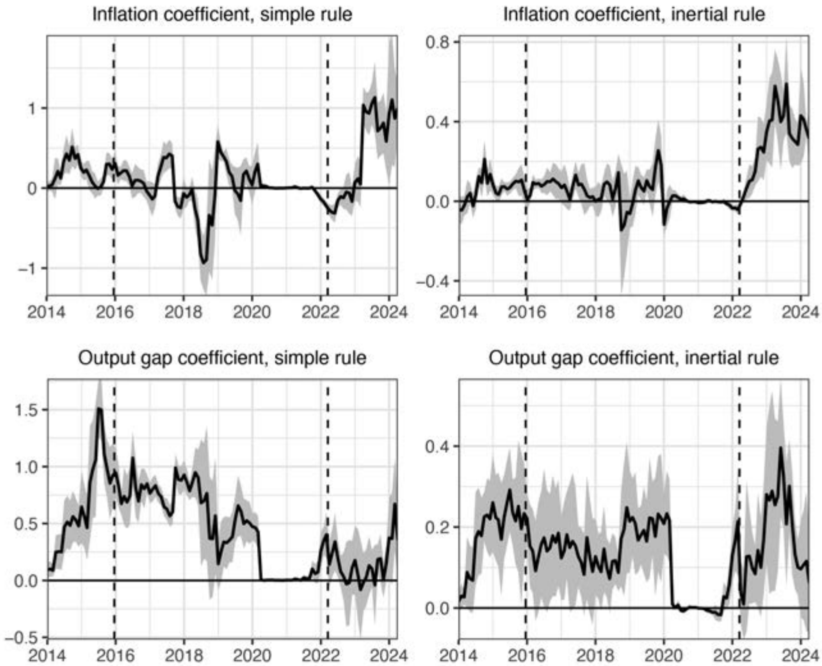


Scatter plots of federal funds rate forecasts against CPI forecasts in the Blue Chip Financial Forecast surveys from September 2021 and June 2023. Different shades of gray correspond to different forecast horizons between the current quarter (zero) and five quarters ahead.

The picture looks markedly different in June 2023, shown in the right panel, where the upward-sloping relationship between CPI inflation forecasts and policy rate forecasts is unmistakable. At this time, there was again substantial disagreement about inflation forecasts, both across forecasters and across forecast horizons. However, different from two years prior, forecasts for the federal funds rate were tightly linked to inflation forecasts. Correspondingly, for the June 2023 survey wave, we estimate a perceived monetary policy inflation coefficient, $\hat{\beta}_t$, close to one.

Figure 2 plots the estimated inflation and output gap coefficients, $\hat{\beta}_t$ and $\hat{\gamma}_t$, estimated separately for each survey wave t between January 2014 and April 2024, where the survey wave is depicted on the x-axis. The estimated relationship (1) differs from the univariate relationship depicted in Figure 1 in that it controls for output gap forecasts and forecaster fixed effects. The left panels show the perceived coefficients from the simple rule, and the right panels show the perceived

Figure 2
Forward-Looking Policy Rules



Coefficients in forward-looking/perceived monetary policy rules, estimated from month-by-month panel regressions on Blue Chip Financial Forecast surveys from January 2014 to April 2024. The left panels show estimates of the simple rule, equation (1), and the right panels show estimates that allow for monetary policy inertia, as in equation (2). Gray-shaded areas are 95% confidence intervals based on standard errors with two-way clustering (by forecasters and horizon). Vertical lines show liftoff dates December 2015 and March 2022.

coefficients from the inertial rule. Vertical dashed lines indicate the two dates when the Fed lifted its policy rate off the ZLB, December 16, 2015 and March 16, 2022.

The figure shows that during the pre-pandemic period $\hat{\beta}_t$ fluctuated close to zero, while $\hat{\gamma}_t$ was generally positive and ranged between 0.5 and 1.0 for the simple rule. In our earlier paper, we estimated the perceived monetary policy rule for a longer sample starting in January 1985 but ending earlier in May 2023. In that analysis, we found a time-varying, generally positive perceived output gap coefficient, and we analyzed in detail its variation over the monetary policy cycle and in response to policy actions. That analysis did not focus on the perceived inflation coefficient, which was generally low and close to zero for most of that sample period, similar to the shorter pre-pandemic period shown in Figure 2.

The time variation in the perceived monetary policy rule over the recent period illustrates the forward-looking nature of our estimates. In particular, the onset of the ZLB period during the pandemic is clearly visible in the estimated perceived monetary policy coefficients, when both drop to zero in March 2020. This result contrasts with our earlier findings for the first ZLB, where we found that the perceived output gap coefficient remained positive until 2011.[8] The rapid drop in the estimated perceived monetary policy parameters reflects well-understood forward guidance in 2020 and contrasts with the first ZLB period, which began with much less explicit forward guidance from the Fed.

Our main result, clearly evident in Figure 2, is a substantial upward shift in the perceived response to inflation in the post-liftoff period, 2022–2024. The top-left panel shows that the inflation coefficient in the perceived simple rule rose from zero to around one, consistent with the Taylor principle that the Fed should raise interest rates at least one-for-one with inflation. The rise in $\hat{\beta}_t$ stands out from the pre-pandemic period and speaks to the exceptional changes in both the macroeconomic environment and monetary policy strategy — true and perceived — during this recent period.

The estimates for the inertial rule in the right panels of Figure 2 show broadly similar patterns to the estimates for the simple rule. The magnitudes for the inertial rule are different because the inertial rule captures the perceived short-term responses to inflation and the output gap.[9] One difference between the two top panels is that the inertial inflation coefficient $\hat{\beta}_t$ on the right turns positive and gradually increases immediately after liftoff in March 2022, while the simple-rule $\hat{\beta}_t$ on the left turns briefly negative around liftoff and then jumps to near one in early 2023. That inertial estimates of $\hat{\beta}_t$ are more consistently positive and increase smoothly after March 2022 suggests that Fed policy was expected to respond gradually to spikes in inflation, which were then expected to mean-revert. The inertial rule also shows a clearer positive perceived output gap coefficient $\hat{\gamma}_t$ immediately after liftoff, further supporting its plausibility.

One concern might be that the estimated response coefficients in Figure 2 exhibit a fair bit of volatility and tend to fluctuate from month to month. One reason for this volatility in the estimated $\hat{\beta}_t$ is that it is based on forecasts for headline CPI inflation. An alternative is to use the Survey of Professional Forecasters (SPF), which contains forecasts for core CPI inflation but is available only at quarterly frequency.

Appendix Figure B.1 shows the usefulness of stripping out food and energy by using SPF forecasts, which leads to $\hat{\beta}_t$ estimates that are smoother and turn negative less often. Another reason for volatility in $\hat{\beta}_t$ is the short horizon of these survey forecasts, which allows short-run, transitory fluctuations in inflation to affect the estimates. Different estimation methods and data sources, including both survey forecasts and financial data, should be used in a complementary fashion when trying to robustly identify changes in monetary policy perceptions.

Overall, panel regressions of forward-looking policy rules using surveys of professional macroeconomic forecasts show a substantial increase in the perceived monetary policy inflation coefficient after liftoff in 2022. This pattern is robust to the choice of different surveys and specifications of policy rules with and without policy inertia.

2.2 Perceived Monetary Policy Rule in Financial Markets

We next estimate the sensitivity of interest rates to inflation news in event-study regressions, and again find a substantial increase in the perceived response of monetary policy to inflation using completely separate approaches and data. This approach is motivated by the idea that the yield curve response in narrow windows around data releases mainly reflects market expectations about the Fed's response to this news. The magnitude of the response therefore reveals how strongly investors expect Fed policy to react to new inflation data. In other words, such event studies estimate the "market-perceived monetary policy rule" (Hamilton, Pruitt and Borger, 2011).

We investigate the relationship between inflation news and interest rates using event-study regressions

$$\Delta y_t = \alpha + \theta s_t + \varepsilon_t, \tag{3}$$

where s_t is the core CPI surprise, the difference between monthly core CPI inflation and the average Bloomberg forecast immediately prior to the release and Δy_t is the daily yield change on the day of the inflation release. The intuition described above suggests that the sensitivity coefficient θ is closely related to the perceived monetary policy response to inflation, $\hat{\beta}_t$. This intuition can be formalized in a model of monetary policy perceptions. In Bauer, Pflueger and Sunderam (2024) we confirmed the predictions of such a model for the time-varying monetary policy output gap coefficient, using event study regressions around non-farm payroll news and a broader macro news index following Swanson and Williams (2014). Here we instead focus on inflation news releases, which have received renewed attention during recent years, to directly compare estimates of the Fed's perceived inflation response from survey forecasts with estimates from financial markets.

Table 1 reports the sensitivity of different interest rates to core CPI surprises over the pre- and post-liftoff periods. We study the responses of two-year and ten-year Treasury yields, and money market futures rates for expirations of 4, 8, 12, and 16 quarters. We use a January 2014 start date to match our survey data analysis.[10] Core CPI releases are monthly, giving 97 observations for the pre-liftoff period and 26 observations post-liftoff. The two-year yield is often used as a summary of the current monetary policy stance and immediate forward guidance, while the 10-year Treasury yield response reflects longer-term monetary policy expectations, term premia, and potentially even unconventional monetary policy (Swanson and Williams, 2014). Money market future rates provide a more granular view of policy rate expectations at specific horizons. Of course, all interest rates may also reflect changes in term premia, though term premia should matter primarily for long-term yields, and should, if anything, bias upwards the pre-liftoff sensitivity of long-term yields (Cieslak, McMahon and Pang, 2024).

The top panel of Table 1 shows that the sensitivity of interest rates to inflation surprises was very low prior to liftoff.[11] The sensitivity over this period is only about 0.1, meaning that a 10 basis point surprise in the core CPI release leads to a 1 basis point increase in

Table 1
Sensitivity of Interest Rates to Inflation News

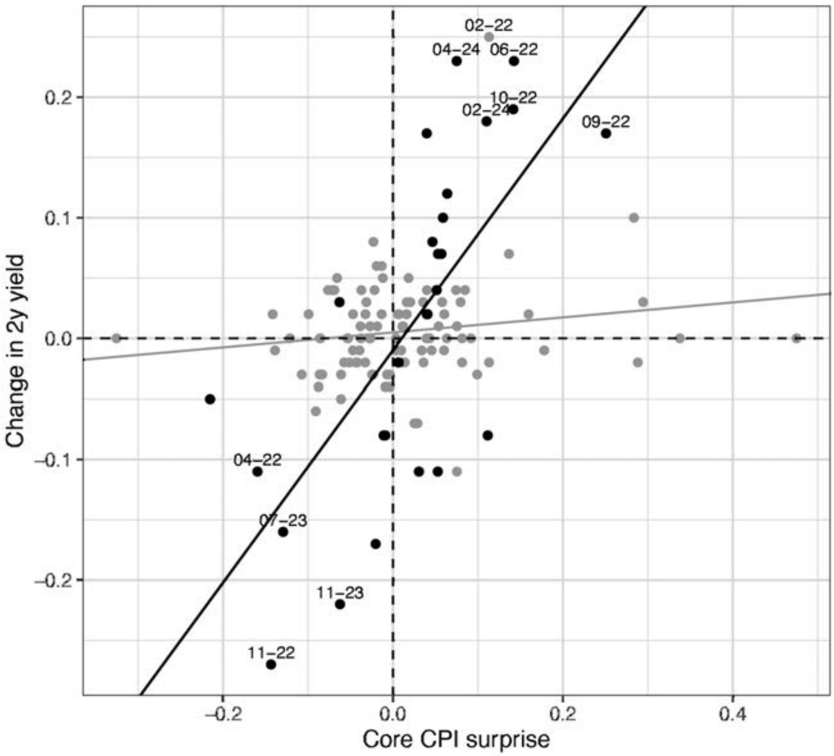
	Treasuries		Money Market Futures			
	2y	10y	4q	8q	12q	16q
Panel A: Pre-liftoff, 2014:01 to 2022:03						
CPI surprise coefficient (θ)	0.06	0.11***	0.08*	0.14**	0.13**	0.13**
	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
Observations	97	97	93	93	93	93
R^2	0.02	0.06	0.03	0.07	0.06	0.06
Panel B: post-liftoff, 2022:04 to 2024:05						
CPI surprise coefficient (θ)	0.96***	0.57***	1.22***	1.11***	0.82***	0.59***
	(0.21)	(0.21)	(0.25)	(0.28)	(0.23)	(0.21)
Observations	26	26	26	26	26	26
R^2	0.48	0.27	0.50	0.43	0.35	0.26

Event-study regressions of daily changes in interest rates on core CPI surprises, the difference between the released monthly core CPI inflation rate and the average Bloomberg forecast immediately before the data release. Treasury yields are constant-maturity rates from the Fed's H.15 release. Money market futures are Eurodollar futures until December 2021 and SOFR futures starting in January 2022. Regression intercept is included but not reported. White robust standard errors are reported in parentheses, and *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

interest rates. The statistical significance for the pre-liftoff period is also low, with the coefficient for the two-year yield not significantly different from zero at the 10-percent level. In contrast, the bottom panel shows that after liftoff, short-term interest rates were about ten times more sensitive to inflation surprises than pre-liftoff. The post-liftoff sensitivities for short-term interest rates were around or even greater than one. The sensitivity of longer-term yields to inflation surprises also increased substantially from the pre-liftoff period to about 0.6 post-liftoff. All coefficients are statistically significant at the one percent level, despite the much smaller sample size of only 26 observations.[12]

Figure 3 plots the raw data to help better understand the increased interest rate sensitivity to inflation news post-liftoff. It depicts a scatter plot of daily changes in the two-year yield on the y-axis against core CPI surprises on the x-axis, with each dot corresponding to a release date. The gray dots correspond to the pre-liftoff observations, and the gray fitted line corresponds to the regression in the first column of the top panel of Table 1. A striking example of the lack of rate sensitivity over this period is the CPI release on May 12, 2021. Reported month-over-month core CPI inflation was 47.5 basis points above the consensus expectation, the largest surprise in our entire sample. The two-year yield, however, did not respond at all

Figure 3
Changes in Two-Year Treasury Yield and Core CPI Surprises



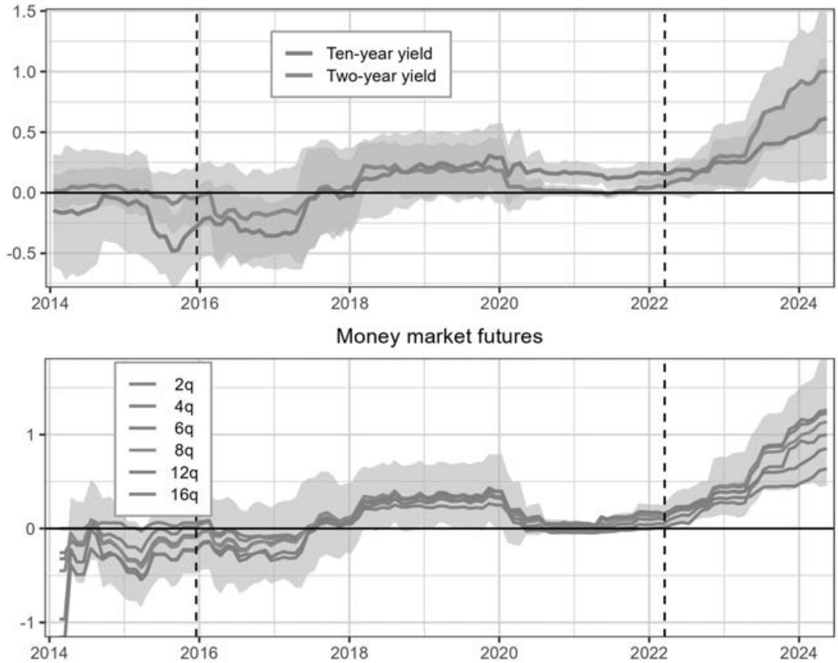
Changes in two-year Treasury yield and core CPI surprises, defined as the difference between released core CPI inflation and consensus expectations. Gray: pre-liftoff sample, January 2014 to March 2022. Black: post-liftoff sample, April 2022 to May 2024. The ten most influential observations in the full-sample (2014-2024) regression are labeled.

and remained unchanged on this day, evidently due to the (ex-post incorrect) perception that the Fed's policy rate would not respond to higher inflation over the subsequent two years. Several other large inflation surprises in 2021 also led to essentially no yield response. This shows that the low sensitivity of yields to inflation surprises before liftoff was not just due to the absence of meaningful surprises.

The black dots in Figure 3 highlight the observations after liftoff, and the corresponding regression line illustrates that core CPI surprises led to an almost one-for-one response in the two-year yield. The ten most influential observations for the full-sample (2014-2024) regression are labeled, and it is notable that most of these observations occurred well after liftoff, in the second half of 2022 or later. Though on average inflation was moderating from its peak after mid-2022, the inflation releases since then still contained both positive and negative surprises, many of which were quite large in magnitude. The strong sensitivity of yields after liftoff appears roughly symmetric for positive and negative inflation surprises, supporting the specification of a simple linear regression and a linear perceived policy rule. A concern might arise that the low pre-liftoff sensitivity and the substantial increase thereafter are a mechanical result of the ZLB constraint on nominal interest rates during 2020–2021. However, we know from Swanson and Williams (2014) that for a significant portion of the 2008–2015 ZLB episode, short-term rates were stuck near zero and unresponsive, but yields on bonds with maturities of two years and longer were unconstrained by the ZLB and remained sensitive to macroeconomic news. It therefore seems unlikely that the low sensitivity of longer-term rates in the top panel of Table 1 is simply mechanical.

To further investigate the timing of the shift documented above, and to better assess the role of the ZLB, we estimate a time-varying sensitivity of interest rates to inflation surprises using rolling regressions. The window length is 24 months, and we report estimates for windows ending in January 2014 up to May 2024. Figure 4 shows that the sensitivity of Treasury yields (top) and for money market futures (bottom) increased substantially after liftoff and through 2023 and 2024, mirroring our results from BCFF survey data in Figure 2. Again, similar to the perceived monetary policy rule from surveys, Figure 4 shows that the ZLB had a visible impact on the two-year yield and futures rate sensitivities, which collapsed to zero in March 2020. The rate sensitivities then increased towards the end of the sample to levels far above those previously seen between the two ZLB episodes. For example, the highest sensitivity of the two-year yield before 2022 was around 0.25 in 2018–2019. In contrast, in 2023 this sensitivity started to exceed 0.5 and reached one at the end of the sample. We also see that the sensitivity of the ten-year yield barely dropped during the period 2020–2021, and then rose to unprecedented levels in 2023 and 2024.

Figure 4
Sensitivity of Interest Rates to Inflation News



Coefficient in rolling regressions of changes in Treasury yields (top panel) or money market futures (bottom panel) for expirations of 2, 4, 6, 8, 12, and 16 quarters onto core CPI news, the difference between released core CPI inflation and consensus expectations. Rolling regressions use a backward-looking window of 24 monthly releases. Sample period: January 2012 to May 2024. Gray-shaded areas are 95% confidence intervals based on robust (White) standard errors.

The main takeaway from these results is that the market-perceived monetary policy response to inflation increased substantially after the liftoff from the ZLB in March 2022, and the magnitude of the response was stronger than at any time earlier in the sample, on or off the ZLB. The increase in the market-perceived inflation response closely mirrors the rise in the survey-based perceived response, $\hat{\beta}_t$, documented in Section 2.1, leading to consistent results across the two approaches.

2.3 Economic Significance of Changes in Perceived Rule

A long line of research in monetary economics has argued that perceptions about monetary policy are crucially important for the effectiveness of monetary policy. The following discussion highlights two channels through which a strong perceived inflation response coefficient — as documented above for the period after liftoff from the ZLB in 2022 — is helpful for monetary policy transmission.

The first channel is based on the insight that monetary transmission depends on expectations of future policy because they determine borrowing rates and asset prices in the economy. When the monetary policy reaction function to macroeconomic data is well-understood, then markets to some extent can "do the central bank's work for it" (Woodford, 2005). Specifically, a strong perceived monetary policy inflation coefficient ensures that long- and short-term interest rates respond to inflation news, with the implication that financial conditions tighten with higher inflation prints and loosen with lower inflation prints, long before any actual changes in the policy rate. Compared with a situation where the market first has to wait for an explicit response from the FOMC, an earlier response in financial conditions is beneficial because it works somewhat akin to an "automatic stabilizer" and helps shorten the lags that usually characterize the effects of monetary policy.

The quantitative importance of this channel over the most recent disinflationary episode becomes evident from a simple back-of-the-envelope calculation. Assume the perceived inflation coefficient equals 0.75 — the estimated value for the simple rule from the October 2023 survey wave. Under this assumption, a string of good inflation news lowering 12-month core PCE from 4.80% (July 2023) to 3.93% (October 2023) should lower interest rates by $0.75 \times (4.80\% - 3.93\%) = 65$ bps. The two-year Treasury yield did indeed fall by 80 bps from 5.03% on September 29, 2023 to 4.23% on December 29, 2023. The ten-year yield also exhibited a decline of similar magnitude over this period, falling by 71 bps to 3.88%.[13] Financial market commentary attributed the fall in longer-term interest rates during the last quarter of 2023 to precisely this channel.[14]

Second, perceptions of a strong interest rate response to inflation can improve the output-inflation tradeoff for monetary policy in standard New Keynesian models. A classic result of this nature is discussed in Clarida, Gali and Gertler (1999), which assumes a constant monetary policy rule, complete information, and rational expectations. We show in a stylized model that once the assumption about identical actual and perceived monetary policy rules is relaxed, it becomes clear that the improved inflation-output tradeoff depends critically on *perceptions* about the future policy response (see Appendix C for details). The key result from this model is that a stronger perceived response to inflation improves the inflation-output tradeoff for the central bank. Intuitively, a strong perceived anti-inflationary monetary policy rule reduces the response of *expected* inflation to a positive cost-push shock, thereby containing the rise in actual inflation through price-setters' equilibrium response. In particular, a positive cost-push shock is predicted to lead to less inflation for any given decline in the output gap if agents in the economy trust that the central bank will counteract inflationary cost-push shocks going forward. Further, in this framework, if agents perceive a strongly anti-inflationary policy rule going forward, then the central bank can achieve lower volatilities for *both* inflation and the output gap. Qualitatively, the improved outcomes from a high perceived $\hat{\beta}_t$ are similar to the benefits of commitment over discretion with regard to the optimal monetary policy of a central bank (Kydland and Prescott, 1977; Taylor, 1993; Clarida, Gali and Gertler, 1999). In related work, Bocola et al. (2024) use a regime-switching New Keynesian model to quantify the impact of the low monetary policy inflation response during the 2020–2023 period, and estimate substantial effects on inflation, underscoring the importance of the perceived policy rule.

Because the model is highly stylized, this analysis should not be taken to imply that the Fed can repeatedly benefit from manipulating perceptions about monetary policy without following through with policy rate actions. As discussed in Section 4, our findings suggest that policy rate hikes in the face of inflation play a crucial role in communicating commitment to a strong inflation response. Implications for the inflation-output tradeoff also rely on some specific modeling assumptions of the standard framework, such as forward-looking and rational (conditional on the monetary policy rule) inflation expectations.[15] While a more thorough theoretical analysis of expectations formation in the New Keynesian model is beyond the scope of this paper, we view this simple modeling exercise as highlighting the value of a clear commitment to a monetary policy strategy of fighting inflation when it arises. Overall, a strong perceived inflation response supports the transmission of monetary policy actions to long-term rates and asset prices and ultimately the macroeconomic impact. Moreover, it likely helps improve the inflation-output tradeoff faced by the central bank.

Given these benefits, we now examine the mechanisms likely contributing to the rise in the perceived monetary policy inflation coefficient during the recent tightening cycle.

3. Timing and Mechanism

In this section, we provide empirical evidence on the potential mechanisms driving the rise in the perceived response of monetary policy to inflation and its timing. While the rise in the perceived monetary policy inflation coefficient was significant and likely contributed to the overall success of the tightening cycle, it also occurred somewhat late. One might have thought that the large positive inflation surprises of 2021 should have led to a change in the perceived monetary policy rule. Since BCFF forecasts and bond yields are forward-looking, our methodology is well-suited to detect a change in the perceived monetary policy rule even when the current policy rate is still at the ZLB. However, the evidence in Section 2 shows that the perceived Fed responsiveness to inflation increased substantially only *after* liftoff from the ZLB in March 2022. Why did the perceived monetary policy inflation response not rise earlier?

We consider three possible explanations: i) the increase in inflation was initially perceived as transitory; ii) forecasters understood that the FOMC was following a history-dependent or non-linear monetary policy rule, such as a well-communicated intent to allow inflation to overshoot for a limited period of time; iii) forecasters learned about the rule from monetary policy actions. Understanding these mechanisms matters because each is linked to different policy strategies. While all three explanations likely played some role in the recent episode, the additional evidence in this section, together with the late timing of the rise in $\hat{\beta}$, favors the third one: forecasters and markets learned about the Fed's inflation response from the Fed's interest rate changes, and this "learning from actions" channel was quantitatively important.

3.1 Transitory Inflation Expectations

The first possible explanation for the late rise in the perceived response of monetary policy to inflation is that the public may have perceived inflation to be transitory throughout 2021. Under this view, inflation would subside even in the absence of a monetary policy response and there was no need for the Fed to raise the federal funds rate. This view was shared by the Fed and many private forecasters through late 2021. In his Jackson Hole speech on August 27, 2021, Chairman Powell emphasized the incomplete labor market recovery and "the absence so far of broad-based inflation pressures" justifying continued low policy rates. To better understand the relevance of beliefs about perceived inflation persistence, we split our sample of professional forecasters according to their mid-2021 inflation expectations into "team transitory" and "team permanent".[16] While the Fed and many forecasters believed that the run-up in inflation was transitory and not broad-based until late in 2021, there was a vigorous debate between policy-makers and commentators that broadly fell into two groups denoted by these terms.[17] If professionals believed that the Fed would not respond to transitory fluctuations in inflation but would respond to more long-lived inflation fluctuations, we would expect that forecasters on team permanent should have predicted an earlier and more vigorous liftoff from the zero lower bound, as well as a higher perceived monetary policy inflation coefficient.

To examine this hypothesis, we exploit the heterogeneity in medium-term inflation expectations across BCFF forecasters and classify forecasters based on their 4-quarter expectations for CPI inflation in July 2021. We define team transitory as all forecasters with 4-quarter CPI inflation forecasts in July 2021 below the median; team permanent consists of all forecasters with above-median four-quarter inflation forecasts. For each group, Figure 5 plots their average 4-quarter forecasts for inflation and the federal funds from July 2021 onwards.

Consistent with the public discussion at the time, there were meaningful differences in inflation forecasts between the two groups throughout 2021 and 2022. Nonetheless, the two groups had very similar forecasts for the federal funds rate throughout the tightening cycle. This finding is also visible in the raw data from the September 2021 wave depicted in the left panel of Figure 1, which shows that most forecasters agreed that there would be no liftoff for the next 5 quarters, even those with very high forecasts for CPI.

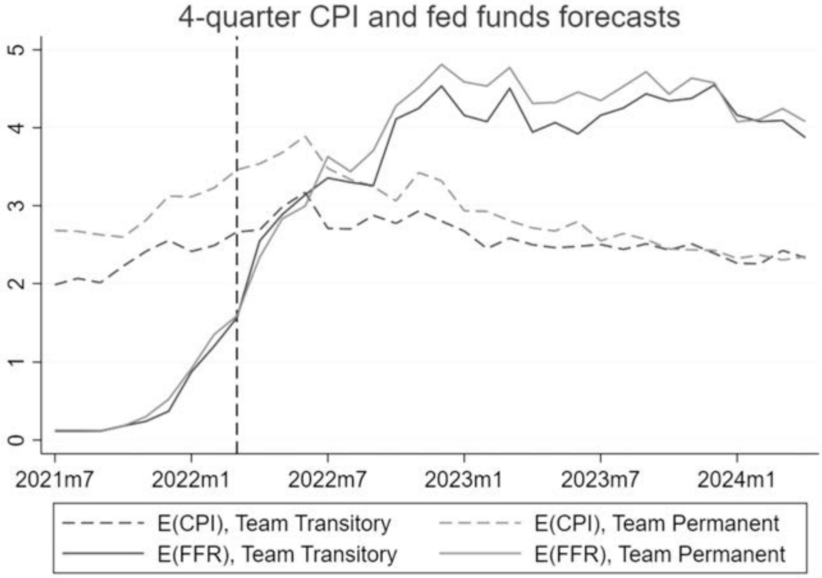
If forecasters understood that the Fed would not respond to transitory inflation, but it would to persistent inflation, then we would expect team transitory to anticipate lower policy rates for longer than team permanent. However, we find that both groups of forecasters predicted essentially the same path for the federal funds rate prior to liftoff.[18] Overall, this evidence from individual forecasters suggests that the belief that inflation was transitory cannot fully explain why the Fed's perceived responsiveness to inflation only rose after liftoff.

3.2 History-Dependent or Non-Linear Monetary Policy Rule

A second possible explanation for the late rise in the perceived inflation coefficient $\hat{\beta}$ is that forecasters believed the FOMC was intentionally allowing for a temporary inflation overshoot. With a well-understood history-dependent or nonlinear monetary policy rule, forecasters might plausibly expect the Fed to show little response to the initial inflation run-up in 2021 in the short-run, while still anticipating a stronger inflation response in the longer-run. This is not just a theoretical possibility, but exactly the idea behind average inflation targeting (AIT), which the Federal Reserve embraced in its newly revised strategic policy framework in 2020. The Fed's revised policy framework is one of many possible make-up strategies, all of which "fundamentally work through the same mechanism of delivering interest rates that are 'lower for longer' following a negative shock" (Williams, 2021). Another example is the policy proposed by Reifschneider and Williams (2000), which would keep interest rates at zero until the cumulative missed monetary policy stimulus due to the zero lower bound has been recovered. Such "lower for longer" strategies and an explicit intention to "overshoot" on inflation would seem consistent with the delayed pickup in the perceived monetary policy inflation coefficient.

The explanation based on a history-dependent or non-linear rule, however, has distinct testable predictions for how long- and

Figure 5
Survey Forecasts for Inflation Optimists and Pessimists



Four-quarter forecasts for federal funds rate and CPI inflation from Blue Chip Financial Forecasts. Forecasters are split into a team transitory, defined as having below-median four-quarter CPI forecasts in July 2021, and a team permanent, who have above-median four-quarter inflation forecasts in July 2021. The vertical line indicates the liftoff date in March 2022. Sample period: July 2021 to April 2024.

short-term interest rates should respond to inflation surprises, that are not borne out in the data. In particular, while this hypothesis can explain why short-term interest rates did not respond to inflation surprises in 2021, it also predicts that longer-term rates should have already started responding to inflation surprises in 2021. However, Figure 4 shows no quantitatively meaningful increase in the responses of either the ten-year Treasury yield (top panel) or longer-term Eurodollar rates (bottom panel) to CPI news surprises until well after liftoff in March 2022. This evidence suggests that even long-term policy expectations did not respond to the inflation surge in 2021, casting doubt on the importance of a perceived "lower for longer" strategy.[19]

International evidence is also helpful for evaluating this second explanation. Like the Fed, the European Central Bank revised its strategic framework in light of the ZLB experience, but it did not formally adopt average inflation targeting or another type of make-up strategy.[20]

Given the differences in the monetary policy frameworks, we consider perceptions about the ECB's monetary policy response to the recent global inflation surge. Figure 6 presents the results of applying our methodology for estimating policy perceptions to the ECB's Survey of Professional Forecasters (ECB SPF).[21] Like the Fed's perceived response, the ECB's perceived response was close to zero throughout 2021 and only started to rise after liftoff from the ZLB, which for the ECB happened in July 2022. Appendix Figure B.3 shows that bond market responses to inflation surprises in Europe also look broadly similar to the responses we document for the U.S. in Section 2.2. The similarity between the two central banks thus further suggests that AIT or a broader make-up strategy were not the main driver for the late shift in the perceived monetary policy rule in the United States.

3.3 Learning from Monetary Policy Actions

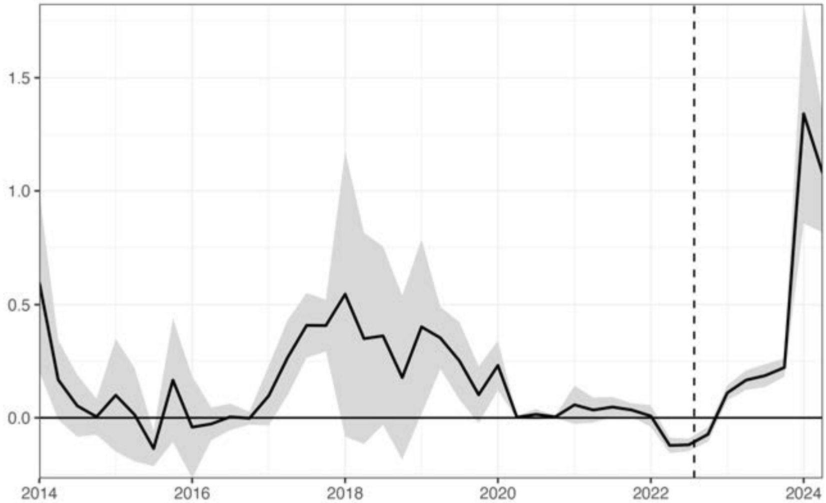
The third possibility is that policy perceptions may have shifted late because high uncertainty about the Fed's reaction function in 2021 and 2022 required concrete policy actions — liftoff and substantial rate hikes — to signal that monetary policy would respond strongly to inflation. The shift in the public's understanding of the Fed's systematic inflation responses occurred clearly after liftoff (see Figures 2 and 4), suggesting that learning from observed rate hikes played an important role. Here we provide additional evidence from high-frequency monetary policy surprises around FOMC announcements and option-based interest rate uncertainty that further supports this mechanism.

If the public's knowledge of the monetary policy rule is incomplete, monetary policy actions provide valuable information about the policy rule followed by a central bank. A simple model, following Bauer and Swanson (2023*a,b*), formalizes this idea.[22] The central assumption is that the inflation coefficient in the policy rule, $\hat{\beta}_t$, is time-varying and not known by the public:

$$i_t = \beta_t(\pi_t - \pi^*) + u_t,$$

where the monetary policy shock u_t is Gaussian white noise with volatility σ_u, and $\hat{\beta}_t$ follows a random walk process,

Figure 6
ECB's Perceived Response to Inflation



Inflation coefficient in forward-looking monetary policy rule, estimated from quarter-by-quarter panel regressions on the ECB's Survey of Professional Forecasters from January 2014 to April 2024. Gray-shaded areas are 95% confidence intervals based on standard errors with two-way clustering (by forecasters and horizon). Vertical lines shows liftoff dates in July 2022.

$$\beta_{t+1} = \beta_t + \xi_{t+1}.$$

For simplicity, we assume that the inflation target π^* is constant and commonly known, and that inflation follows the exogenous AR(1) process

$$\pi_t - \pi^* = \varphi\left(\pi_{t-1} - \pi^*\right) + v_t,$$

with Gaussian white noise innovation v_t. Beliefs about the inflation coefficient are characterized by the prior mean $\hat{\beta}_t = E\left(\beta_t \mid \gamma_{t-1}\right)$ and variance $\sigma^2_t = Var\left(\beta_t \mid \gamma_{t-1}\right)$, where the information set γ_{t-1} includes observed policy rates and inflation up to period $t-1$.

The key implication of this incomplete information setting is that *monetary policy surprises* are driven not only by policy shocks u_t but also by misperceptions about the monetary policy rule:

$$mps_t \equiv i_t - E\left(i_t \mid \mathcal{Y}_{t-1}, x_t\right) = \left(\beta_t - \hat{\beta}_t\right)\left(\pi_t - \pi^*\right) + u_t. \tag{4}$$

Equation (4) demonstrates that, for example, a hawkish policy surprise ($mps_t > 0$) can arise either from a contractionary monetary policy shock ($u_t > 0$) or because the Fed responds to high inflation more strongly than the public anticipated ($\beta > \hat{\beta}$ and $\pi_t > \pi^*$).

Agents learn from observed monetary policy surprises about the unknown rule. In the special case where policy shocks are absent ($u_t = 0$), the policy rule can be learned perfectly from observed surprises. In this case, equation (4) implies $\hat{\beta}_{t+1} = \beta_t = \hat{\beta}_t + mps_t/(\pi_t - \pi^*)$. More generally, with uncertainty about u_t, application of the Kalman filter shows that rational forecasters scale down their updating according to the signal-to-noise ratio ω_t:

$$\hat{\beta}_{t+1} - \hat{\beta}_t = \omega_t \frac{mps_t}{\pi_t - \pi^*}, \quad \omega_t = \frac{\sigma_t^2 (\pi_t - \pi^*)^2}{\sigma_t^2 (\pi_t - \pi^*)^2 + \sigma_u^2}. \tag{5}$$

During times of high inflation ($\pi_t > \pi^*$) a hawkish surprise ($mps_t > 0$) should lead to an upward revision in the perceived inflation response coefficient ($\hat{\beta}_{t+1} > \hat{\beta}_t$). The strength of the updating depends on policy uncertainty: Perceptions update more strongly in response to observed surprises when uncertainty about the monetary policy rule is high, as the signal-to-noise ratio ω_t increases with the prior variance σ_t^2.

To provide empirical evidence for this kind of updating, one would ideally follow the approach of our earlier work (Bauer, Pflueger and Sunderam, 2024, Section 3), directly relating changes in the perceived policy rule coefficient to monetary policy surprises. Since the recent bout of inflation has been too short for this type of analysis, however, we provide three pieces of complementary evidence.

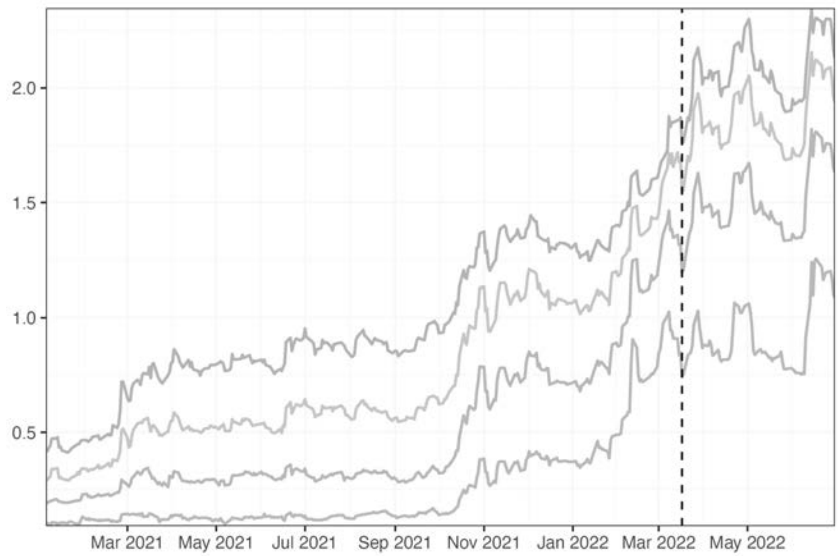
First, we note that anecdotal evidence suggests that observed rate hikes caused significant increases in $\hat{\beta}_t$. Around liftoff, contemporaneous market commentary interpreted the pace and magnitude of early rate hikes as strong signals of the Fed's disinflationary commitment.[23]

Second, we provide empirical evidence for two necessary conditions for learning from policy actions to drive perceptions of the monetary policy rule. As shown in equation (5), significant updates to the perceived inflation coefficient $\hat{\beta}$ require both high uncertainty about the Fed's policy responses, σ_t^2, and large monetary policy surprises, mps_t.

There is ample evidence that uncertainty about the Fed's policy response to inflation was significantly elevated during 2021 and 2022 (e.g. Cieslak, McMahon and Pang, 2024). This uncertainty is not surprising, given that the inflation surge was by far the largest experienced in the U.S. in over three decades: recent history provided the public with little information about the Fed's likely course of action. Financial market data confirms that monetary policy uncertainty was elevated. Figure 7 provides evidence from options markets suggesting high uncertainty about the Fed's policy response in 2021 and 2022. It plots the option-based uncertainty measure for future short-term interest rates from Bauer, Lakdawala and Mueller (2022), extended to December 2022. Uncertainty across all reported horizons, from six to 24 months, increased substantially before liftoff, starting in October 2021. A caveat of this time series evidence is that changes in interest rate uncertainty can arise from shifts in either macroeconomic uncertainty or policy uncertainty. However, some of the largest increases in short-rate uncertainty over the pre-liftoff period followed FOMC communications, including speeches by Governors and Bank Presidents.[24] This suggests that policy uncertainty likely contributed meaningfully to the increased rate uncertainty shown in Figure 7.

Figure 8 then shows that there were large monetary policy surprises after liftoff. It plots high-frequency surprises for FOMC announcements from January 2014 to December 2023, calculated as the first principal component of 30-minute changes in money market futures rates covering the first four quarters after each announcement, following Bauer and Swanson (2023*a*).[25] The magnitude of the surprises increased significantly starting with the March 16, 2022 FOMC announcement that marked liftoff from the ZLB, notably exceeding the magnitude of earlier surprises. As equation (4) suggests, such large monetary policy surprises are likely due, at least in part, to misperceptions and uncertainty about the policy rule. If market participants

Figure 7
Option-Based Interest Rate Uncertainty

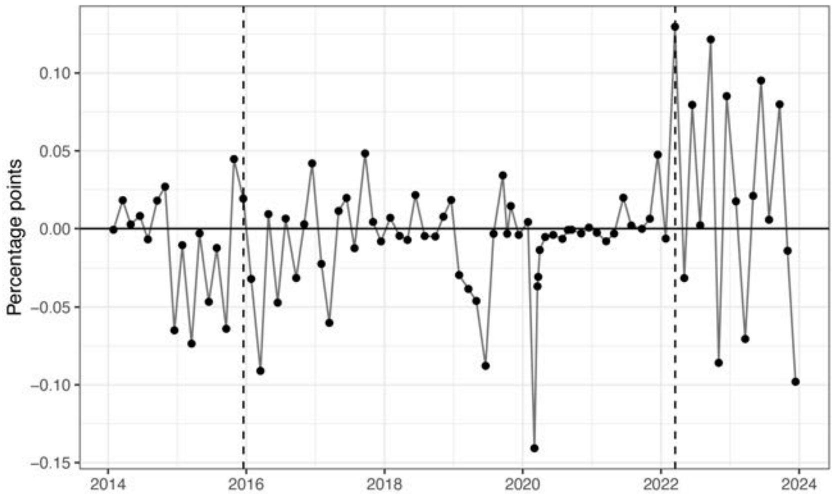


Option-based uncertainty about future short rates, measured as risk-neutral conditional standard deviations of short-term rates in 6, 12, 18, and 24 months using Eurodollar futures and options, following Bauer, Lakdawala and Mueller (2022). The line with lowest (highest) uncertainty corresponds to the shortest (longest) horizon. Vertical line shows liftoff date March 17, 2022. Sample period: January 4, 2021 to December 30, 2022.

had known the Fed's monetary policy strategy prior to liftoff, then surprises post-liftoff likely would have been smaller.

Third, we conduct a simple back-of-the-envelope calculation to assess the potential quantitative importance of learning from observed policy actions. Table 2 reports monetary policy surprises and plausible learning updates based on equation (5) under various parameter assumptions. The first column reports each monetary policy surprise that exceeded 7 bps in absolute value. The second column reports the cumulative monetary policy surprise (including smaller ones not listed here). The third column shows the implied cumulative change in the perceived monetary policy inflation coefficient, using the BCFF 4-quarter inflation forecast for πt and assuming a signal-to-noise ratio of $\omega_t = 1$, i.e. maximal uncertainty about the policy rule. For example, the FOMC meeting on March 16, 2022 featured a monetary policy surprise of 13 bps and BCFF 4-quarter inflation forecast of 3.03%, implying an inflation gap of 3.03%

Figure 8
Monetary Policy Surprises



Monetary policy surprises, calculated as the first principal component of 30-minute changes around FOMC announcements in money market futures rates covering the subsequent four quarters. Vertical lines indicate liftoff dates December 16, 2015 and March 16, 2022. Sample period: January 2014 to December 2023.

Table 2
Numerical Illustration of Learning Mechanism

			Implied $\hat{\beta}_{t+1} - \hat{\beta}_{2022:01}$			
	Monetary Policy Surprise		BCFF 4-Quarter CPI		SEP Core PCE	
Date	mps_t	Cumulative	$\omega_t = 1$	$\omega_t = 0.5$	$\omega_t = 1$	$\omega_t = 0.5$
16-Mar-22	0.130	0.123	0.12	0.06	0.09	0.04
15-Jun-22	0.080	0.171	0.15	0.07	0.11	0.06
21-Sep-22	0.122	0.295	0.26	0.13	0.18	0.09
2-Nov-22	–0.086	0.209	0.19	0.09	0.14	0.07
14-Dec-22	0.085	0.295	0.27	0.13	0.18	0.09
22-Mar-23	–0.071	0.242	0.20	0.10	0.12	0.06
14-Jun-23	0.095	0.358	0.38	0.19	0.21	0.10
20-Sep-23	**0.080**	**0.443**	**0.54**	**0.27**	**0.28**	**0.14**
13-Dec-23	–0.098	0.331	0.26	0.13	0.16	0.08

This table shows FOMC announcements between January 2022 and December 2023 when monetary policy surprises exceeded 7 basis points in absolute value. The column "Cumulative" reports the sum of monetary policy surprises from January 2022 up to the indicated announcement (including smaller ones not listed here). The next two columns compute the implied cumulative change in the perceived monetary policy coefficient from equation (5) using the empirical monetary policy surprise and the latest BCFF 4-quarter CPI inflation forecast for different scenarios of the signal-to-noise ratio ω_t. The last two columns report the analogous calculation using the simple average of the current-year and next-year core PCE forecast (midpoint of central tendency) from the latest Summary of Economic Projections. The September 2023 meeting in bold shows the peak effect on the perceived monetary policy inflation coefficient.

– 2% = 1.03% and an update in the perceived inflation coefficient of $\hat{\beta}_{16-Mar-22} - \hat{\beta}_{1-Jan-22} = 1 \times 0.13/1.03 = 0.12$ (up to rounding).

The peak implied perceived monetary policy inflation coefficient due to learning occurred in September 2023 at a substantial 0.54 and is highlighted in bold. For comparison, the empirical estimate of $\hat{\beta}_t$ from the inertial rule in the top-right panel of Figure 2 increased from roughly zero in January 2022 to 0.32 in the October 2023 survey, and the simple-rule estimate of $\hat{\beta}_t$ in the top-left panel of Figure 2 increased by roughly 0.89 over the same time period. Of course, the third column in Table 2 should be regarded as an upper bound for the relevance of the learning channel, as the uncertainty about the monetary policy rule was high during this period but perhaps did not drive the entire variation in monetary policy surprises on FOMC dates.

The remaining columns of Table 2 show that the magnitude of the learning update for $\hat{\beta}_t$ remains substantial using different values of the signal-to-noise ratio and different inflation measures. If we set $\omega_t = 0.5$, consistent with the estimates we obtained in Bauer, Pflueger and Sunderam (2024) for empirical updating about the output coefficient in the perceived policy rule over a much longer sample, the implied peak increase in $\hat{\beta}_t$ is still 0.27. The last two columns of Table 2 show that if we use the latest core PCE forecast available from the Fed's Summary of Economic Projections, the implied magnitudes are smaller, though still substantial compared to the increase in our empirical estimates of $\hat{\beta}_t$. Taken together, these calculations suggest that signals from the Fed's policy actions likely played a quantitatively significant role in shifting public perceptions towards a stronger policy response to inflation.

Overall, the timing of the observed shifts in $\hat{\beta}_t$, as well as financial market evidence based on high-frequency monetary policy surprises and option-based interest rate uncertainty, are consistent with the view that uncertainty about the Fed's reaction function was high in 2021 and 2022. This initial lack of clarity about the policy response to inflation likely made it particularly beneficial for the Fed to act decisively, in the form of significant and sustained rate hikes, to convince the markets and the public of its strong response to inflation and commitment to price stability.

4. Policy Implications

The analysis in this paper implies several broader lessons for policy. Both survey- and market-based measures of the perceived response of monetary policy to inflation rose significantly during the recent tightening cycle. Such shifts tend to improve the inflation-output tradeoff in standard models of monetary policy, and may have contributed to the relatively smooth disinflation during the recent hiking cycle. The rise in the perceived inflation coefficient also appears to have linked medium- and long-term interest rates more closely to inflation news, accelerating the transmission of monetary policy through financial markets.

Going forward, how can the Federal Reserve and other central banks around the world monitor and guide policy perceptions to enhance the effectiveness of monetary policy? First, our results suggest that central banks may find it beneficial to track the perceived rule using tools such as those proposed in this paper: the perceived rule measured from linked interest rate and macroeconomic forecasts and the market-perceived rule estimated from macroeconomic news announcements. The complementarity of different survey data sources, rule specifications, and high-frequency market reactions should prove useful for distinguishing meaningful changes in monetary policy perceptions from month-to-month fluctuations due to noise in the data or a particular model specification.

Second, our evidence on the mechanism behind the recent shift in perceptions suggests that central bank actions help shape public perceptions about the monetary policy rule. Said differently, actions and words are complements in the conduct of monetary policy. Our findings imply that when uncertainty about the monetary policy rule is high, as in 2021 and 2022, policy actions can play a particularly important role in conveying information about the monetary policy rule. Financial markets and the broader public are likely to perceive a higher responsiveness of monetary policy to inflation if they observe rate hikes following high inflation, and if subsequent easings follow inflation developments. Monetary policy perceptions tend to change mainly in response to unanticipated policy actions, such as policy rate surprises, while fully anticipated actions are unlikely to change beliefs. The signaling power of policy rate changes implies that there is an added benefit for central banks to hike early and consistently in response to high inflation, and makes it particularly important to condition subsequent easings on improving inflation data.

Finally, central banks can provide more information about their reaction function using various communication tools, shifting policy perceptions and potentially improving the effectiveness of monetary policy. Even if forward guidance is effective at shaping market expectations for the near-term policy path, it may not ensure that the public understands the broader monetary policy framework and how monetary policy will respond to changes in the economic outlook. We have shown that projections like the BCFF survey — which link forecasts for the policy rate, inflation, and economic activity — contain useful information about the perceived monetary policy rule. The FOMC produces a very similar set of forecasts for its Summary of Economic Projections (SEP). However, the individual projections underlying the SEP, in which forecasts for the federal funds rate are linked to those for macroeconomic variables, are released only with a five-year lag. Publishing the individual (anonymized) projections in real time would allow public observers and researchers to obtain timely estimates of the Fed's monetary policy rule by applying our methodology.[26] In other words, by "connecting the dots" of the SEP — publishing the individual projections for macroeconomic variables linked to those for the federal funds rate — the FOMC could provide valuable information about its policy strategy and reaction function.

5. Conclusion

This paper estimates changing perceptions of the Fed's monetary policy rule around the inflation surge of 2021 and the tightening cycle of 2022–2023. It shows that the perceived monetary policy response to inflation increased substantially over this period. The shift is visible both in surveys of professional forecasters and in the changing bond market sensitivity to inflation surprises. It likely mattered for monetary policy transmission by amplifying bond yield responses to inflation news and would have been important for containing the rise in inflation expectations within a standard model of monetary policy.

We also find that the increase in the perceived response to inflation occurred later than the actual rise in inflation and only after liftoff from the ZLB. Our evidence suggests that this late shift in perceptions was not due primarily to the fact that inflation was believed to be transitory, or an anticipated temporary inflation overshooting, as one might expect under a strategy of average inflation targeting. Rather, the delayed shift appears to be due, at least in part, to the high uncertainty about the Fed's policy strategy and reaction function before liftoff. Forceful policy actions — in the form of large rate hikes that repeatedly took markets by surprise — were necessary to shift the public's perceptions. We conclude from our calculations that learning about the policy rule from the Fed's rate hikes likely played a quantitatively significant role in shifting policy perceptions towards a strong inflation response.

These findings have implications for how policy can build and improve on its recent successes in fighting inflation. Our research suggests that central banks may want to monitor perceptions about the monetary policy rule through survey- and market-based data, as demonstrated in this paper. For the Federal Reserve, "connecting the dots" of the SEP may be a simple but effective tool to provide information about its reaction function to the public. Finally, raising policy rates promptly in response to realized inflation, and following a highly data-dependent policy rate path thereafter, may have the additional benefit of credibly conveying a strong systematic inflation response.

Endnotes

[1]See, for example, Cukierman and Meltzer (1986), Erceg and Levin (2003), Orphanides and Williams (2004), Blinder et al. (2008), Eusepi and Preston (2010), and Cogley, Matthes and Sbordone (2015).

[2]Hamilton, Pruitt and Borger (2011), Swanson and Williams (2014) and Elenev et al. (2024) also studied the role of monetary policy for the sensitivity of financial markets to macroeconomic announcements.

[3]More generally, the perceived monetary policy rule is priced in bonds and stocks and matters for risk and term premia (Piazzesi, 2005; Song, 2017; Bianchi, Lettau and Ludvigson, 2022; Bianchi, Ludvigson and Ma, 2022; Drechsler, Savov and Schnabl, 2018; Campbell, Pflueger and Viceira, 2020).

[4]Earlier work in monetary economics has linked the "sacrifice ratio," the economic cost of a disinflation, to expectations, central bank credibility, and perceptions about the monetary policy framework (Ball, 1995; Erceg and Levin, 2003; Goodfriend and King, 2005; Orphanides and Williams, 2005).

[5]See for example Williams (2021) for a discussion of the policy implications of the theory of average inflation targeting and Jia and Wu (2022) for a theory of average inflation targeting in the presence of supply shocks.

[6]Similar predictions would hold if markets believed that the Fed was wrong in its assessment of inflation and would eventually come around to a more persistent view of inflation (Caballero and Simsek, 2022).

[7]The "monetary policy reaction function" describes how a central bank adjusts its monetary policy tools in response to economic and financial conditions. A "monetary policy rule" is typically understood as a linear function that relates the short-term interest rate to inflation and economic activity. In this paper, we use these terms interchangeably.

[8]See also Swanson and Williams (2014) for evidence that the first ZLB episode was initially believed to be short-lived.

[9]The estimated perceived inertia coefficient averages 0.8 over our sample period.

[10]Constant-maturity market yields are from the Fed's H.15 release, obtained via FRED. We use data for Eurodollar futures until December 2021 and SOFR futures starting in January 2022.

[11]The last observation in this sample is the February 2022 CPI release, which was made public on March 10, 2022, a week before the FOMC announcement of liftoff on March 16, 2022.

[12]Kroner (2024) studies the incorporation of inflation surprises into inflation expectations using similar high-frequency regressions and argues that attention to inflation news releases has increased during the recent high-inflation period from

May 2021 onwards. To see how the incorporation of inflation surprises into inflation expectations matters, note that in equation (3), the coefficient θ reflects both the perceived policy rule coefficient, $\hat{\beta}$, and the change in inflation expectations given the news $\Delta E[\pi_t|s_t]$. Two pieces of evidence suggest that changes in the perceived policy rule coefficient $\hat{\beta}$ played an important role in the rising post-liftoff sensitivity of yields documented in Table 1. First, the sensitivity of inflation swap rates to inflation surprises rose substantially earlier than the sensitivity of interest rates, as we confirm in Appendix Figure B.2. Markets believed there would be little Fed response to inflation even after they ceased to believe that inflation would be transitory. Second, our survey-based estimates in Section 2 measure expectations directly and are hence not sensitive to how inflation expectations are formed.

[13]In this calculation, core PCE inflation is lagged by two months to account for publication lag.

[14]See, for example, "Cooling Inflation Likely Ends Fed Rate Hikes: Mild October prices report unleashes stock and bond rallies", *Wall Street Journal,* November 14, 2023.

[15]Empirically, Phillips curves are often found to be backward-looking (Fuhrer, 1997) and macroeconomic expectations to exhibit over- or under-reaction (Angeletos, Huo and Sastry, 2021).

[16]In late 2021, much of the discussion centered around "team transitory" vs. "team permanent". We adopt this popular terminology, recognizing that it seems unlikely that anyone viewed inflation as truly permanent.

[17]For example, Joel Naroff from Naroff Economics is quoted in the September 2021 BCFF survey as follows: "He [Chairman Powell] has been making the argument that the factors driving the surge in inflation were transitory for a while now, but his defense today was as strong as it gets. I almost believe him. Almost."

[18]Appendix Figures B.4 and B.5 provide additional consistent evidence by estimating the perceived monetary policy rules separately for both groups of forecasters.

[19]Cieslak, McMahon and Pang (2024) also find a very small increase in the yield sensitivity to inflation news over the period from January 2021 through February 2022. Furthermore, they attribute most of the sensitivity of yields pre-liftoff to bond risk premia, not the expected path of short-term interest rates.

[20]The ECB's monetary policy strategy statement indicates that the Governing Council may tolerate a "transitory period in which inflation is moderately above target" but does not refer to past policy misses or make-up considerations.

[21]The ECB SPF survey is conducted quarterly and asks professional forecasters for forecasts of policy rates, inflation, and unemployment across multiple horizons. While the frequency and forecast horizons are somewhat different from the U.S.

estimates in Figure 2, Figure 6 for the Eurozone is constructed as similarly to the U.S. as possible.

[22]In Bauer, Pflueger and Sunderam (2024), we showed that a somewhat richer version of this model with belief heterogeneity across forecasters tied together our central empirical findings. In particular, the model demonstrated that we can estimate the perceived monetary policy rule from panels of survey data. It also showed that policy perceptions would update in a state-contingent manner following monetary policy surprises, consistent with what we found in the data.

[23]For example, the *Wall Street Journal* cited Gary Pollack of Deutsche Bank as saying "The Fed sent a strong signal to the market that it has the commitment and willpower to cool inflationary pressures" (*Wall Street Journal*, March 17, 2022). Similarly, the *Wall Street Journal* reported in July 2022 that "U.S. interest-rate expectations are volatile partly because the Fed made a surprising shift in June", referring to the fact that the 75 bps rate hike in June 2022 had surprised markets.

[24]For example, the biggest pre-liftoff increase in uncertainty was on February 10, 2022. Markets reacted to new inflation data, but the biggest market response came "after remarks from [Fed President Bullard] who signaled the central bank may move more drastically to curtail inflation. The data and comments injected fresh uncertainty . . ." (*Wall Street Journal,* February 10, 2022). Further substantial increases in rate uncertainty followed the speeches of Governors Waller and Quarles on October 19 and 20, 2021, and the FOMC meeting ending on January 26, 2022.

[25]Different from Bauer and Swanson (2023*a*), we scale the loadings so that they sum up to one, meaning that the surprises are weighted averages of high-frequency changes in futures rates. We also transition from Eurodollar futures to SOFR futures in January 2023; see Acosta, Brennan and Jacobson (2024) for details on Eurodollar vs. SOFR futures in this context.

[26]Feroli et al. (2017) reached a similar recommendation based on analyzing historical SEP data. A different but related possibility would be to publish projected interest rates conditional on different macroeconomic scenarios (Bernanke, 2024), though this would represent a more significant deviation from the Fed's current communication framework.

[27]In some cases, we use vintages of real GDP or potential GDP released shortly after the survey deadline. We do this either to obtain real GDP in the quarter immediately before the survey (in case this was released after the deadline), or to obtain consistent units for actual and potential real GDP (in case the dollar base year changed for the actual GDP but not for the potential GDP numbers). Furthermore, since the real-time vintages start in 1991, we use the earliest vintages for the surveys before that time.

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Appendix

A. BCFF Survey Data

In the Blue Chip Financial Forecasts (BCFF) survey, about 30–50 professional forecasters are queried each month about their forecasts for interest rates, other financial market variables, and their macroeconomic "assumptions" underlying their financial forecasts. Participants are queried near the end of the month preceding the release of the survey. Specifically, the deadline for the survey responses is the 26th of the previous month, with the exception of December, when the deadline is the 21st. The BCFF contains quarterly forecasts. For the federal funds rate, the forecast target is the quarterly average of the daily effective funds rate, in annualized percent, as reported in the Federal Reserve's H.15 statistical release. The macroeconomic forecasts for output growth and inflation are reported as quarter-over-quarter forecasts in annualized percent.

We calculate year-over-year inflation forecasts as follows: For forecasts with horizons of three to five quarters, we simply calculate annual inflation forecasts from the quarterly forecasts for the four longest horizons. For forecasts with horizons of less than three quarters, we combine the forecasts with actual, observed CPI inflation over recent quarters.

We derive output gap forecasts from real GDP growth forecasts from 1992 onwards and from real GNP growth forecasts before. Conceptually, the calculation is straightforward: Using the current level of real output and the quarterly growth forecasts, we calculate the forecasted future level of real output, which we then combine with CBO projections of potential output to calculate implied output gap forecasts. In practice, the calculations are slightly involved, since careful account needs to be taken of the timing of the surveys and the available real-time GDP data and potential output projections. First, we need real-time GDP for the quarter before the survey. We obtain real-time data vintages for GDP from ALFRED, and use the most recently observed vintage before the deadline of each survey. Second, we calculate forecasts for the *level* of real GDP, denoted as $E_t^{(j)} Y_{t+h}$ using the level in the quarter before the survey and the growth rate forecasts. Third, we obtain real-time vintages for the CBO's projections of future potential GDP, also from ALFRED, and again use the most recent vintage that was available to survey participants at the time.[27] Fourth and finally, output gap forecasts are calculated as the deviation of the GDP forecasts from the potential GDP projections in percentage points:

$$E_t^{(j)} x_{t+h} = 100 \frac{E_t^{(j)} Y_{t+h} - E_t Y_{t+h}^*}{E_t^{(j)} Y_{t+h}^*},$$

where x_t is the output gap and Y_t^* is potential GDP in the quarter ending in t.

In Table A.1 we report summary statistics for our survey data. Across surveys, horizons, and forecasters, there are about 120,000 individual forecasts. Output gap forecasts are negative on average, in line with the fact that both real-time and revised estimates of the output gap were negative for the majority of our sample period. Forecasted CPI inflation averages around 2.7% and the average fed funds rate forecast equals 3.5%, in line with realized inflation and interest rates over our sample. All variables exhibit substantial within-month variation. This within-month variation reflects variation across both forecasters and forecast horizons.

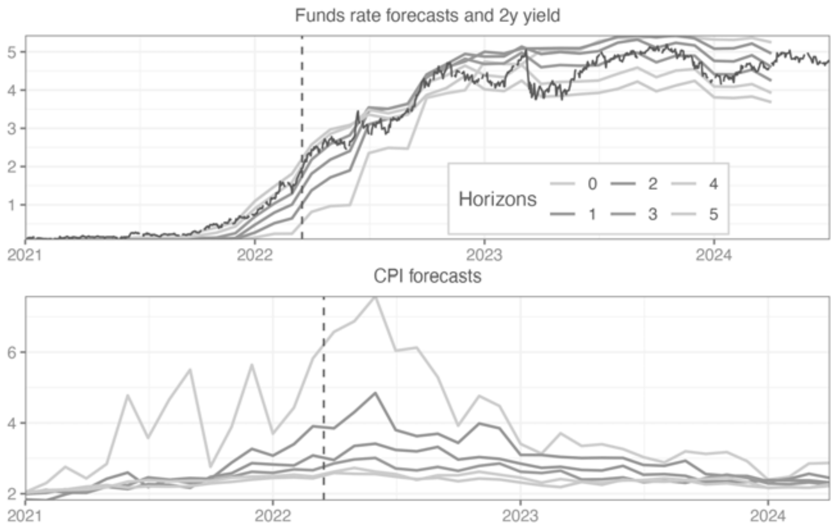
Figure A.1 shows the evolution of consensus forecasts — the arithmetic mean of the individual forecasts — for the federal funds rate and CPI inflation. The date on the horizontal axis refers to the date of the survey, and the lines correspond to the different forecast horizons.

Table A.1
Summary Statistics for Survey Forecasts

				Standard Deviations Within		
	N	Mean	Overall	Month	Month-ID	Month-Horizon
Fed funds rate	31,572	1.6	1.5	0.38	0.32	0.22
CPI inflation	30,647	2.4	1.3	0.67	0.60	0.36
Output growth	31,161	2.5	2.8	1.23	1.07	0.82
Output gap	31,157	–1.0	1.9	0.67	0.48	0.49

Summary statistics for individual survey forecasts in the Blue Chip Financial Forecasts from January 2014 to April 2024. Horizons are from current quarter to five quarters ahead. Number of forecasters in each survey is between 33 and 49. Interest rate forecasts are in percentage points. CPI inflation forecasts are for four-quarter inflation, calculated from the reported quarterly inflation rates and, for short horizons, past realized inflation, in percent. Output growth forecasts are for quarterly real GDP growth in annualized percent. Output gap forecasts are calculated from growth forecasts, real-time output, and CBO potential output projections as described in the text, in percent. The within-month standard deviation reports the average of the standard deviation of forecasts conditional on month t. The within-month-id standard deviation is the average standard deviation within each month-forecaster (t, j) cell. The within-month-horizon standard deviation is the average standard deviation within each month-horizon (t, h) cell.

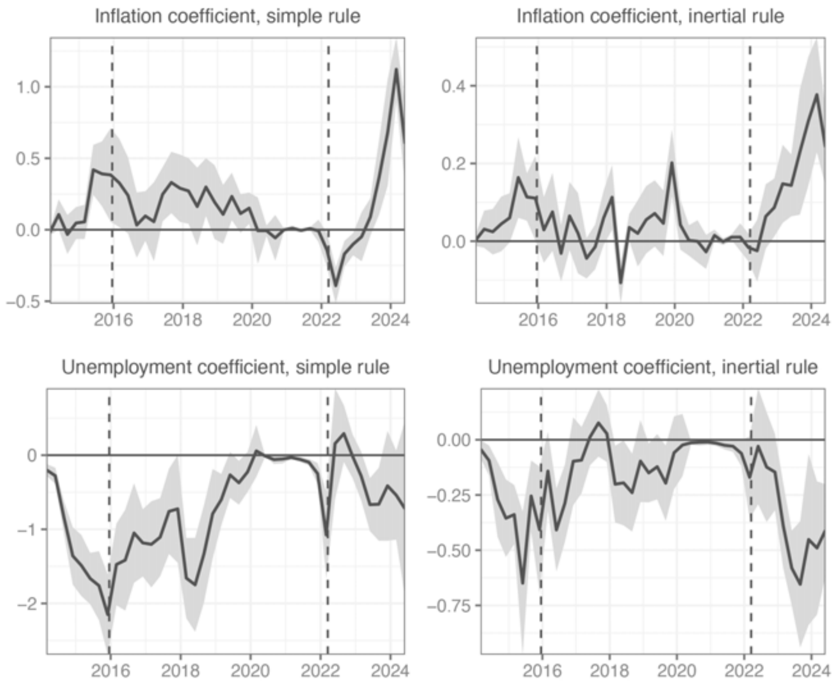
Figure A.1
Consensus Forecasts: Federal Funds Rate and CPI Inflation



Top panel: Forecaster average for federal funds rate forecasts from Blue Chip Financial Forecasts, current quarter to five quarters ahead, with (daily) two-year Treasury yield. Bottom panel: Forecaster average for one-quarter CPI inflation rate (annualized, %). Vertical line shows liftoff date, March 16, 2022. Sample period: January 2021 to April 2024.

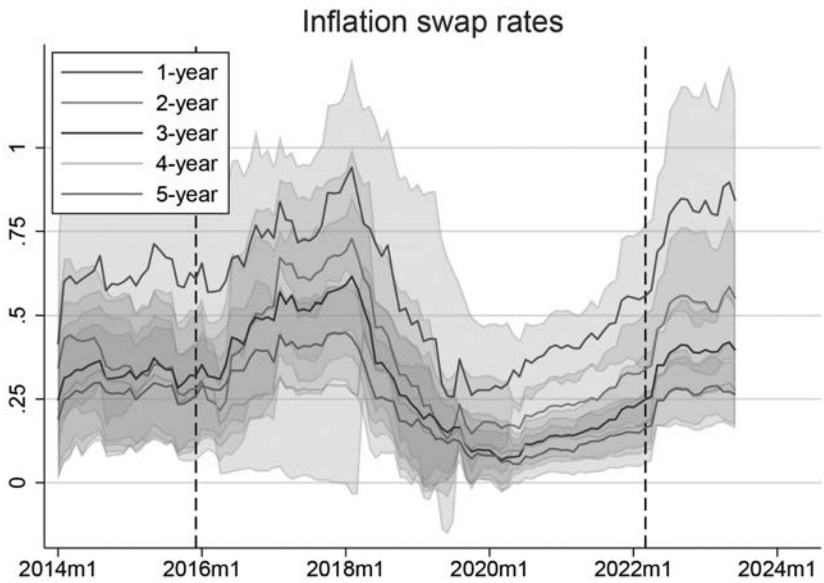
B. Additional Results

Figure B.1
Forward-Looking Policy Rules From Survey of Professional Forecasters



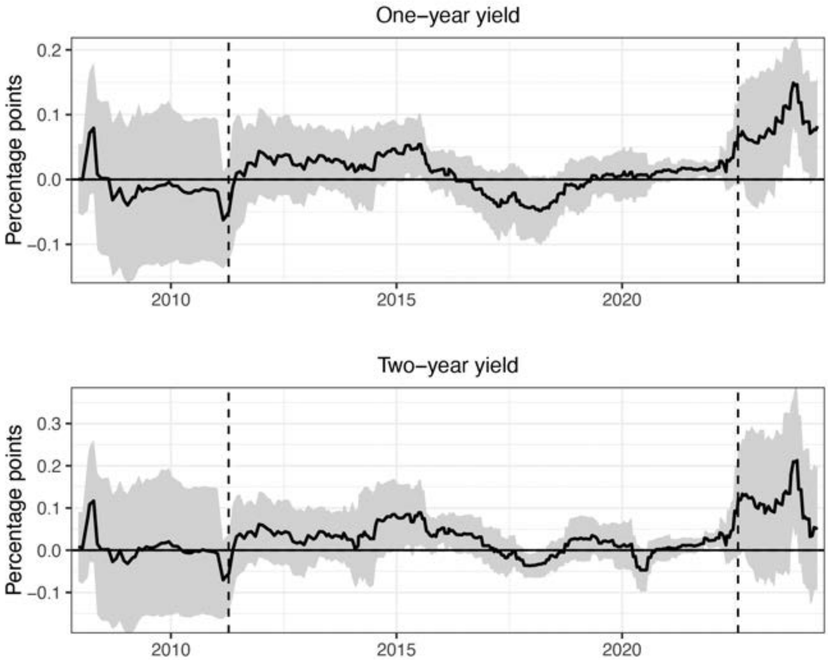
Coefficients in forward-looking/perceived monetary policy rules, estimated from quarterly panel regressions on Survey of Professional Forecasters from 2014:Q1 to 2014:Q2. Inflation forecasts are for core CPI inflation. Gray-shaded areas are 95% confidence intervals based on standard errors with two-way clustering (by forecasters and horizon).

Figure B.2
Sensitivity of Inflation Swap Rates to Inflation News



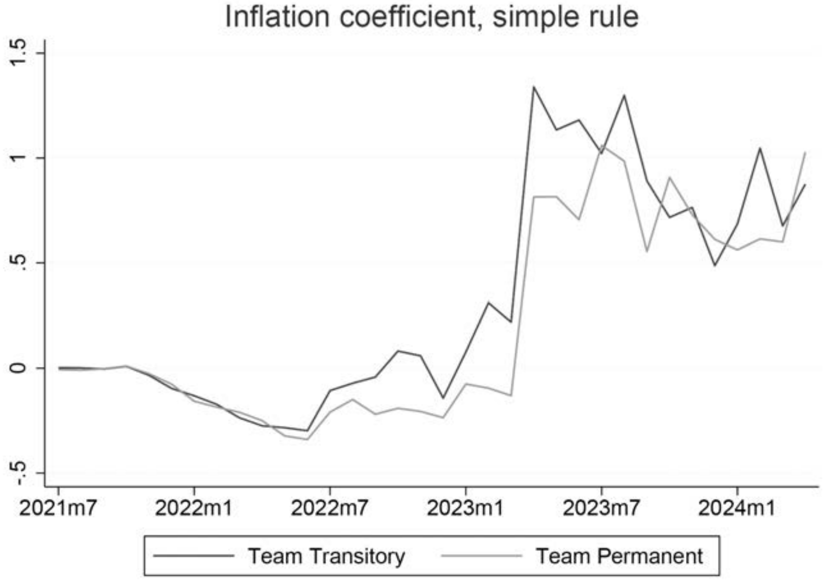
Coefficient in rolling regressions of changes in inflation swap rates on core CPI news, the difference between released core CPI inflation and consensus expectations. Rolling windows use 24 monthly releases. Sample period: January 2012 to May 2024. Gray-shaded areas are 95% confidence intervals based on robust (White) standard errors.

Figure B.3
Sensitivity of European Yields to Inflation News



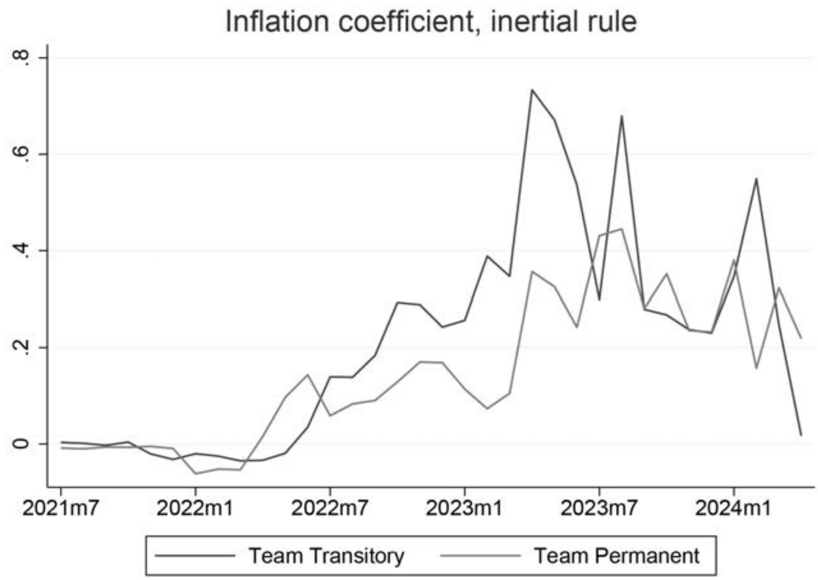
Coefficient in rolling regressions of changes in European yields on core CPI news, that is, the difference between released core CPI inflation and consensus expectations. Rolling windows use 24 monthly releases. Sample period: January 2003 to April 2024. Gray-shaded areas are 95% confidence intervals based on robust (White) standard errors.

Figure B.4
Estimated Inflation Coefficients for Inflation Optimists and Pessimists: Simple Rule



Coefficients in forward-looking/perceived simple monetary policy rules, estimated from month-by-month panel regressions on Blue Chip Financial Forecast surveys from July 2021 to April 2024. Forecasters are split into inflation optimists, who have below-median four-quarter CPI forecasts in July 2021, and inflation pessimists, who have above-median forecasts.

Figure B.5
Estimated Inflation Coefficients for Inflation Optimists and Pessimists: Inertial Rule



Coefficients in forward-looking/perceived inertial monetary policy rules, estimated from month-by-month panel regressions on Blue Chip Financial Forecast surveys from July 2021 to April 2024. Forecasters are split into inflation optimists, who have below-median four-quarter CPI forecasts in July 2021, and inflation pessimists, who have above-median forecasts.

C. New Keynesian Model

We start with the setup of Clarida, Gali and Gertler (1999). The demand side of the economy is given by the Euler equation with no shocks

$$x_t = -\varphi \left[i_t - E_t \pi_{t+1} \right] + E_t x_{t+1}, \tag{C.1}$$

where x_t is the log output gap, i_t is the nominal policy rate from time t to $t + 1$, π_{t+1} is inflation from time t to $t + 1$, and the parameter φ is the elasticity of intertemporal substitution. Inflation obeys a forward-looking Phillips curve with serially-correlated cost-push supply shocks

$$\pi_t = \lambda x_t + \delta E_t \pi_{t+1} + u_t, \;\; u_t = \psi u_{t-1} + \hat{u}_t, \tag{C.2}$$

where $\hat{u}_t$ is iid, the parameter λ is the slope of the Phillips curve, and δ is the discount factor. We follow Clarida, Gali and Gertler (1999) in assuming that the central bank follows a rule whereby it contracts the output gap by $-\omega u_t$ in response to a cost-push shock u_t. This can be achieved by setting the nominal policy rate i_t according to the Euler equation (C.1). Note that in this framework, demand shocks can be perfectly offset by the central bank, and the assumed rule nests the optimal rule under discretion.

Different from Clarida, Gali and Gertler (1999), we assume that the actual and perceived rules can be different with

$$x_t = -\omega u_t, \; E_t x_{t+\tau} = -\hat{\omega} E_t u_{t+\tau}, \; \tau \geq 1. \tag{C.3}$$

The case with $\omega = \hat{\omega}$ is the familiar rational expectations case with a constant monetary policy rule and nests Clarida, Gali and Gertler (1999).

Substituting into the Phillips curve

$$\begin{aligned} \pi_t &= \lambda x_t + \delta E_t \pi_{t+1} + u_t, && \text{(C.4)} \\ &= -\lambda \omega u_t + u_t + E_t \sum_{\tau=1}^{\infty} \delta^{\tau} \left(-\lambda \hat{\omega} u_{t+\tau} + u_{t+\tau}\right), && \text{(C.5)} \\ &= \lambda x_t + \quad 1 + \frac{\delta\psi(1 - \lambda\hat{\omega})}{1 - \delta\psi} \quad u_t && \text{(C.6)} \end{aligned}$$

Hence, a cost-push shock has a smaller impact on inflation when the perceived monetary policy coefficient $\hat{\omega}$ is higher, holding fixed the impact on the current output gap.

Assuming that $\hat{\omega}$ is given and constant, we next solve for inflation and the output gap for the optimal actual monetary policy coefficient ω. The central bank's objective function is assumed to be quadratic in inflation and the output gap, with a discount factor δ and output gap weight α

$$min \left[\alpha x_t^2 + \pi_t^2\right] + E_t \sum_{\tau=1}^{\infty} \delta^{\tau} \left[\alpha x_{t+\tau} + \pi_{t+\tau}^2\right] \tag{C.7}$$

Taking the first-order condition with respect to x_t gives

$$x_t = -\frac{\lambda}{\alpha} \pi_t. \tag{C.8}$$

Substituting into relation (C.6) gives

$$\pi_t = \frac{\alpha}{\alpha + \lambda^2}\left(1 + \frac{\delta\psi(1 - \lambda\hat{\omega})}{1 - \delta\psi}\right) u_t, \tag{C.9}$$

$$x_t = -\frac{\lambda}{\alpha + \lambda^2}\left(1 + \frac{\delta\psi(1 - \lambda\hat{\omega})}{1 - \delta\psi}\right) u_t. \tag{C.10}$$

These expressions show that a central bank that is perceived to more actively counteract cost-push shocks in the future (higher $\hat{\omega}$) achieves lower volatilities for inflation and the output gap today. Hence, the inflation-output tradeoff today is improved if perceptions of the future anti-inflationary monetary policy response are high.

To formally see that a higher perceived policy coefficient $\hat{\omega}$ corresponds to a higher perceived interest rate sensitivity to inflation, first solve for $E_t\pi_{t+1}$ in terms of $\hat{\omega}$ and $E_t u_{t+1}$. From period $t + 1$ onwards, the central bank is expected to follow a policy rule with constant coefficient $\hat{\omega}$, so $E_t\pi_{t+1}$ satisfies (C.6) with ω set equal to $\hat{\omega}$:

$$E_t\pi_{t+1} = -\lambda\hat{\omega}E_t u_{t+1} + \left(1 + \frac{\delta\psi(1 - \lambda\hat{\omega})}{1 - \delta\psi}\right) E_t u_{t+1}, \tag{C.11}$$

$$= \left(\frac{1 - \lambda\hat{\omega}}{1 - \delta\psi}\right) E_t u_{t+1} \tag{C.12}$$

The expected $t + 1$ policy rate from iterating the Euler equation (C.1) one period forward

$$E_t i_{t+1} = -\frac{E_t x_{t+1} - E_t x_{t+2}}{\phi} + E_t\pi_{t+2}, \tag{C.13}$$

$$= \hat{\omega}\psi\frac{1 - \psi}{\phi}u_t + \left(\frac{1 - \lambda\hat{\omega}}{1 - \delta\psi}\right)\psi^2 u_t, \tag{C.14}$$

$$= \underbrace{\left(\frac{(1 - \psi)(1 - \delta\psi)}{\phi}\frac{\hat{\omega}}{1 - \lambda\hat{\omega}} + \psi\right)}_{\hat{\beta}} E_t\pi_{t+1}. \tag{C.15}$$

The relationship for $i_{t+\tau}$ and $\pi_{t+\tau}$ for $\tau > 1$ is analogous. Because $\frac{\hat{\omega}}{1-\lambda\hat{\omega}}$ is a strictly increasing function of $\hat{\omega}$, it follows that a higher perceived willingness to contract future output in response to a cost-pus shock, $\hat{\omega}$, corresponds to a higher perceived policy rate sensitivity to inflation, $\hat{\beta}_t$.

Commentary: Changing Perceptions and Post-Pandemic Monetary Policy

Janice Eberly

I appreciate the invitation to read and discuss this paper and to learn more about the authors' research agenda. The discussions started about a month ago with an illuminating back and forth with the authors; they have done a lot of work on this and their related paper and were very forthcoming with their accumulated thinking and data on this topic.

The paper focuses on the transmission of monetary policy via expectations of the Fed's reaction function; they propose that in seeing inflation, the Fed will tighten according to a Taylor Rule now and potentially in the future. The latter is the crucial piece in getting markets "to do the Fed's work for it" as Michael Woodford (2005) emphasized. Rates should rise with expected future inflation and unleash the Taylor Rule's dampening effects along a path of rising expected future interest rates.

The authors, Michael Bauer, Carolin Pflueger and Adi Sunderam (BPS) try to uncover this effect in a clever way, using data from forecasters, who predict interest rates, inflation and output at different horizons. By connecting forecasted future inflation and output to forecasted future interest rates, they estimate the Taylor Rule that is implicitly built into the forecasters' models.

I'll explain the methodology in more detail, but the result the authors emphasize is the strongest one in the paper and consistent with auxiliary evidence that market rates did not play the role that Woodford envisioned, particularly around the rate increases in 2022–23. The estimated response of interest rates to contemporaneous inflation was essentially zero until the fed funds rate itself rose; there is little sign of the anticipatory effects that Woodford emphasized. However, I will raise some doubts about interpreting the estimated coefficients more generally as Taylor Rule coefficients and hence using them as a guide to monetary policy, given the challenges in estimation that I explain below.

To be concrete, the equation and the data that is used throughout the paper to estimate the effects of monetary policy is given by a Taylor Rule specified as:

$$E_t^j i_{t+h} = \alpha_t^j + \beta_t E_t^j \pi_{t+h} + \gamma E_t^j x_{t+h} + e_{t+h}^j$$

where all the variables are forecasted at time t for h quarters ahead, and i is the federal funds rate (FFR), π is inflation, x is the output gap, and e is the regression error term; the data are for each forecaster j and there is a fixed effect α_t^j for each forecaster.

The estimation employs data from Blue Chip forecasts of the federal funds rate, inflation, and the GDP gap. Forecasts are made at time t, for horizon 0 through 5 quarters, where horizon 0 is the concurrent forecast, and 5 is the quarter 12 to 15 months ahead. There are roughly 40 forecasters in each survey, but they come in and out so the panel size varies from month to month. Importantly, the authors run a separate regression each month t when the forecasts are updated, so the estimated parameters change each month. For each monthly regression, the panel of forecasts is N x h, or roughly 40 forecasters by 6 quarterly forecast horizons.[1]

Identification comes from forecast variation at each horizon, for example: when a forecaster increases their inflation forecast one year out, how much does their FFR forecast change one year out? This co-movement gives the estimate of β, and similar co-movement for the output gap gives estimated γ.

Since the forecasters use models to generate their forecasts, the regression equation essentially reverse engineers a linearized version of the model that forecasters are using to predict the fed funds rate, inflation and output. What do they find? Looking at Figure 1 in the paper, they find quite substantial variation in the implied Taylor Rule over time. Using the simple rule results on the left-hand side of the figure, the inflation responses vary from –1 to 1, but are mostly between 0 and 0.5. Output responses vary from 0 to 1.5, mostly between 0 and 1 and are lower recently.

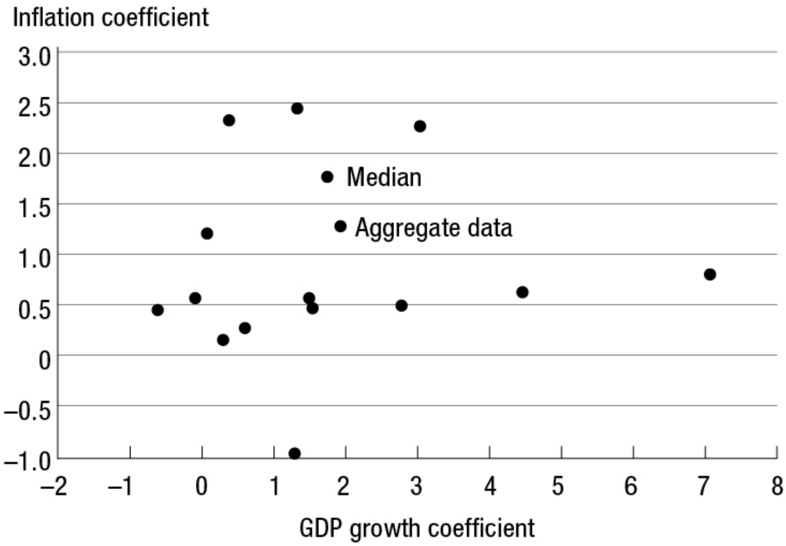
Taken at face value, forecasters seem to be substantively updating their view of the Fed's reaction function at high frequency, including some negative coefficients and high variation.[2] If taken literally, this could be concerning, suggesting that market participants are frequently changing their assessment of the Central Bank's reaction function and in sometimes puzzling ways.

Before asking about implications for policy, first consider what is driving this apparent frequent updating and variation in the monetary policy rule.

The first place to look is at the underlying data. Forecasters, as economists, do not always agree, and previous work has established that forecasters also incorporate different reaction functions into their models.

Forecasters disagree about both their economic forecasts and about the Taylor Rule. The commentary from the Federal Reserve Bank of Cleveland examines the data forecaster by forecaster rather than month by month, so that forecaster disagreement is clearer to see. Their forecasts embed very different views of the Taylor Rule. The article shows the substantial range of forecasts for GDP growth, inflation, and interest rates, as well as the variation in implied Taylor Rule coefficients, plotted above. This forecaster disagreement will add noise to the regression estimates across forecasters. The paper includes forecaster fixed effects as a control for heterogeneity, taking out the average for a given forecaster, but it is still a noisy sample, and there is additional variation as forecasters move in and out of the sample.

Figure 1
Regression Coefficients of Individual Forecasters



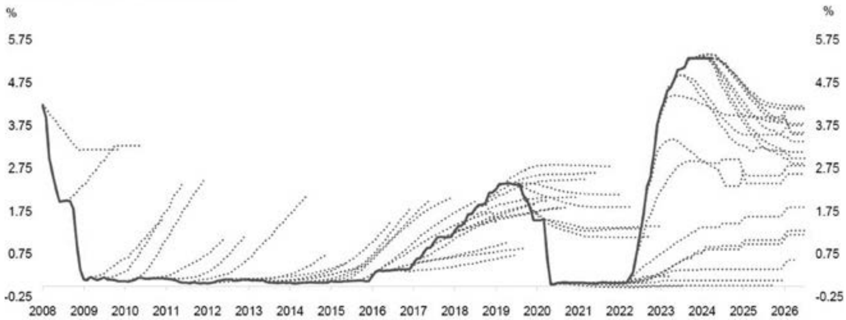
Note: Federal Reserve Bank of Cleveland, Economic Commentary, September 2015.
Source: Authors' calculations using Survey of Professional Forecasters data (Federal Reserve Bank of Philadelphia).

Among all of this variation, however, the shift in forecasts from 2022 to 2023 stands out in Figure 1 in the paper. The strongest result in the paper shows up clearly because there is a mass shift of forecasted responses to inflation — from nearly zero to nearly one — following the federal funds rate increases in 2022. This change in their modeling is apparent in the forecasters' version of dot plots; each dot is a forecast and different marks indicate different horizons.

Initially in September 2021, in the left-hand panel, almost all forecasts held the fed funds rate at zero, while inflation was five to six percent and expected to fall toward two percent over the 18 month forecast horizon. A single forecaster has FFR rising in 3 quarters, spring 2022, and others in four to five quarters. The main point of the paper — focusing on the events in 2022 and 2023 — is reflected in the zero inflation coefficient in the Taylor rule until spring 2022, despite rising inflation.

In the right-hand panel of Figure 2 for June 2023, after rate increases were well underway, most of the current forecasts have the

Figure 2
Federal Funds Rates: Actual and Futures



FFR at five percent with three to four percent inflation, and falling rates and inflation in mid-2024. This co-movement produces a positive coefficient on inflation in the Taylor Rule, as found in the regressions for later in 2023.

Importantly, this inference is also validated in the financial market data that the authors show, and in the Fed Funds futures market, where futures priced in rising rates in advance of actual increases, along with continued increases in 2015–16, but not in 2021–22. In the latter period, there is little pricing of rising rates, even in the short term, until early 2022 and then with actual rate increases.

This finding is the main point of the paper, providing an event study of the period around the initial rate hikes in 2022. The shift in forecasts is reflected in the regressions for these months and also in financial market data, including 2-year treasury and other more liquid assets. Asset prices did not reflect an increase in FFR until early 2022, as the rate increases began, or even later.

However, the paper estimates the inflation response for a full 10 years of data and also includes the output response coefficient. These should also be of interest to policymakers, since they shed light on how markets view the fed reaction function, and as noted earlier, they also show substantial variation. Should these observations inform policy?

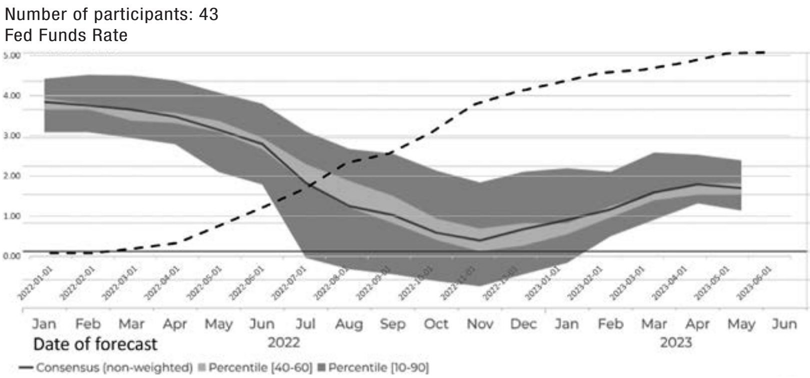
Outside of the event the authors emphasize, the Taylor Rule interpretation becomes more nuanced. As examples, recall from the chart of the coefficients in Figure 2 in the paper that the inflation coefficient becomes negative before rising toward one in 2023.

When those data were forecast inflation was already beginning to fall, and the forecaster dot plots predicted it would continue to do so, while rates were rising. This countermovement is also evident in the CPI inflation and fed funds rate forecasts in Figure 5 in the paper. The negative contemporaneous relationship between inflation and FFR is in opposition to the positive comovement from Fed policy in the Taylor Rule, tending to downward bias the coefficient. This occurs not just because the data are noisy, but because the increase in the fed funds rate was not aligned with the increase in inflation, as would be suggested by the Taylor Rule. Instead, the rate increases came later, when inflation had already risen and was becoming more subdued. The coincident regression does not account for these lags, and hence tends to bias the coefficient estimates.

Turning to the output coefficient in the Taylor Rule, in the same period and throughout 2023, the output coefficient declines, though the inflation coefficient eventually rises. Recall that many forecasters started predicting a recession in 2023 as the FFR rose. Figure 3 below shows forecasts for 2023 growth: output growth forecasts started 2022 at about 2.5% and then fell to zero by late fall, before rising when the expected 2023 recession did not come to fruition. Hence, over this period there is a negative co-movement between the interest rate and output forecasts. Importantly, forecasters expected higher rates to induce a recession. The forecasted negative real feedback from interest rates to output confounds the positive effect expected from a Taylor Rule.

In general, period to period estimates of the co-movement between the federal funds rate and output and inflation are influenced not only by perceptions of monetary policy, but also by shocks, timing, and feedback in the real economy. These effects can muddy or even reverse causation, preventing a clean estimate of the Taylor Rule. A mass change in forecasts can reveal an underlying dynamic, as the forecasters' shift to higher rates did in 2022. But in general,

Figure 3
Blue Chip Economic Indicators:
Evolution of the 2023 U.S. Real GDP Growth Forecast



Source: Wolters Kluwer, Blue Chip Economic Forecasts.

the forecasters' models incorporate both a monetary policy reaction function and the response of the economy to changes in monetary policy. A single coincident equation cannot cleanly distinguish the two, nor account for misalignments in timing.

Recent work by other authors has explored the same question using financial market data directly. A recent paper by Bocola, Dovis, Jorgenson, and Kirpalani uses daily data from TIPS and bonds to back out expected inflation, forward rates for different horizons, using rolling data. They find that the coefficient on inflation is remarkably stable at 1.5 from 2000 to 2019, then falls to 1 after 2020. Similarly, the Taylor rule estimates that Eric Swanson included in his panel discussion at this conference were also smoothed and indicated a trend over time.

The forecaster data has the advantage of an internally consistent set of forecasts for rates, inflation, and output, but still faces the identification problem of separating the monetary policy reaction function from other factors endogenously driving interest rates, inflation, and output.

This paper has a potentially unique opportunity to address identification. The forecaster models are essentially a laboratory, which economists always bemoan that we do not have. There are several approaches one could use — for example, running an exogenous perturbation through the model to identify the implied reaction of the central bank, or looking at experiments that have already been run. For example, as noted above, forecasters predicted a recession in 2023 after rapid rate increases. They were wrong, and they ultimately revised their forecasts — but not because of monetary policy. These forecast revisions are a way of identifying the part of the model that drives from interest rates to output and inflation, so the estimation can explicitly address endogeneity.

The robust message of the paper concerns the events surrounding the first increases in the Fed Funds rate, in 2022. At least initially, responsiveness to inflation was lower post 2020, but as demonstrated in this paper, it quickly rose again post tightening in 2022. The authors argue that this is because actions speak louder than words. However, as was discussed earlier at this conference, policymakers also changed their assessment of how the economy was evolving, in a way that was not anticipated by forecasters. So perhaps it was not that actions speak louder than words, but that policymakers observed a change in the evolution of the economy, which precipitated action by the central bank. Market participants rapidly updated thereafter.

It is difficult to distinguish these two narratives in these data, since both suggest that forecasters did not anticipate monetary policy actions despite higher inflation. One hypothesis to add to the learning model the authors propose is that policymakers were also learning about the structure of the economy during the pandemic and thereafter, so both the Fed and the forecasters jointly faced a challenging inference problem.

Going back to the hypothesis of the paper, Woodford may yet get his wish of a well-anticipated rate increase priced into market rates. Though it may require a clearer understanding of the economy and monetary transmission, not just clear communication predicated on a given model of the economy during a policy cycle (not in retrospect). At least during this cycle, that challenge has tended to humble both policy makers and forecasters.

Endnotes

[1]A short panel potentially generates biased coefficients, especially with a lagged dependent variable. These comments will not focus on that issue but will use the "simple rule" that omits the lagged dependent variable for this reason.

[2]There are several periods over which the estimated coefficients are close to zero. As the authors note, this is not a mechanical result of the zero lower bound on the Fed Funds rate. However, when there is little variation in the Fed Funds rate, there is a low covariance with inflation, so the regression coefficient is not very informative.

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General Discussion: Changing Perceptions and the Transmission of Monetary Policy

Moderator: Andréa Maechler

Andréa Maechler (Moderator): Thank you, Carolin and Janice, for the very rich and insightful discussions. Let us now open the floor for the discussion. So what is the balance between actions and words? I'll start with Anusha Chari and then go to Agustín Carstens. So I'll do it by sections, and I'll start with the very big section in the middle of the room.

Anusha Chari: Thank you, Carolin, for a very interesting paper and presentation. I just had a quick question about, and I thought it would be interesting to do an out-of-sample forecast after April 2024. Do you expect to see the perceived monetary policy inflation coefficient in the monetary policy reaction function to decline? And do the coefficients change as we are getting closer to the target and there are signs of the labor market easing? Therefore, if rate cuts are forthcoming, do you think that the public perception of the monetary policy response will shift again?

Agustín Carstens: Carolin, thank you very much for this very insightful paper. I enjoyed it very much. I would like to make a comment and a recommendation. For obvious reasons, a lot of your analysis is based on the U.S., but there are many other countries in the world where there is far more experience with inflation. Like in Latin America. At the beginning of this decade, when inflation in the

U.S. increased a lot, and it was expected that the Fed would have to tighten at some point, many emerging market economies anticipated their policy response. And I have to pay tribute to Roberto Campos Neto, who had to leave, but I would like him to have heard that I made reference to him. And also Mexico, both in a way, their way of thinking was, we have seen this movie before. It would be very bad for us to be perceived that we are lagging behind, and therefore let's act in an anticipatory way. And as a matter of fact, both Brazil and Mexico and other Latin American countries reacted much sooner. And the outcome of this inflationary event for emerging markets was much better than what traditionally you would have forecasted. So it would be very interesting — this is my suggestion, and in a way a petition because it would be interesting to see your results — you apply your research methodology to countries like Mexico, Brazil, and so on, because I think you would have precisely events where central banks followed your policy recommendations.

Andréa Maechler (Moderator): Thank you. We go to Roger Ferguson at the back.

Roger Ferguson: Thank you. Let me pick up, I think, where Agustín is leading us. It seems like this was a pretty unusual event, as in the Fed said, we are going to be data dependent, we're going to wait to see the whites of their eyes, so to speak, and then move. And the forecasters, it seems, were believing that. And so they were then also, if one wanted to say, delaying or changing to Jan Eberly's point, their reaction function, where you thought the Fed's not going to react to inflation until it's really strong, and then they're going to react very strongly as we see. So I do pick up on Agustín's point, which is the Fed had said we're going to be much more anticipatory, would we have seen different results? And then it goes to, Carolin, to your last point, which I'd love for you to pick up on, which is some of this has to do with the SEP, perhaps, or the Fed can fix this, perhaps, by saying, if we are forecasting inflation, our forecast for interest rates will be much more tightly tied to the SEP in a way that's much more explicit. And so I think this is a little bit of Agustín's point, is a little bit of, to me, this pretty unusual, fortunately, hopefully successful situation, which the Fed was waiting, it was much more data dependent as opposed to anticipating as it got into this transitory versus permanent discussion.

Agnès Bénassy-Quéré: Thank you for the paper. I'm really convinced that understanding the reaction function is part of anchoring expectations. So, well taken. I would be interested to have more comments on the period before 2021, where the coefficient on inflation is close to zero, but the coefficient on the output gap is positive and quite significant. So isn't this a sign that, also during the effective lower bound period, the reaction function was well understood? Hence, it is not a negative result. In my view, it would rather be a positive one, but I would be happy to have your view on this. Additionally, since the expectations of households and non-financial firms are key for the inflation dynamics, would you be able to replicate such an analysis with other agents' expectations?

Andréa Maechler (Moderator): All right. I think I'll turn now to the presenter, Carolin.

Carolin Pflueger: First of all, thank you so much, Janice. This was a fantastic discussion, and thanks for digging into our data so much and making us think via emails. I completely agree with what you're saying. There are these higher frequency fluctuations in our estimated coefficients, which means that from a policy point of view, I would certainly not ring the alarm bells if one of these coefficients goes up or down. Our main result is this strong and persistent increase in the perceived inflation coefficient, which remains high for a while after March 2022. I'm pretty convinced of this main result. I am also quite happy with the cross-validation via cross-financial data. If anyone wants to implement our estimates, I would continue to use these complementary methods, precisely to address some of the concerns about higher-frequency fluctuations. For example, in 2018 when our inflation coefficient briefly turned negative, this estimate reflected the expected time path of inflation and interest rates. One way to deal with it is to use the rule that controls interest rate for inertia, as we do in the paper. Overall, I think having a multitude of approaches helps with understanding which variation is persistent and economically meaningful.

Anusha Chari's question is very insightful. What do I expect going forward? Obviously, I can't divine the future any more than anyone else here. What matters is that the perceived inflation coefficient should be different if interest rate cuts happen in times of lower inflation or because of a deteriorating labor market. If they happen because inflation is lower, that's something that can drive the perceived inflation coefficient up, and that's totally fine in our framework. So in that sense, this is a little bit different from an approach that says you always have to tighten in order to be credible. It says you that have to tighten when inflation is high. So, perceptions will probably shift again, and for this perceived inflation coefficient it is crucial to have interest rate cuts tied to inflation developments.

Agustín Carstens, regarding emerging markets, completely agree. It was remarkable that emerging markets reacted earlier this time around, and I think that's fantastic. Roger Ferguson, I agree that linking the forecasts in the SEP would be very useful. This could help improve the understanding whether a zero projected Fed funds rate path is because of a low inflation forecast, or whether there is an unconditional commitment to zero interest rates. I would absolutely love to see an anonymized link showing whether the FOMC participant with whose model generates a higher inflation forecast also has a higher policy rate forecast.

And regarding the last question about nonfinancial agents: Yes, it's always harder to work with surveys of nonfinancial agents, of course they matter. They set prices, they set wages, they take out mortgages. The way to think about it is that these professionals who are in our data are, if anything, an upper bound on rationality and potentially understanding and following what central banks say. I would expect households, if anything, to be slower in response to anything that happens. But there is lots more work to be done.

Andréa Maechler (Moderator): Okay. I saw a question from Viral Acharya.

Viral Acharya: Carolin, great presentation, great discussion. I had a fundamental question on the estimation, which is at the zero lower bound, is it right to keep estimating Taylor Rule coefficients? I think what I have in mind is that we know markets and analysts are using forward guidance to monitor the impact of monetary policy. And so the signal that markets are looking for is when's going to be the exit from quantitative easing, when's the forward guidance going to be broken, when's the central bank becoming state contingent, when it is not sticking to a credible forward guidance on this path, etc. And so the question I have is whether in a world of zero lower bound and forward guidance, you're actually trying to learn the state contingent Taylor Rule, because at some point the central bank is going to break from its forward guidance. And I think we saw this at the time of Taper Tantrum. We saw that initially Fed wanted to get out of that, but then there was a market reaction, then we delayed again. So it seems that estimating the Taylor Rule coefficients at the zero lower bound is particularly challenging, because markets are trying to estimate the response function as a function of future state variables rather than where the state variables are right now.

Anna Cieslak: Thank you. A very interesting paper. I want to follow up on the endogeneity issue that Jan highlighted and link it back to communication. It seems important in communication about inflation and policy response to recognize that endogeneity. In the following sense, it is dangerous to argue that inflation expectations are anchored, therefore we don't need to move. Well, they remain anchored on the assumption that the Fed will actually move. I think we see this clearly also in the forecast data that you are presenting. They remain very anchored because there was a strong assumption that the Fed would act. It's tricky to use that argument the other way around.

Guido Lorenzoni: Thanks a lot, Carolin. I enjoyed the paper a lot. I think my main question would be about the interpretation of these parameters really as parameters of a Taylor Rule. Again, looking back at the past, it looks like the coefficient of inflation is always below one for a very long time. Do I believe that that means that investors had a view that the Fed was very passive and that we were in a passive environment? I don't think so. I would separate what is the theoretical Taylor Rule, which is really actually something about how off the equilibrium stuff, right? If really things got really bad, how do we think the Fed would act? And instead how people think about the reaction function of the Fed in the short run where they know the Fed is very data driven and they're trying to make forecasts about how the data are going to drive the correlation between Fed actions and outcomes. I think these two things are conceptually different.

Carolin Pflueger: Thank you so much. Excellent, excellent questions. Viral, what happens at the zero lower bound? In our previous paper we estimated the perceived monetary policy rule back to 1985, including the earlier period when the economy was at the zero lower bound after the global financial crisis. Interestingly enough, during that earlier zero lower bound we estimate positive coefficients, especially on the output gap. The reason that we do is that until roughly 2012 many forecasters expected interest rates to be stuck at zero for only a quarter or two, so for the longer forecast horizons the estimation works exactly the same as off the zero lower bound. You also see that in the high frequency market data. Eric Swanson and John Williams have a nice paper where they show that long term yields remained very much sensitive to macro news for a long time into the first zero lower bound. So it's not mechanical that we find a zero coefficient during the second zero lower bound starting in 2020. I think there's something specific about 2021 when forecasters expected interest rates to be insensitive to whatever was happening on the inflation side.

Regarding Anna's question, I absolutely agree that it would be dangerous to argue that expectations are anchored and therefore the Fed doesn't need to do anything. My message is the opposite: We show that this particular measure of credibility - the perceived inflation coefficient - is quite responsive to Fed actions. Endogeneity might still matter for our estimates if inflation forecasts in our data reflect expected policy actions. In the specific episode that we're looking at this would work against us in the sense that most forecasters should believe that rate hikes will drive down inflation. So if you look at inflation and policy rates in forecasters models, this should give you an interest rate-inflation coefficient that is biased downwards. This should work against our finding of a strongly positive perceived inflation coefficient in this recent episode. So, if anything, inflation forecasts that are endogenous to monetary policy make our main result stronger.

Guido, yes, the question is this a Taylor Rule or is it more of a short run reaction function? The answer is that we have forecasts up to six quarters out. So that's the horizon that we can measure. For example, in 2015 the Fed hike at the time was of course motivated by inflation concerns, but it was not inflation that was expected to materialize in the next six quarters or so. So, this ends up showing up more as a coefficient on the output gap in our estimation. In that sense I think it is interesting that during the recent period the coefficient on inflation went up a lot, which had not happened in a long time. That really speaks towards the strength of the perceived inflation response. This is consistent with financial markets data, which also reflect longer maturities. Even if you think that our evidence captures a bit more the medium term, I think the rise in the perceived inflation responsiveness is remarkable.

Janice Eberly: I will add a quick follow up on the zero lower bound question from Viral. I think Carolin's exactly right that there's nothing mechanical about the result, but when in the data starting in 2020, the forecasters are projecting zero inflation, or no change in inflation, and zero fed funds rate, even a year out. So you get a zero coefficient, but there's no volatility, there's no variance, so it's not a very informative zero — this is the point during the zero lower bound period.

Sebnem Kalemli-Özcan: Thank you. Carolin, fantastic paper, and great discussion, Jan. So I want to go back to what Agustín said on the international side and ask you if you can also bring exchange rates to the picture, like what you are doing with your ECB story. So we have done a paper for Brookings to look at the effect of U.S. monetary policy this time around on emerging markets. And we found that the countries, with improved policy credibility and monetary policy frameworks, were affected less. Not just that they responded earlier, even among those early responders the ones that earned the credibility were affected less, especially in terms of exchange rates. Because that's a key transmission mechanism to other countries. The exchange rate risk was priced-in much less. I'm not asking you to look at all the emerging markets, but maybe Japan, ECB, and Switzerland. Can you look at that just to add yet another measure?

Alan Blinder: This is a terminology point. I'm very unaccustomed to speaking for my friend John Taylor. But if John were here, I think he would say the second word in Taylor Rule was rule. And if what's going on is that the reaction of anything to anything, but let's say the beta on inflation to the inflation rate, sounds a lot like discretion. Not like following a Taylor Rule. Which may have something to do, I suspect, with Guido's point that nobody had mentioned before. That hardly any of these coefficients are above one. Which is what we all teach our students is the Taylor Principle. That last is a guess. But the first, I think, is not a guess. That it doesn't seem to be a rule.

Amir Yaron: Just, I think, the Russian invasion that we are sort of kind of not really talking about. That's very approximate to where the transitory kind of moved into non-transitory. And that affected perceptions on all accounts. And it would be actually really interesting to see what, if we could, what would have been the counterfactual if this had not happened. If inflation had stayed longer and all the discussion would have been different. But I think that had an eminent effect on the market participants and probably on the Fed as well.

Carolin Pflueger: Excellent questions, Sebnem. Thank you for the note on exchange rates. I agree with this. It would be fascinating to look at exchange rates. We didn't get around to it here, but absolutely. Alan, I agree that in the end what we're finding looks a lot more like discretion. But I'll need to leave it up to the forecasters' minds how long they're projecting these relationships out. But there clearly is a lot of variation. Amir, I agree the Russian invasion is fascinating. Our contribution is to provide a methodology to look at these things. Interestingly, we find that the ECB perceived inflation response did not increase right around the Russian invasion, even though supply concerns — I'm from Germany originally were very salient.

Janice Eberly: I just had one memory in response to Alan's question about the Taylor Rule. When I was first looking at the equation that they're running and trying to interpret the results in light of that, of course, anybody who runs regressions, you immediately go to the error term and think, what's in that error term and what's it correlated with? And then I thought, if this was really a rule, there shouldn't be an error term. But a lot of what we worry about in estimating this is, why is there an error term if it's a rule, and what's in it, and what's it doing to the estimation?

Andréa Maechler (Moderator): I guess you're coming back to the point of uncertainty, right? How do you put uncertainty into policymaking, which is inevitable?

Monetary Policy and the Mortgage Market

Itamar Drechsler, Alexi Savov, Philipp Schnabl and Dominik Supera

Abstract

Mortgage markets are central to monetary policy transmission. We show that this is because monetary policy impacts the supply of mortgage credit by the two largest mortgage holders: banks and the Federal Reserve. The Fed's supply of mortgage credit consists of buying or selling mortgage-backed securities (MBS) under its quantitative easing and tightening (QE and QT) programs. Banks' supply of mortgage credit is driven by the deposits channel of monetary policy. Under the deposits channel, when the Fed lowers rates, banks receive large inflows of deposits. They invest these deposits in long-term fixed-rate assets, in particular MBS, to match the interest rate sensitivity of their income and expenses. The deposits channel reverses when the Fed raises rates: deposits flow out and banks sell MBS. Through the combined effect of QE/QT and the deposits channel, monetary policy drives mortgage rates, mortgage originations, and residential investment. We show that QE/QT and the deposits channel played a large role in the expansion and contraction of mortgage credit during the 2020–24 monetary policy cycle. Our results imply

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that monetary policy will continue to operate through these channels in future cycles.

1. Introduction

The last four years saw massive changes in monetary policy. The Federal Reserve cut interest rates sharply at the onset of Covid-19 to address the economic effects of the pandemic. The Fed also implemented an aggressive program of quantitative easing (QE), purchasing large amounts of Treasury bonds and mortgage-backed securities (MBS). As the economy recovered, inflationary pressures emerged, and the stance of monetary policy shifted. The Fed raised rates rapidly, from 0% to over 5% in the course of a year and a half. The Fed also undertook a program of quantitative tightening (QT), aimed at reducing its Treasury and MBS holdings.

There has been wide discussion of the economic effects of these monetary policy actions. It remains an open question to what extent the loosening and tightening of monetary policy affected household consumption, the labor market, and corporate investment. One area for which there is agreement, is that monetary policy had a large impact on the housing sector through its effect on mortgage markets. Mortgage rates fell rapidly during the loosening phase of the cycle. Mortgage originations boomed, house prices rose, and residential investment surged. All of these trends reversed during the tightening phase. This experience shows that mortgage markets are central to the transmission of monetary policy. How does this transmission work, and why is it so central?

We show that monetary policy had a powerful impact on mortgage markets by shifting the supply of mortgage credit of the two largest mortgage holders, banks and the Fed. Banks and the Fed bought enormous quantities of mortgages during 2020–21, causing mortgage rates to decline drastically. The decline was so large that the spread between mortgage rates and Treasury yields, the mortgage spread, fell to a historic low. When monetary policy reversed course, banks and the Fed cut back their mortgage holdings, causing mortgage rates to rise and the mortgage spread to widen. Monetary policy thus had an outsized impact on mortgage rates, leading them to move more than one-for-one with Treasury yields. This explains why mortgage markets were so central to monetary policy transmission.

How does monetary policy shift the supply of mortgage credit by banks and the Fed? For the Fed it does so directly: MBS purchases under QE are exactly a shift in the Fed's mortgage credit supply. Because the Fed's MBS purchases are large, this shift has a significant impact on the MBS market, which is the largest source of mortgage financing. By expanding mortgage credit, the Fed seeks to lower borrowing costs for homeowners and spur economic activity.

For banks, monetary policy affects mortgage credit supply through the deposits channel of monetary policy (Drechsler et al., 2017). In the deposits channel, banks have market power in deposit markets, which allows them to keep deposit rates low when the Fed raises rates, i.e. deposit rates have a "low beta". Holding deposits thus becomes more expensive when rates rise, which leads some depositors to withdraw their deposits from banks and invest in other assets. When the Fed lowers rates, the reverse happens and banks receive deposit inflows.

Deposit flows drive banks' supply of mortgage credit because banks invest low-beta deposits in long-term fixed-rate assets such as MBS (Drechsler et al., 2021; Supera, 2021). A low beta means that banks' interest expense on deposits is insensitive to the Fed funds rate, similar to long-term debt. Investing in long-term fixed-rate assets generates interest income that is also insensitive to the Fed funds rate. By matching the interest sensitivity of their interest income and expenses, banks hedge their cash flows to fluctuations in interest rates. This is why banks invest low-beta deposits in assets like MBS. Thus, monetary policy drives banks' supply of mortgage credit by causing inflows and outflows of deposits via the deposits channel.

The impact of this channel is large because banks are the largest provider of mortgage credit in the economy. Banks both hold mortgages that they themselves originate (portfolio loans) and invest heavily in securitized mortgages (MBS). As of 2024q1, banks own $6.3 trillion of residential mortgage debt, roughly half of the entire market (their share of MBS is close to a third). As a result, when banks change their mortgage holdings, the effect on the total supply of mortgage credit is large.

The second largest investor in mortgages is the Federal Reserve due to QE. At the peak of its MBS holdings in 2021, the Fed held $2.7 trillion of MBS, which is about a quarter of all MBS and a fifth of all mortgages. Together, banks and the Fed hold more than half the MBS market and close to three quarters of the total mortgage market.

The equilibrium impact of Fed and bank MBS purchases depends on the response of other MBS investors. These investors are mainly asset managers such as mutual funds, pension funds, and private wealth managers. In contrast to banks and the Fed whose purchases are driven by monetary policy, asset managers respond to changes in MBS prices. When banks and the Fed purchased MBS during 2020–21, driving MBS prices up, asset managers became net sellers. Conversely, when banks and the Fed cut their holdings during 2022–23, driving MBS prices down, they bought. For this to occur, the equilibrium price of mortgage credit had to change. This explains why mortgage spreads fell during 2020–21 and then rose during 2022–23.

These changes in the cost of mortgage credit led to large quantity responses from mortgage borrowers. The fall in mortgage spreads in 2020–21 contributed to a massive $8-trillion mortgage origination boom.[1] Many of these were refinance originations, which allow households to lower their mortgage payments and increase their spending on goods and services. Other originations were for purchasing new homes, some of which were newly constructed, leading to an increase in residential investment. The rise in originations led to a large increase in MBS issuance even after netting out prepayments. The rise in mortgage spreads in 2022–23 had the opposite effect: mortgage originations, MBS issuance, and residential investment fell. These dynamics explain why mortgage markets were important for monetary policy transmission.

The impact of monetary policy on mortgage credit supply is not confined to the recent cycle. While this impact was especially large during this time due to the combination of QE and conventional monetary policy, we document that monetary policy has always had a large effect on banks' mortgage holdings and the mortgage spread through the deposits channel. Specifically, we find a tight relationship between deposit, banks' MBS holdings, and mortgage spreads over the past four decades. We therefore expect that the deposits channel, in addition to any future rounds of QE, will continue to play a large role in monetary policy transmission.

The first part of the paper presents aggregate evidence of the impact of monetary policy on the supply of mortgage credit. To isolate the disproportionate impact of monetary policy on mortgage costs, we focus on the mortgage spread. We find that the mortgage spread declined by about 100 bps during the easing phase of 2020–21 and then rose by over 100 bps during the tightening phase of 2022–23. The same pattern holds for the option-adjusted spread (OAS), which removes the estimated value of the prepayment option and other components such as mortgage fees. This confirms that monetary policy impacted mortgage rates over and above Treasury yields.

Turning to quantities, total mortgage originations grew from $2.3 trillion in 2019 to $4.7 trillion in 2021 and then fell to $1.3 trillion in 2023. The negative relationship between the price of mortgage credit (the mortgage spread) and the quantity (originations) indicates that there was a net shift in mortgage credit supply. Other factors, such as increased demand for housing due to work-from-home, represent shifts in demand that would lead mortgage spreads and originations to move in the same direction.

To explain the shift in mortgage credit supply, we analyze the mortgage holdings of banks and the Fed. We show that the changes in their holdings were very large: during 2020–2022q1, the Fed increased its MBS holdings from $1.4 trillion to $2.7 trillion. At the same time, banks increased their MBS holdings from $2.2 trillion to $3.1 trillion, a 41% increase.[2] This increase closely tracks the growth of their deposits, which was 45%. Combined, banks and the Fed thus purchased over $2.2 trillion of MBS, representing almost a quarter of MBS outstanding. Other MBS investors (asset managers) were net sellers during this period, reducing their MBS holdings by about $1.5 trillion. The equilibrium result of this reallocation was the large reduction in the mortgage spread.

The subsequent increase in mortgage spreads during 2022–23 also closely aligns with changes in the MBS holdings of banks and the Fed. From the end of 2021, when the mortgage spread began to rise, to the end of 2023, when it was near its peak, banks decreased their MBS holdings by $0.5 trillion. Over the same period, the Fed reduced its MBS holdings by $0.3 trillion under QT. Asset managers again took the other side and bought MBS. Since the mortgage spread had risen, they did so at a low price.[3]

The second part of the paper provides a simple framework to interpret our findings and quantify the impact of monetary policy on the supply of mortgage credit. Our framework features two price-insensitive agents: banks and the Fed, and a price-sensitive asset manager. Together, these three agents supply credit to mortgage borrowers by purchasing MBS. When banks and the Fed buy MBS, they drive down the mortgage spread. As mortgage costs decline, borrowers take out more mortgage debt.

The equilibrium impact of Fed and bank MBS purchases depends on two key parameters. The first is the price elasticity of asset managers. Identifying this parameter is challenging because prices are an equilibrium quantity that depends on unobserved demand and supply shocks. We address this challenge by instrumenting for changes in the mortgage spread using Fed MBS purchases. The identifying assumption is that the Fed is guided by broad economic conditions (e.g., the output and inflation gap) and not unobserved changes in asset managers' demand for MBS. To avoid confounding factors during Covid-19, we estimate the relationship up to 2019.

We find that Fed MBS purchases have a large negative impact on mortgage spreads. A 10 percentage point increase in Fed holdings as a share of total MBS leads to a 40-bps decline in the mortgage spread. Consistent with our identification assumption, the result is not sensitive to controlling for economic conditions. As a more stringent test, we control for the expected amount of Fed MBS purchases using survey data from primary dealers. To the extent primary dealers factor the Fed's objectives into their forecasts, this helps to control for potential unobserved factors.

Our instrumented regression shows that asset managers are price-sensitive. When the mortgage spread widens by 100 bps, they shrink their holdings by as much as 20% of total MBS. The estimated sensitivity is significantly larger than if we use an OLS regression. This is expected given the downward bias in OLS due to unobserved demand shocks. This confirms the need for an instrument.

We find that banks behave very differently from asset managers. Their purchases do not respond significantly to changes in mortgage spreads. Instead, banks' MBS holdings are explained well by deposit growth. Banks are thus price-insensitive, similar to the Fed. It is therefore the combined MBS purchases of banks and the Fed that drive outcomes in the MBS market.

The second key parameter is the elasticity of mortgage borrowers with respect to the cost of mortgage borrowing. We estimate it in two ways, using OLS and by backing it out from the instrumental variables estimation based on the relationships implied by our model. We find that changes in mortgage rates have a large impact on mortgage originations, both gross (including refinancings) and net. When mortgage rates drop by 100 bps, gross originations rise by 10.8% while net originations rise by 4.3%.

We use these estimates to quantify the impact of monetary policy on mortgage markets during the recent cycle. Our counterfactual analysis isolates the impact of monetary policy from other factors such as increased demand for housing due to work-from-home. We find that banks and the Fed were each responsible for about a 40-bps reduction in the mortgage spread during 2020–21. Our estimates imply that this led a cumulative increase in net MBS issuance of about $1 trillion. Of this, banks were responsible for about half. The impact on gross mortgage originations is even larger, almost $3 trillion, again roughly balanced between banks and the Fed.

The remainder of the paper is organized as follows: Section 2 reviews the literature, Section 3 presents the aggregate evidence, Section 4 provides the framework, Section 5 summarizes data sources used in the estimation, Section 6 shows the estimation results, Section 7 runs the counterfactual analysis, and Section 8 concludes.

2. Related Literature

Our work connects to the literature on the impact of quantitative easing (QE) on asset prices and the real economy. This literature emphasizes two main transmission channels: the portfolio rebalancing channel (Bernanke, 2010) and the signaling channel (Woodford, 2012; Bauer and Rudebusch, 2014). The portfolio rebalancing channel is predicated on the idea that different assets are imperfect substitutes, possibly due to investors' "preferred habitats" (Vayanos and Vila, 2009) resulting from specialized expertise, liquidity needs, or regulatory constraints (Gertler and Karadi, 2011). When the central bank purchases assets, investors rebalance into similar assets, thereby raising their prices and reducing their risk premia. The signaling channel posits that QE communicates information about the future path of short-term interest rates, possibly signaling a commitment to keep rates lower in the future. The portfolio rebalancing channel primarily works through risk premia, while the signaling channel works through the expected path of the short-term rate (Bernanke, 2020).

A more skeptical strand of the literature argues that QE has little effect since it simply exchanges one form of government debt (e.g., Treasury bonds or agency MBS) with another (bank reserves). Along these lines, Curdia and Woodford (2011) and Woodford (2012) argue that QE is generally ineffective, except for targeted purchases when financial markets are disrupted. A common thread across both views is that QE only affects financial markets and the real economy if asset markets are segmented.

A large empirical literature examines the effects of QE on Treasury yields, MBS yields, and other asset prices, mostly relying on high-frequency event studies. Most studies find that QE affects asset prices, but estimates vary in terms of magnitude and the precise channel. Some studies find support for a signaling channel (Krishnamurthy and Vissing-Jorgensen, 2011; Bauer and Rudebusch, 2014; Bhattarai et al., 2015), while others favor portfolio rebalancing (Gagnon et al., 2011; Joyce et al., 2011; Swanson, 2011; D'Amico et al., 2012; Carpenter et al., 2015; Neely, 2015). In their Jackson Hole paper, Krishnamurthy and Vissing-Jorgensen (2013) find evidence for a relatively narrow portfolio rebalancing channel. Borio and Zabai (2018) provide an overview of the empirical literature on QE. A challenge in interpreting the event study evidence is the small number of QE announcements and the difficulty of controlling for investors' expectations about QE on the eve of these announcements (Greenlaw et al., 2018; D'Amico and Seida, 2024). Different from the rest of this literature, Selgrad (2023) uses portfolio holdings data to test the portfolio rebalancing channel directly and finds support for its existence.

A smaller literature studies quantitative tightening (QT). Lopez-Salido and Vissing-Jorgensen (2023) study the impact of QT on the Fed's ability to control short-term interest rates. Ludvigson (2022), Smith and Valcarcel (2023), and Du et al. (2024) run event studies of QT similar to the QE literature. Du et al. (2024) find smaller announcement effects for QT than QE, consistent with a possible asymmetry in the impact of QE and QT. However, they caution this could be due to differences in the market environment or investor expectations.

Our paper also connects to the literature on monetary policy transmission through bank lending. Traditional theories of the bank lending channel operate through changes in bank reserves (Bernanke, 1983; Bernanke and Blinder, 1988; Kashyap and Stein, 1994). The reserves mechanism ceased to operate due to changes in banking structure, calling into question the idea of a sizable bank lending channel (Romer and Romer, 1990; Bernanke and Gertler, 1995; Woodford, 2010). The deposits channel of monetary policy (Drechsler et al., 2017) provides an alternative mechanism for how monetary policy affects bank lending based on deposit market power. Deposit market power allows banks to keep deposit rates low when the Fed raises rates. This leads some depositors to withdraw their deposit, which induces a contraction in bank lending. The deposits channel provides a new foundation for the large empirical literature on the bank lending channel (Bernanke and Blinder, 1992; Kashyap et al., 1993; Kashyap and Stein, 2000; Xiao, 2020; Wang et al., 2022; Drechsler et al., 2022). Drechsler et al. (2021) show that deposit market power also explains why banks hold long-term fixed rate assets such as MBS: deposit market power makes deposit rates interest-insensitive (i.e., "low beta"), making them resemble long-term liabilities. Banks hedge these liabilities with long-term assets. Thus, due to the deposits channel, monetary policy has a large impact on bank deposits, and by extension on banks' mortgage holdings.

Many papers examine the impact of monetary policy and QE on mortgages, refinancing, and housing markets. Fuster and Willen (2011) measure the effect of QE on the mortgage origination market, while Di Maggio et al. (2020) study the impact of QE on mortgage refinancing. This work generally finds that mortgage refinancing increases consumer spending (Bhutta and Keys, 2016; Di Maggio et al., 2017; Agarwal et al., 2018; Abel and Fuster, 2021; Beraja et al., 2019). The literature also finds that the effects of monetary policy through the refinancing channel are state-dependent (Berger et al., 2021; Eichenbaum et al., 2022). Amromin et al. (2020) survey the mortgage refinancing literature. Fuster et al. (2021) study originator markups during the Covid-19 crisis. DeFusco and Paciorek (2017) uses micro data to estimate the elasticity of mortgage demand to mortgage interest rates. Drechsler et al. (2022) analyze the impact of monetary policy on mortgage financing before the 2008 financial crisis.

A strand of the literature looks at the impact of QE on bank lending. Acharya and Rajan (2022) argue that QE leads to an increase of uninsured deposits, creating fragility. Chakraborty et al. (2020) and Rodnyansky and Darmouni (2017) find that banks that sell MBS to the Fed increase their own mortgage lending. Diamond et al. (2024) argue that the additional reserves created by QE crowd out bank lending.

Our quantitative analysis builds on the work of Koijen and Yogo (2019) who show how to construct demand systems for studying the impact of asset purchases on asset prices. Koijen et al. (2017) and Koijen et al. (2021) apply a version of this methodology to asset purchases by the European Central Bank. They find sizable effects of purchases on asset prices, similar to our quantitative results.

3. The Transmission of Monetary Policy to Mortgage Credit

3.1 The Fall and Rise in the Cost of Mortgage Credit

The U.S. mortgage market experienced large changes since the onset of COVID-19. Figure 1 shows the average interest rate for the most common mortgage product, the 30-year fixed-rate conforming mortgage, from January 2019 to June 2024. Before COVID-19, the mortgage rate hovered at around 4%. It dropped to 3% at the start of the pandemic in March 2020. The rate hit a historic low of 2.8% in December 2020 and remained around 3% until late 2021. Starting in late 2021, the mortgage rate rose sharply as the Federal Reserve increased interest rates to combat inflation. By March 2023, the rate had surged to close to 7% and has stayed at around 7% or higher since, reaching a peak of 7.8% in October 2023.

Figure 1 also shows the 10-year Treasury yield, a common benchmark for the 30-year fixed rate mortgage because the two have similar duration. The 10-year Treasury yield fell from around 2% before COVID-19 to less than 1% after the onset of COVID-19. It remained at around 0.5–1.5% until late 2021. From late 2021 to early 2023, the 10-year yield increased from 1.5% to around 3.5–4.5%. This increase is attributable to a shift in the stance of monetary policy, reflected in changes in the expected path of short-term rates and in the term premium.[4]

Figure 2 plots the mortgage spread, measured as the difference between the 30-year fixed rate conforming mortgage rate and the 10-year Treasury yield (i.e, the difference 30Y Fixed Rate Conforming Mortgage Index 10Y U.S. Treasury Securities Market Yield between the two lines in Figure 1). The mortgage spread represents the yield premium that mortgage borrowers pay in excess of long-term Treasury rates. As shown in the figure, the mortgage spread fell and rose in line with overall interest rates. This means that mortgage rates moved more than one-for-one with other long-term rates.

The mortgage spread was around 2.1% before COVID-19. It briefly spiked to around 2.9% at the start of the pandemic. This spike reflected uncertainty about COVID-19's impact on the mortgage market and an increase in the markup charged by mortgage

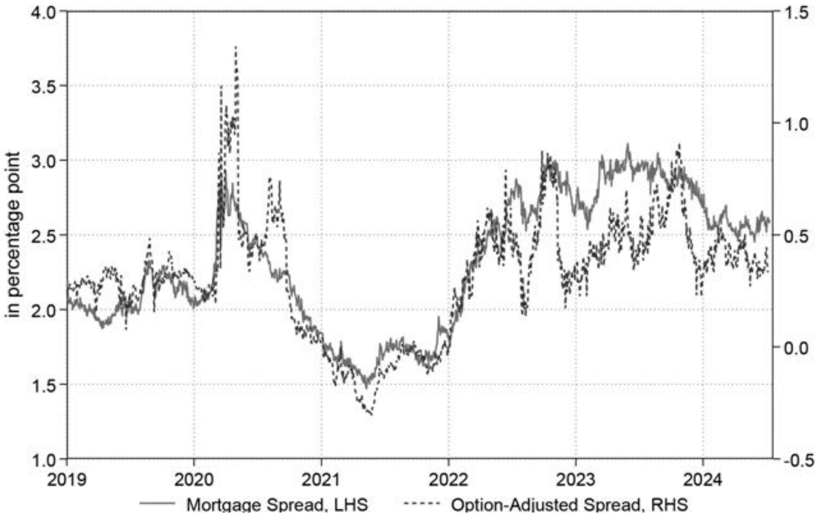
Figure 1
Mortgage and U.S. Treasury Rates

Note: This figure plots the mortgage rate and U.S. Treasury rate from 1 Jan 2019 to 5 Jul 2024. The mortgage rate is the 30-year fixed rate conforming mortgage index from FRED. The U.S. Treasury rate is the market yield on U.S. Treasury securities at 10-year constant maturity, also from FRED.

originators due to the difficulty of processing large refinancing volumes during the first months of COVID-19. After this initial spike, the spread decreased to less than 1.5% by early May 2021. The spread remained constant for several months and then began to increase as monetary policy turned to a tightening stance in late 2021. For most of 2023, the mortgage spread was around 2.9%, slightly declining thereafter.

For comparison, the figure also plots the OAS ("option-adjusted") spread, which removes the estimated value of the prepayment option and the primary-secondary spread. The prepayment option is the cost of providing mortgage borrowers with the option to refinance. The primary-secondary spread is the difference between the rate mortgage borrowers pay and the rate MBS investors receive. It covers mortgage fees and the originator's markup. The OAS spread follows a similar pattern as the mortgage spread. The increase in 2022 is somewhat smaller primarily due to the rise in the value of the prepayment option. The OAS spread declined to less than −0.4% in June 2021 and increased to around 0.4–0.9% during 2023. As shown in the

Figure 2
Mortgage and Option-Adjusted Spreads



Note: This figure plots the relationship between the mortgage spread and the option-adjusted spread (OAS) from 1 Jan 2019 to 5 Jul 2024. The mortgage spread is the spread between the 30-year fixed rate conforming mortgage index and the 10-year U.S. Treasury yield, both from FRED. The OAS is the FNCL TBA Current Coupon BAM OAS I25 Discounting series from Bloomberg, which uses Treasury discounting to adjust Bloomberg's 30-year FNCL Par Coupon index.

figure, there is a high correlation between the mortgage spread and the OAS mortgage spread.[5]

In sum, the mortgage spread isolates changes in the cost of mortgage credit over and above changes in the general level of interest rates. The fact that it co-moves with the level of interest rates indicates that monetary policy has a disproportionate impact on the cost of mortgage credit. Understanding this disproportionate impact can explain why the mortgage market plays such a central role in the transmission of monetary policy.

Moving forward, we focus on the mortgage spread as our preferred measure of the excess cost of mortgage credit.

3.2 The Rise and Fall in Mortgage Originations and MBS Issuance

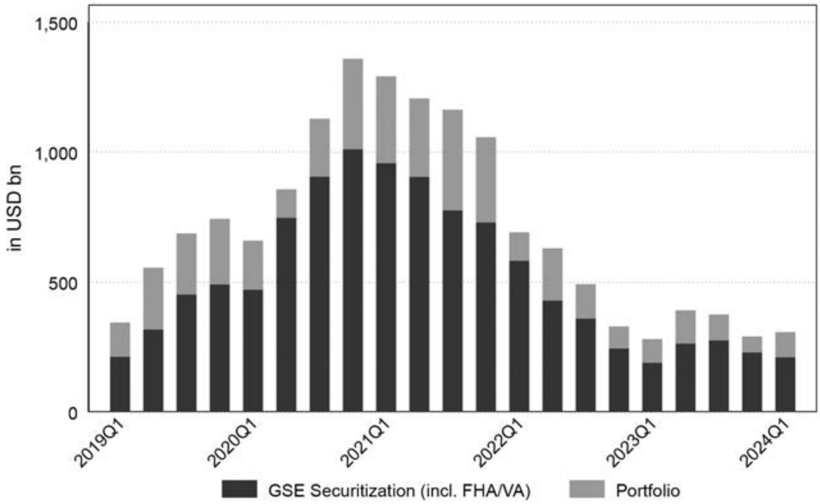
The previous section showed that the cost of mortgage credit fell in 2020/21 and rose once the Federal Reserve started raising interest rates in 2022. This change in price could be due to a change in either the demand for, or supply of, mortgage credit. To determine which one, we can look at mortgage quantities. If mortgage costs and quantities move in opposite directions, this implies a net shift in the supply curve of mortgage credit. Conversely, if they move in the same direction, it suggests a net shift in the demand curve for mortgage borrowing.

Figure 3 plots total quarterly mortgage originations from January 2019 to March 2024. Quarterly originations averaged around $600 billion from January 2019 to March 2020. About two-thirds of these originations were securitized by the GSEs, i.e., they were sold to the GSEs to be insured against default and packaged into MBS, while the remaining one-third were portfolio loans held on bank balance sheets. From March 2020 to December 2021, average quarterly mortgage originations nearly doubled to $1,050 billion, peaking at around $1,360 billion in the last quarter of 2020. Total new mortgage originations during these seven quarters exceeded $8 trillion. For comparison, total residential mortgages stood at $11 trillion in March 2020, showing there was significant turnover relative to the stock of all mortgages. Total mortgage originations declined significantly after 2021. Average quarterly originations from the first quarter of 2022 to the first quarter of 2024 were about $420 billion, reaching a low of $281 billion in the first quarter of 2023.

A large share of new mortgage originations is refinancing originations. In a refinancing, a homeowner extinguishes an existing mortgage with a new one at a lower rate. Some homeowners also choose to increase their mortgage balances in what is known as a "cash-out refinancing." Refinancing relaxes homeowners' budget and liquidity constraints, allowing them to increase spending on other goods and services. A large literature finds that this has a large impact on aggregate consumption (e.g., Di Maggio et al., 2017; Eichenbaum et al., 2022; Agarwal et al., 2023).

Mortgage originations increase the total amount of outstanding mortgages but less than one-for one. Cash-out refinancings increase outstanding mortgages by the change in the mortgage balance. All refinancings extend mortgage duration and hence increase the

Figure 3
Primary Mortgage Originations

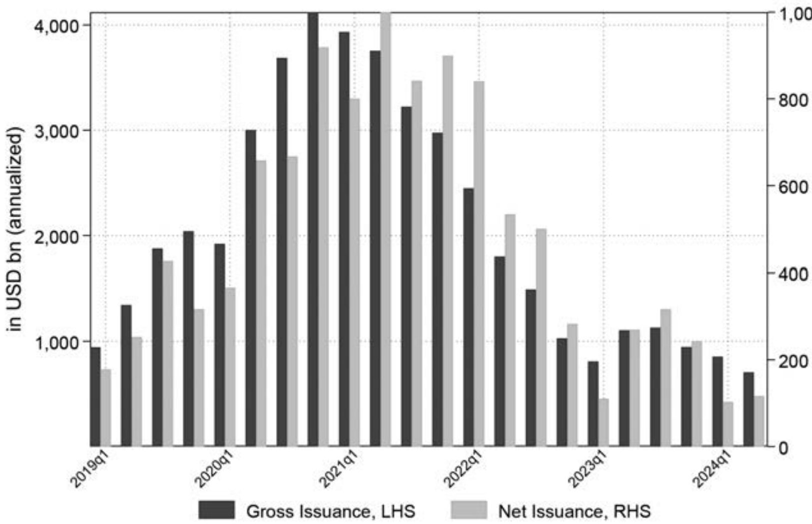


Note: This figure plots quarterly first lien primary mortgage originations from 2019Q1 to 2024Q1. Mortgage originations are broken down into whether they are portfolio loans or securitized by the government sponsored enterprises (GSE; i.e. Fannie Mae, Freddie Mac, and Ginnie Mae) or the Federal Housing Administration and the U.S. Department of Veteran Affairs (FHA/VA). The figure excludes the small amount of originations that goes into private label securitization. The data source is Urban Institute.

amount of interest rate risk that mortgage lenders must bear. Purchase loans for existing homes increase outstanding mortgages by the difference in size between the mortgage of the buyer and that of the seller (if the seller has a mortgage). Finally, purchase loans for newly constructed homes increase total mortgages one-for-one. These also have a direct effect on economic activity via residential fixed investment.

We can see directly how much gross originations translated into changes in the total amount of outstanding mortgages by looking at net mortgage originations. We do so in the context of the MBS market. Figure 4 plots the quarterly gross and net issuance of agency MBS from the first quarter of 2019 to the first quarter of 2024. Agency MBS includes all securitized residential mortgages guaranteed by U.S. government agencies (Fannie Mae, Freddie Mac, and Ginnie Mae). Annualized gross and net issuances were around \$1,600 billion and \$300 billion, respectively, from January 2019 to March 2020.

Figure 4
Agency MBS Issuance, Gross and Net

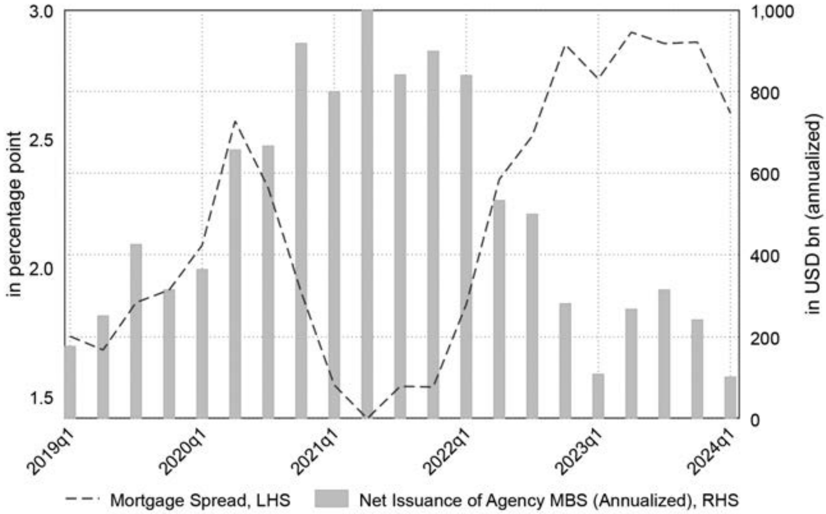


Note: This figure plots annualized quarterly gross and net MBS issuance by Fannie Mae, Freddie Mac, and Ginnie Mae from 2019Q1 to 2024Q1. The data source is the Ginnie Mae Global Markets Analysis Report.

These figures increased to around $3,500 billion and $830 billion, respectively, from the second quarter of 2020 to the fourth quarter of 2021. However, from the end of 2021 MBS issuance declined rapidly. From the first quarter of 2022 to the first quarter of 2024, annualized gross and net MBS issuance averaged just $1,300 billion and $350 billion, respectively.

Figure 5 puts together evidence on the quantity of mortgage credit (MBS net issuance) and the price of mortgage credit (the mortgage spread). The figure shows that the mortgage spread contracted from the second quarter of 2020 through the fourth quarter of 2021, coinciding with a boom in MBS issuances and mortgage originations. Once the mortgage spread increased after 2021, total MBS issuance and origination sharply declined. This evidence shows that there was a positive net supply shift in mortgage credit in 2020/21, when the price of mortgages decreased and the quantity of mortgage credit increased. The reverse occurred in 2022/23, when the price of mortgages increased and the quantity of mortgage credit decreased.

Figure 5
Agency MBS Net Issuance and MBS Spread



Note: This figure plots the relationship between the mortgage spread and net agency MBS issuance (i.e. by Fannie Mae, Freddie Mac, and Ginnie Mae) from 2019Q1 to 2024Q1. The mortgage spread is the spread between the 30-year fixed rate conforming mortgage index and the 10-year U.S. Treasury yield, both from FRED. The values are quarterly average of the daily spread. Net agency MBS issuance is annualized and sourced from the Ginnie Mae Global Markets Analysis Report.

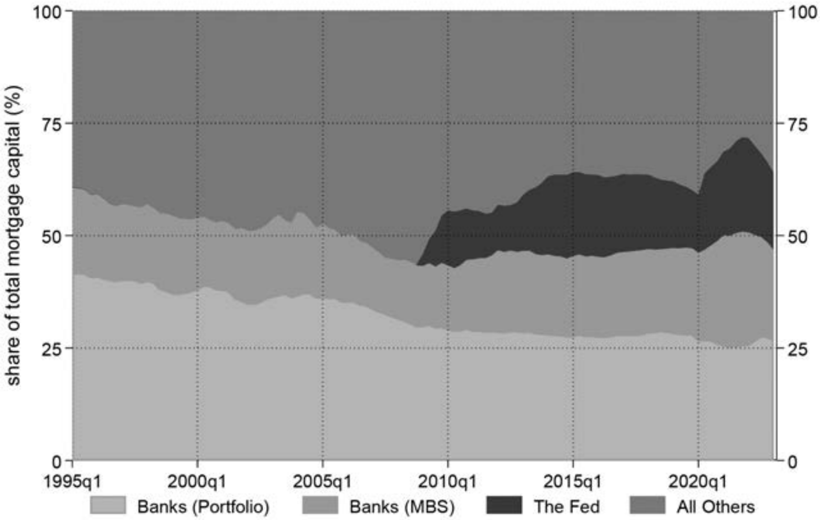
3.3 What Caused the Shift in the Supply of Mortgage Credit?

3.3.1 The Main Providers of Mortgage Credit

Figure 6 plots the share of mortgages owned by by the three main groups of mortgage investors over the period from 1995 to 2023: (i) the banking sector, (ii) the Federal Reserve, and (iii) other MBS investors. We compute the share based on the ultimate investors in the mortgage, i.e., the investor holding the mortgage on balance sheet, or if the mortgage is securitized, the investor holding the MBS. We refer to securitized mortgages as MBS and non-securitized mortgages as portfolio loans. Total mortgages are the sum of MBS and portfolio loans.

The figure shows that banks have consistently financed around 50% of total mortgages over the past three decades. Their share has been remarkably stable, even though this period witnessed major developments in mortgage markets, including the 2008 financial crisis,

Figure 6
Mortgage Financing by Entity



Note: This figure plots the share of mortgage financing by banks (divided into portfolio and MBS), the Fed, and all other MBS investors from 1995Q1 to 2023Q1. These shares are calculated by first obtaining residential mortgage and MBS holding by the different entities (i.e. banks, Fed, rest of the world, household, REITs, mutual funds, money market funds, pension funds, life insurance, non-bank ABS issuers), all from the Z.1 release or the flow of funds data in FRED, then dividing each by their sum. For banks, we add up primary mortgages or mortgage-backed securities holdings of U.S.-chartered depository institutions and credit unions. The data are in market values.

the growth of non-bank mortgage originators, and the emergence of FinTech lenders.

This result may be surprising since there is a common misconception that banks no longer play a major role in financing mortgages due to the rise of securitization. While securitization has grown, and non-bank mortgage originators (e.g., Quicken Loans/Rocket Mortgage) issue an increasingly large share of securitized mortgages, these non-bank originators do not provide the ultimate financing for these loans. Instead, they almost immediately sell them to the Government-Sponsored Enterprises (GSEs), Fannie Mae and Freddie Mac, who then securitize them into MBS which they sell to investors. The cost of credit for these securitized mortgages is determined by the investors who are the final buyers of the MBS, not by the mortgage originators.

Banks are the largest investors in MBS, holding about 30% of all MBS, in addition to their holdings of portfolio loans. This means that banks play a major role even when focusing solely on MBS. Together with their holdings of portfolio mortgage loans, they are by far the largest provider of mortgage credit to the economy.

The main change in mortgage credit provision over the last 30 years has been the increasing role of the Federal Reserve in the MBS market. The Fed started buying MBS in 2008 as part of its effort to stabilize the economy and support the housing market in the aftermath of the 2008 financial crisis. Since then, the Fed has owned between 10% and 25% of the MBS market. The Fed's increased footprint has reduced the share of other investors in the mortgage market, including pension funds, mutual funds, insurance companies, and foreign investors, but not banks. These investors owned around 50% of mortgages from 1995 to 2007, but their share has since declined to 35–40%. The share of banks, meanwhile, has remained stable.

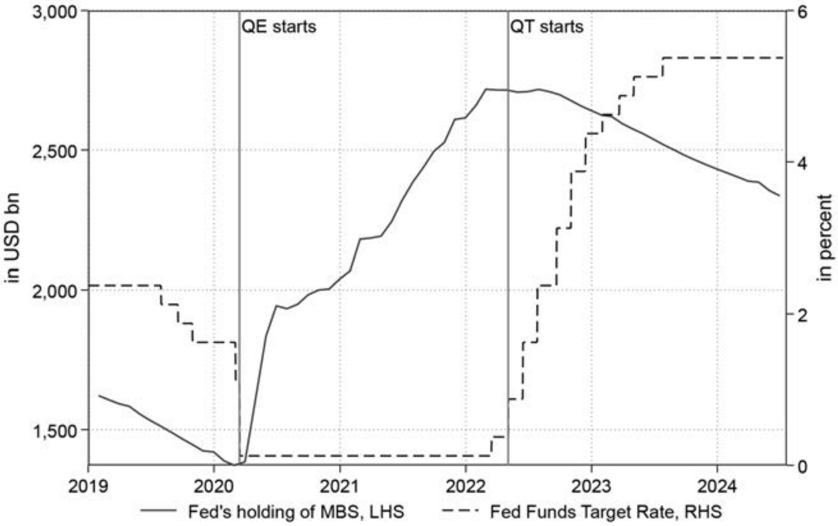
Therefore, while specialized non-bank originators have become prominent in the origination of mortgages, banks have remained at the center of mortgage credit provision through their investments in MBS and portfolio loans. Together with the Federal Reserve, they play a dominant role in the mortgage market.

3.3.2 The Federal Reserve's MBS Purchases

Over the past four years, the Federal Reserve bought and sold large amounts of MBS as part of its quantitative easing (QE) and tightening (QT) programs. At the end of 2019, the Fed held around $1.4 trillion in MBS, which it had purchased during previous rounds of QE (the Fed was engaged in QT at the onset of Covid-19). When the Covid-19 pandemic began in March 2020, the Federal Reserve announced a new round of QE in order to support the economy.

Figure 7 plots the Federal Reserve's MBS holdings. The Fed purchased around $550 billion in the second quarter of 2020 and gradually increased its holdings in the following quarters with further purchases. By the first quarter of 2022, the Federal Reserve had increased its holdings by another $750 billion, leading to total purchases of

Figure 7
The Fed's Holding of MBS and the Federal Funds Rate



Note: This figure plots the Fed's monthly holding of MBS against the Federal Funds Target Rate from Jan 2019 to Jul 2024. The Fed's MBS holding is in face value, sourced from the H.4.1 release table in FRED.

$1.3 trillion since the onset of COVID-19 and total holdings of $2.7 trillion.

In early April 2022, the Fed announced that it would start QT. The Fed initially decreased its holdings by a predetermined amount per month, eventually settling on a decrease of $35 billion per month. The expectation was that the Federal Reserve would not need to actively sell MBS but simply let its holdings run off without reinvesting the proceeds. Since 2022Q2, the Fed has reduced its total holdings by around $300 billion, with Fed's holding of MBS, LHS Fed Funds Target Rate, RHS total holdings declining from $2.7 trillion to $2.4 trillion by the first quarter of 2024.

This strategy of predetermined purchases and reductions in MBS is a central element of the Federal Reserve's quantitative easing and tightening policies. It is viewed as maximizing the impact of quantitative easing by providing forward-looking investors with certainty, thereby reducing market volatility. Importantly, this strategy means the Fed is effectively price-inelastic when implementing QE/QT, i.e., it purchases and sells MBS regardless of the mortgage spread.

We therefore consider the Fed to be a price-insensitive buyer and seller of MBS.

3.3.3 Banks' MBS Purchases

Figure 8 plots the total MBS holdings of the U.S. banking sector together with the Fed's holdings. As mentioned in the previous section, banks are the single largest holders of MBS. At the start of 2020, they held about $2.2 trillion in MBS, or 57% more than the Federal Reserve. Including portfolio loans that are originated and held on balance sheets, banks owned close to half of all U.S. mortgages.

Like the Federal Reserve, the U.S. banking sector significantly increased its MBS holdings after the onset of Covid-19. Banks purchased about $1 trillion in MBS from the first quarter of 2020 until the first quarter of 2022. Banks began reducing their holdings earlier than the Fed, during the first quarter of 2022. From the second quarter of 2022 to the first quarter of 2024, banks reduced their holdings by around $0.4 trillion, 35% more than the Fed's reduction under QT.

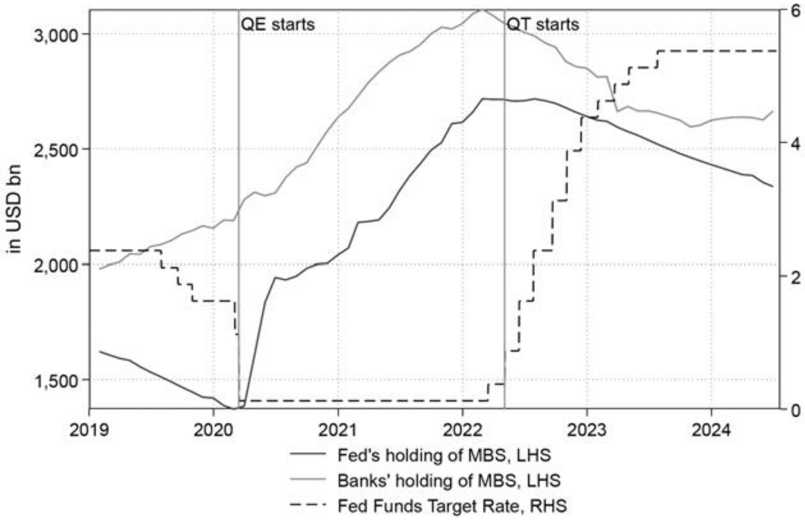
Like the Federal Reserve, banks purchased MBS when the mortgage spread was low (i.e., the price of MBS was high) and sold MBS when the spread was high (i.e., the price was low). Since a price-sensitive behavior would behave in the opposite fashion, this suggests that, similar to the Fed, banks buying and selling was price insensitive, and hence driven by a factor other than the mortgage price.[6] As the figure shows, the MBS purchases of banks and the Fed tracked each other over time and hence their combined impact drove the changes in the supply of mortgage credit.

3.4 Why Do Banks Invest in MBS?

3.4.1 The Deposits Channel of Monetary Policy

Prior research shows that banks' purchases of MBS are driven by inflows and outflows of deposits, such as checking and savings account, whose deposit rates have a low "interest rate beta," meaning they increase much less than one-for-one with market rates (Drechsler et al., 2021; Supera, 2021). Banks have market power in deposit markets, which they exercise by paying deposit rates that are low and insensitive to market rates. This low beta allows banks to invest in

Figure 8
The Fed's and Banks' Holding of MBS and the Federal Funds Rate



Note: This figure plots the Fed's holding of MBS and banks' holding of MBS against the Federal Funds Target Rate monthly from Jan 2019 to Jul 2024. The Fed's MBS holding is sourced from the H.4.1 release table in FRED. The banks' MBS holding is sourced from the H.8 release table in FRED.

assets whose cash flows are also insensitive to interest rates, namely long-term fixed-rate assets, such as MBS, without risking insolvency if interest rates change. Banks also incur substantial operating costs to maintain their deposit market power (for branches, marketing, salaries). These costs are also interest-insensitive. To make sure they have sufficient income to pay them, banks must in fact hold a certain amount of long-term fixed-rate assets like MBS. As a result, when low-beta deposits flow in, banks purchase MBS, and when low-beta deposits flow out, banks sell MBS.

What makes deposits flow in and out? The main driver of deposit flows is the Fed Funds rate, the standard measure of conventional monetary policy. When the Federal Reserve increases the Fed funds rate, banks exercise their market power by keeping deposit rates low. This increases the opportunity cost of holding deposits, the spread between the Fed funds rate (the market rate) and the deposit rate, leading some depositors to reduce their deposit holdings and invest in other, higher-yielding assets. Conversely, when the Fed lowers the Fed funds rate, the deposit spread shrinks, and deposits flow into the banking system. This mechanism is known as the deposits channel of monetary policy (Drechsler et al., 2017).

Figures 9 and 10 show the deposits channel at work over the past four decades. Figure 9 plots the Fed funds rate and the average deposit rate from January 1987 to December 2023. The average deposit rate is below the Fed funds rate and rises less than one-for-one with it. When the Fed funds rate is low, deposit rates are also low and the opportunity cost of holding deposits (the deposit spread) is small. But when the Fed funds rate is high, deposit rates are far below it, and deposits become much more costly to hold. This dynamic also took place during the recent cycle. When the Fed cut rates at the onset of Covid-19, the deposit spread narrowed to zero. When the Fed raised rates in 2022–23, a wide deposit spread opened up. The behavior of deposit rates during the recent cycle is thus fully in line with past cycles.

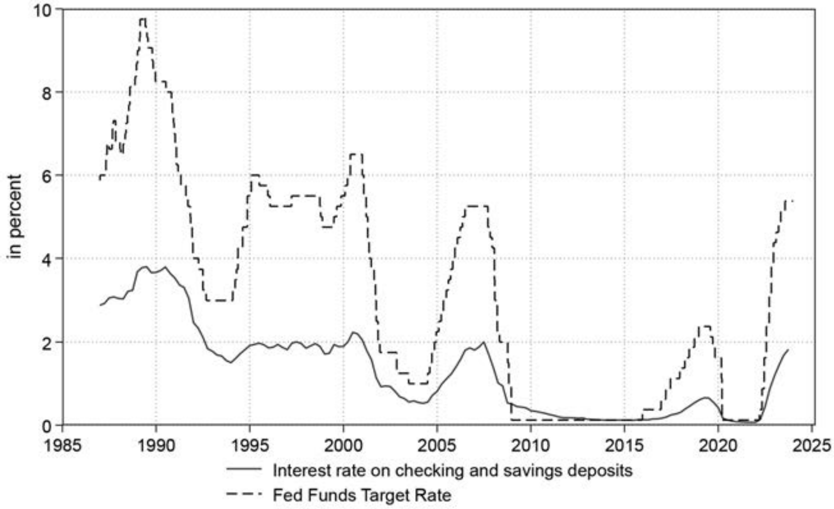
Figure 10 shows the impact of the deposits channel on deposit growth. It plots year-over-year growth in checking and savings deposits (net of reserves) and year-over-year changes in the Fed funds rate from January 1985 to March 2024. The figure shows that deposits flow in when the Fed funds rate falls and the deposit spread shrinks, and deposits flow out when the Fed funds rate rises and the deposit spread expands. As with rates, this pattern takes place during all monetary policy cycles, including the recent one. As the Fed funds rate and deposit spread fell at the start of Covid-19, deposit growth shot up, and as the Fed funds rate and deposit spread rose in 2022–23, deposit growth plummeted.[7]

These patterns show that the deposits channel is a robust mechanism that has played out in past cycles as well as the recent one. It is therefore likely to play a similar role in the future.

3.4.2 Deposit Inflows and Outflows During the Recent Cycle

Figure 11 zooms in on the deposits channel during the recent cycle. It plots total savings and checking deposits net of reserves issued by the U.S. banking sector from January 2019 to March 2024.[8] Savings

Figure 9
The Federal Funds Rate and Deposit Rate



Note: This figure plots the relationship between the Federal Funds Target Rate and interest rate on transaction and savings deposits quarterly from 1987Q1 to 2023Q4. Interest rate on transaction and savings deposits are calculated by adding interest expense on transaction deposits and interest expense on savings deposits then dividing it by the sum of transaction and savings deposits, all from the call reports. The sample includes all commercial banks.

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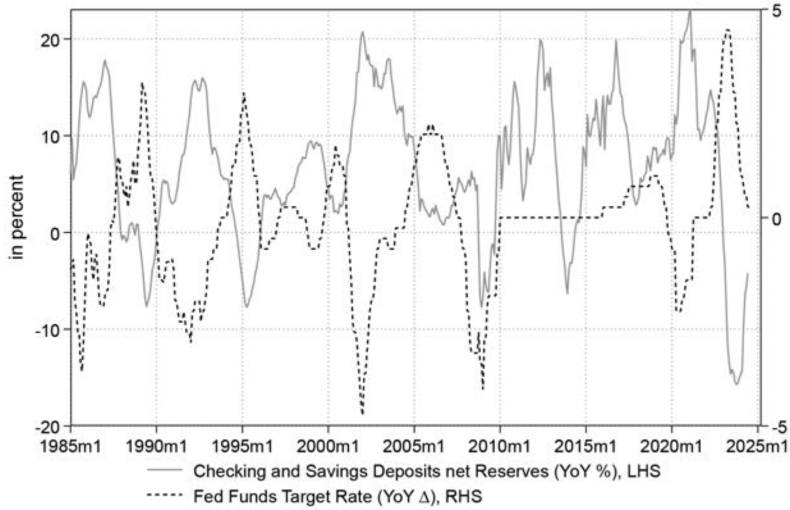
and checking deposits are generally referred to as zero-maturity deposits because they can be withdrawn at will. These deposits are the main sources of funding for U.S. banks, representing 84% of total bank deposits.[9]

The figure shows that zero-maturity deposits (net of reserves) grew by an astounding $4.7 trillion or 45%, from around $10.5 trillion in February 2020 to $15.2 trillion in May 2022. This substantial increase in the size of the U.S. banking sector occurred over a period of less than two years and, since we net out banks' reserve holdings, was over and above any increase due to the expansion of the Federal Reserve's balance sheet.

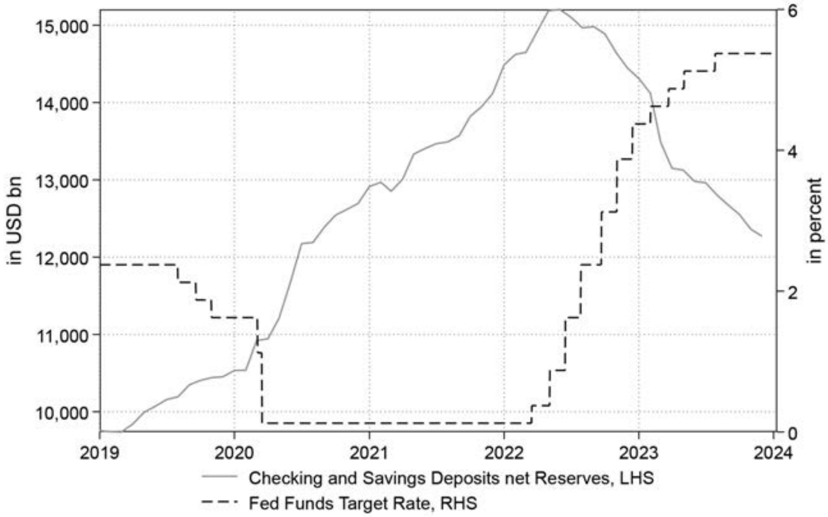
The growth in zero-maturity deposits reversed in the beginning of 2022. From the first quarter of 2022 to the fourth quarter of 2023, deposits declined by $2.9 trillion, from $15.2 trillion to $12.3 trillion. These outflows undid almost 40% of the earlier inflows. Given the importance of deposits for bank funding, the magnitude of this reduction required a large contraction of bank balance sheets.

Figure 10
The Federal Funds Rate and Deposits Change



Note: This figure plots the relationship between the change in the Federal Funds Target Rate and the growth of deposits from Jan 1985 to Jun 2024. Deposits are computed as transaction plus savings deposits minus reserves. Transaction deposits are demand deposits while savings deposits are other liquid deposits, which are the sum of savings deposits and other checkable deposits, both from the H.6 release in FRED. Reserves are reserve balances also from the H.6 release.

Figure 11
Deposits and the Federal Funds Rate



Note: This figure plots the relationship between the Federal Funds Target Rate and bank deposits monthly from Jan 2019 to Dec 2023. Deposits are computed as transaction plus savings deposits minus reserves. Transaction deposits are demand deposits while savings deposits are other liquid deposits, which are the sum of savings deposits and other checkable deposits, both from the H.6 release in FRED. Reserves are reserve balances also from the H.6 release.

3.4.3 Banks Invest Deposits in MBS

Consistent with the prior literature, the large inflows and outflows of low-beta deposits since 2020 can account for the large increase and decrease of banks' MBS holdings. Figure 12 plots the growth in checking and savings deposits (net of reserves) against the growth of banks' MBS holdings from January 2019 to April 2024, both indexed to 100 in the first quarter of 2020. The increase in MBS holdings closely tracks the growth in zero-maturity deposits, with both increasing by about 45% from the first quarter of 2020 to the first quarter of 2022. Both then decline in tandem by around 25% from the first quarter of 2022 to the first quarter of 2024, demonstrating how deposit inflows and outflows lead banks to change their MBS holdings.

3.5 Equilibrium in the MBS Market

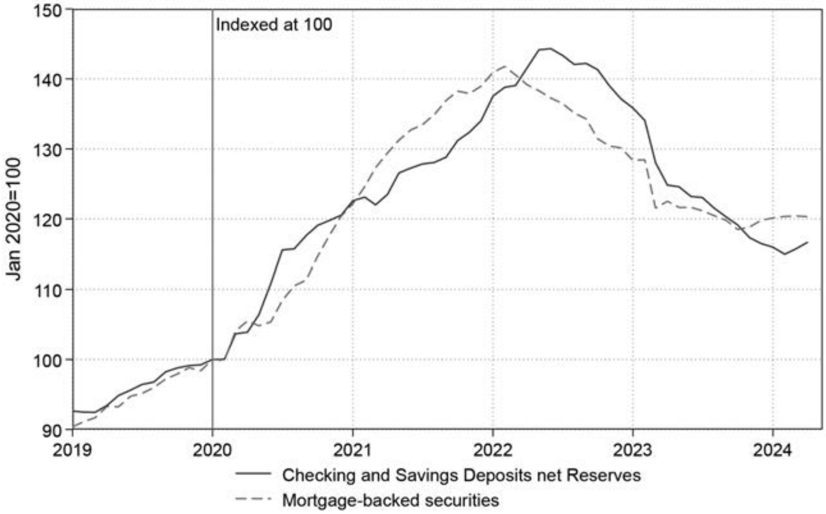
How do the Federal Reserve's and banks' MBS purchases and sales affect the mortgage market? As discussed above, when monetary policy induces the Fed or banks to change their holdings of MBS, they tend to be price-insensitive buyers and sellers. The Federal Reserver purchases and sells MBS based on the broad economic objectives of its QE/QT policy. Banks purchase and sell MBS based on their deposit inflows and outflows. Who takes the other side?

There are two groups: price-sensitive MBS investors who absorb Fed and bank purchases by reducing their own holdings, and mortgage borrowers who do so by taking out additional mortgage debt. We consider them in turn.

3.5.1 The Role of Price-Sensitive MBS Investors

The main groups of MBS investors besides banks and the Fed are pension funds, insurance companies, hedge funds, private wealth (households), and foreign investors. We refer to them collectively as other MBS investors. These investors tend to be price-sensitive, meaning their demand is more elastic with respect to price than that of banks and the Fed. In equilibrium, the price sensitivity of other MBS investors determines the impact of changes in Fed and bank MBS holdings on the price of mortgage credit.

Figure 12
Bank Deposits and MBS Holding

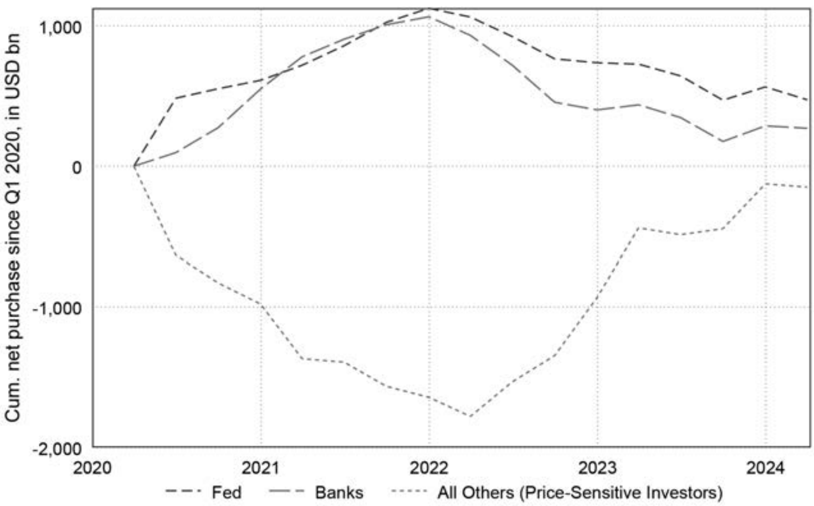


Note: This figure plots the relationship between the growth in bank deposits and the growth in banks' MBS holdings monthly from Jan 2019 to Apr 2024. Bank deposits and banks' MBS holdings are both normalized to 100 as of January 2020. Deposits are computed as transaction plus savings deposits minus reserves. Transaction deposits are demand deposits while savings deposits are other liquid deposits, which are the sum of savings deposits and other checkable deposits, both from the H.6 release in FRED. Reserves are reserve balances also from the H.6 release. MBS holdings are obtained from the H.8 release in FRED.

Figure 13 looks at the MBS purchases and sales of the Fed, banks, and other MBS investors. The figures plots the cumulative purchases for each investor group from January 2020 to March 2024. The Fed and the banking sector purchased \$2.2 trillion from the first quarter of 2020 until the first quarter of 2021. At the same time, other MBS investors sold \$1.4 trillion of MBS. Recall from Figure 2 that the mortgage spread was historically low during this period. Thus, other MBS investors sold when the price of MBS was high, consistent with a high degree of price sensitivity.

The figure shows the same dynamic in reverse during the QT period. Banks and the Fed reduced their MBS holdings by around \$1.2 trillion while other MBS investors increased theirs by \$1.4 trillion. The mortgage spread was high during this period, hence other MBS investors again acted in a price-sensitive manner.

Figure 13
Cumulative Net Purchase of MBS, by Entity



Note: This figure plots the cumulative net purchase of MBS since 2020Q1 for the Fed, banks, and all others, quarterly from 2020Q1 to 2024Q1. Net purchase of MBS is calculated by taking the quarterly change in the outstanding agency and GSE-backed securities held by each entity from the Z.1 release in FRED. Banks comprise of U.S.-chartered depository institutions, banks in U.S.-affiliated areas, and credit unions. We normalize the net purchase of MBS to zero in 2020Q1 to get cumulative net purchase. The data are in market values.

Note, however, that if other MBS investors were perfectly price-sensitive, mortgage spreads would neither have fallen during the QE period nor risen during the QT period.

The fact that they did, and did so substantially, implies that other MBS investors have considerations other than price, such as the increased risk that larger holdings pose to their portfolios. It also implies that bank and Fed MBS purchases have a significant impact on the price of mortgage credit.

3.5.2 The Quantity Response of Mortgage Borrowers

As we saw in Figure 13, when the Fed and banks purchased $2.2 trillion of MBS during 2020–22, other MBS investors sold $1.4 trillion. This implies that the overall size of the MBS market increased by $800 billion. Thus, the reduction in mortgage spreads induced by Fed and bank MBS purchases translated into a large, positive aggregate quantity response. Similarly, the subsequent widening of mortgage spreads induced by Fed and bank MBS sales during 2022–23 induced a large negative quantity response. We saw these quantity responses in Figures 3 and 4. They imply significant economic effects on consumer spending and residential investment.[10]

3.5.3 Putting it All Together

We argue that monetary policy, acting both directly through the Fed and indirectly through the banking sector, played a large role in first expanding and then contracting the supply of mortgage credit since 2020. It did so through two mechanisms: the Fed's QE/QT programs and banks' buying and selling of mortgages driven by the deposits channel of monetary policy. The combination of these two mechanisms explains why mortgage markets played such a central role in monetary policy transmission during the recent cycle.

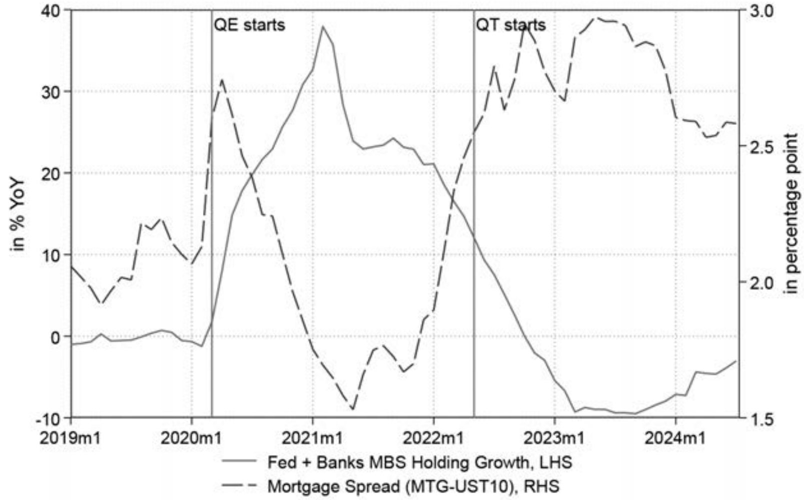
Figure 14 illustrates the key dynamics of this transmission. Panel A plots the year-on-year growth in the combined MBS holdings of the Fed and banks against the mortgage spread from January 2020 to March 2024. The figure shows that when the Fed and banks grew their MBS holdings, the cost of mortgage credit fell and when the Fed and the banks shrank their MBS holdings, the cost of mortgage credit rose.

Panel B plots the same year-on-year growth in the combined Fed and bank MBS holdings against net MBS issuances over the same time period. It shows that when the Fed and banks bought MBS, making mortgage credit cheaper, the net issuance of new MBS rose. Conversely, when the Fed and banks sold off their MBS and the cost of mortgage credit rose, there was a significant reduction in new MBS issuance. This supports the view that banks and the Fed induced large shifts in the supply curve of mortgage credit.

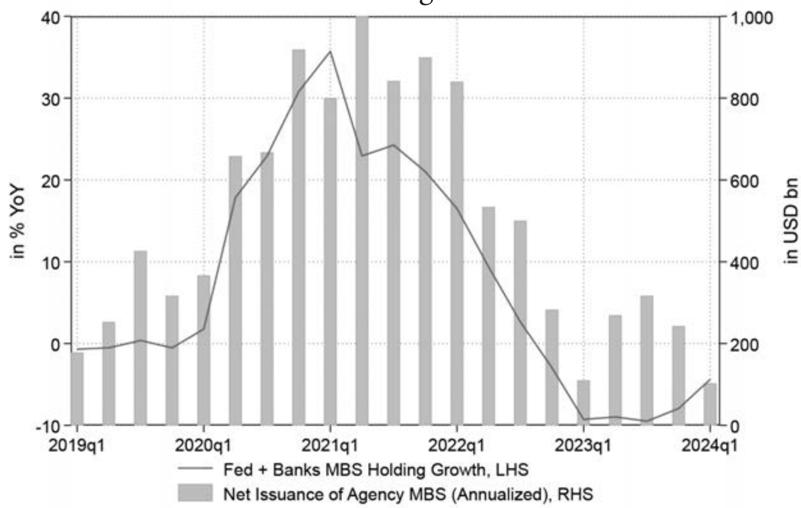
This shift in the supply of mortgage credit contributed to significant fluctuations in the housing market. Moreover, it helps to explain the disproportionate impact that monetary policy had on housing during the recent cycle. Through this impact, monetary policy directly influences the accessibility and affordability of housing and the construction of new housing units.

Figure 14
The Fed and Banks' MBS Holding, Mortgage Spread and MBS Net Issuance

Panel A: MBS Holding and Mortgage Spread



Panel B: MBS Holding and Net Issuance



Note: Panel A plots the relationship between the growth in the Fed and banks' MBS holding and the mortgage spread, monthly from Jan 2019 to May 2024. The Fed's MBS holding is sourced from the H.4.1 release table in FRED. The banks' MBS holding is sourced from the H.8 release table in FRED. We sum them then take the year-over-year percentage growth. The mortgage spread is the spread between the 30-year fixed rate conforming mortgage index and the 10-year U.S. Treasury yield, both from FRED. The values are quarterly average of the daily spread. Panel B plots the relationship between the growth in the Fed and banks' MBS holding and net issuance of agency MBS, quarterly from 2019Q1 to 2024Q1. Net agency MBS issuance is annualized and sourced from the Ginnie Mae Global Markets Analysis Report.

3.5.4 Beyond the Recent Cycle

While the Federal Reserve's involvement in mortgage markets is a relatively recent development, monetary policy has always influenced banks' willingness to supply mortgage credit. Figure 15 shows the relationship between banks' MBS purchases and mortgage spreads over the past three and a half decades. Panel A plots year-on-year deposit growth against year-on-year growth in banks' MBS holdings. The close relationship observed during the recent cycle is also evident in each previous one. Panel B plots the year-on-year growth in MBS holdings against the year-on-year change in the MBS spread over the same period. Here too, we find that the relationship observed recently mirrors the historical one: the mortgage spread declines when banks expand their MBS holdings and the mortgage spread rises when banks reduce their MBS holdings.

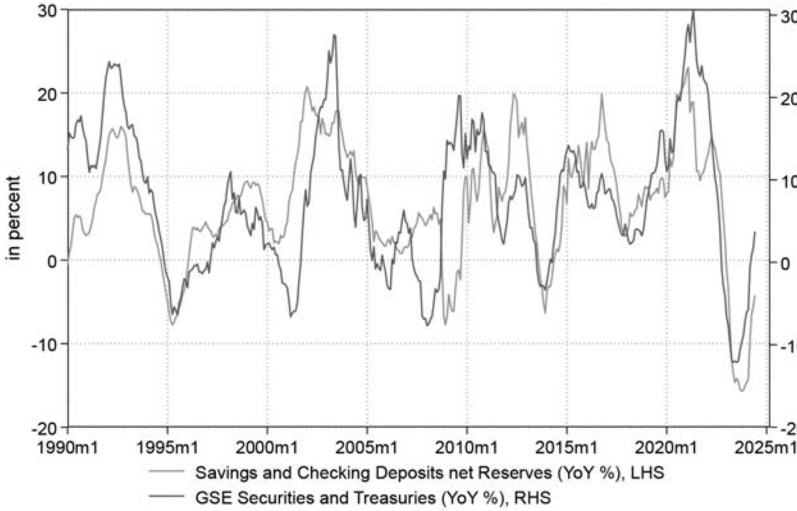
Consequently, the influence of monetary policy on mortgage credit does not require QE. When only conventional monetary policy is in effect (e.g. away from the zero lower bound), it influences mortgage credit through banks and the deposits channel. When the Fed also steps in and conducts its own asset purchases in addition to banks, the two add up and play an outsized role. The robustness of this mechanism over the past decades makes it likely that it will continue to play a central role in the transmission of monetary policy going forward.

3.6 The Regional Banking Crisis of 2023: An Event Study

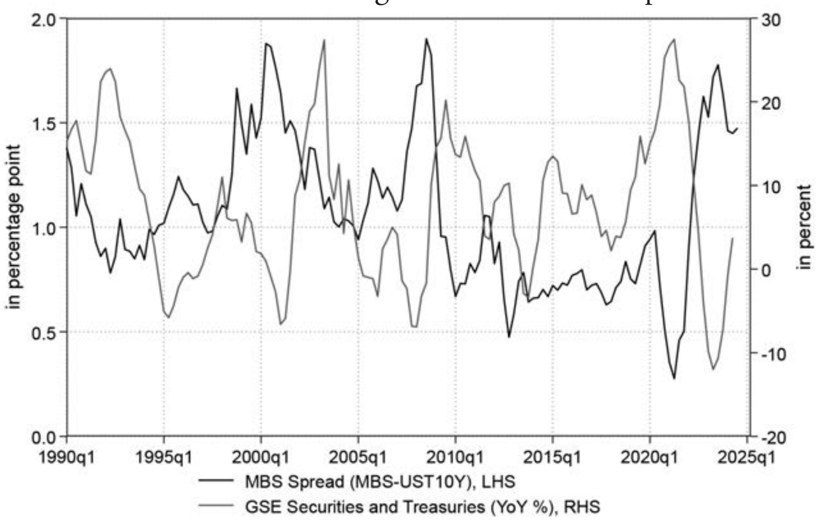
To underscore the importance of banks in the MBS market, we present evidence from an event study examining the regional banking crisis of 2023. We argue that this event serves as a shock to banks' demand for MBS. The crisis raised concerns that banks would face large deposit outflows and an increase in deposit betas. Since banks use low-beta deposits to invest in MBS (Drechsler et al. (2021); Supera (2021); Drechsler et al. (2023)), this translates into lower bank demand for MBS. If banks are important for the MBS market, this should lead to a drop in MBS prices and an increase in mortgage spreads.

Figure 15
Banks' Deposits, MBS Holding and MBS Spread

Panel A: Deposits and MBS Holding Growth



Panel B: MBS Holding Growth and MBS Spread



Note: Panel A plots the relationship between the year-over-year growth rate in bank deposits and banks' holding of MBS and Treasury securities, monthly from Jan 1990 to Jun 2024. Deposits are computed as transaction plus savings deposits minus reserves. MBS and Treasury securities holding by banks is taken from the H.8 release in FRED. Panel B plots the relationship between the MBS spread and the year-over-year growth in banks' holding of MBS and Treasury securities, quarterly from 1990Q1 to 2024Q2. The MBS spread is the spread between the 30-year FNCL Par Coupon index from Bloomberg and the 10-year U.S. Treasury yield from FRED. The values are quarterly average of the daily spread.

We test this prediction using an event study methodology. Specifically, we perform a high-frequency analysis of an MBS exchange-traded fund (ETF) that tracks a broad market index of agency MBS. Figure 16 plots the return of this index in excess of the return of a duration-matched Treasury ETF (jagged line) around the collapse of Silicon Valley Bank (SVB) on March 10, 2023 (vertical line), which triggered the regional banking crisis.[11] The two ETFs move closely together in early 2023, which supports using the duration-matched Treasury ETF as a benchmark.

The MBS and Treasury ETFs diverge significantly in March 2023. On the day SVB failed, the MBS ETF lost around 1 percent in value relative to the Treasury ETF.[12] The gap that opened up between the MBS and Treasury ETFs remained for the next few months after the start of the regional banking crisis. The drop value of the MBS ETF aligns closely with an abrupt outflow of deposits from small banks (black dash line), illustrating the concerns raised by the crisis.

This high-frequency evidence demonstrates how deposits impact the mortgage market, with MBS prices immediately reflecting banks' expected demand for these long-term assets.

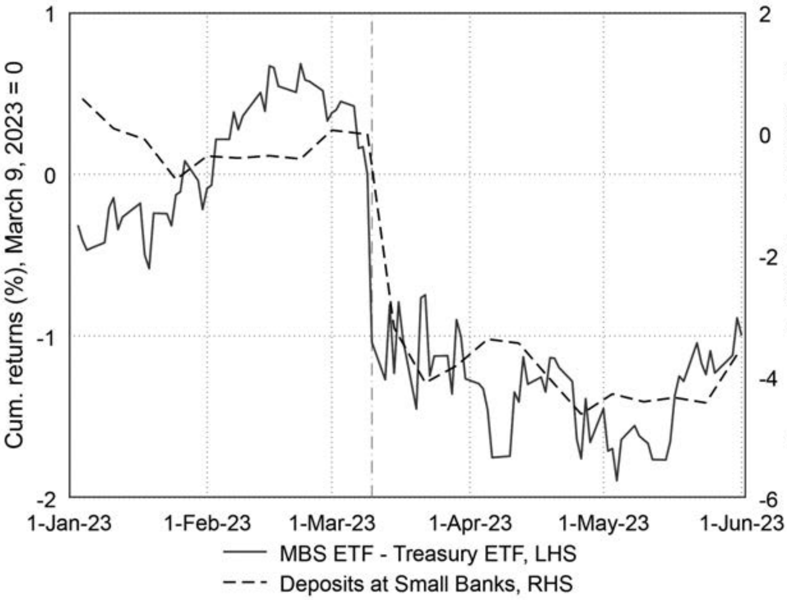
4. Framework

We now provide a stylized framework for quantifying the impact of banks and the Fed on mortgage spreads and originations during 2020–2023.

Time is infinite and discrete, $t \geq 0$. There is an asset, MBS, whose expected rate of return is R_t^{MBS}, which is endogenous. There is also a bond whose rate of return is R_t, which is exogenous. There are three types of agents who hold MBS: the Fed (F), banks (B), and investors (I). There are also mortgage borrowers who supply MBS.

The Fed: The Fed holds MBS in the amount F_t each period, according to its QE program. We take the process F_t as exogenous, but in principle it could be driven by economic conditions such as whether the policy rate is at the zero lower bound, whether the output gap is high or low, and whether inflation is running above or below target. We can control for these factors empirically.

Figure 16
MBS Excess Returns and Deposits Around the Collapse of Silicon Valley Bank



Note: This figures plot MBS excess returns and deposits at small banks, weekly from 1 Jan 2023 to 1 Jun 2023. Excess returns is measured by the difference in cumulative returns between iShares MBS ETF (MBB) and iShares 7–10 Year Treasury Bond ETF (IEF). Deposits at small banks is the cumulative growth in total deposits at small domestically chartered commercial banks from the Federal Reserve's weekly H. 8 report on assets and liabilities of commercial banks in the U.S. Both series are normalized to be 0 on March 9, 2023. Vertical line denotes March 10, 2023, when SVB collapsed.

Banks: Banks are risk averse agents with background risk in the form of a deposit franchise. As in Drechsler et al. (2021), the deposit franchise has negative duration, creating a hedging demand for MBS. Consistent with this theory, there is a strong empirical relationship between deposit growth and bank MBS purchases. We therefore directly assume that banks' demand for MBS depends on deposits D_t:

$$B_t = \alpha^B D_t, \tag{1}$$

where α^B is banks' portfolio share of MBS. By omitting the rate of return on MBS, we are implicitly assuming that banks are price-insensitive, i.e. they care only about hedging. We can test this assumption in the data.

What drives deposits? Following the deposits channel of monetary policy (Drechsler et al., 2017), we assume deposits are a decreasing function of the interest rate: $D_t = D(R_t)$ with $D' < 0$.[13] This means that when interest rates fall banks purchase MBS, and when interest rates rise they sell MBS.

Investors: Investors have mean-variance preferences. They hold a portfolio of MBS and bonds. Their demand for MBS therefore depends on the spread between MBS and bonds:

$$I_t = \alpha^I \left(R_t^{MBS} - R_t \right) + \epsilon_t^I, \tag{2}$$

where α^I is the elasticity of investors' demand for MBS with respect to the MBS spread. This elasticity is given by $\alpha^I = 1/(\gamma^I \sigma^2)$, where γ^I is investors' risk aversion and σ_t^2 is the variance of MBS returns.

Investors' demand for MBS includes a demand shock ϵ_t^I. This could be due to flight to quality effects from other (risky) assets or a general increase in assets under management. The demand shock is generally unobserved, hence it presents an identification challenge when estimating investors' demand elasticity α^I.

Supply: The supply of MBS is decreasing in the MBS rate, capturing mortgage borrowers' demand for mortgages:

$$S_t = -\alpha^S R_t^{MBS} + \epsilon_t^S, \tag{3}$$

where α^S is the elasticity of MBS supply with respect to the mortgage rate and ϵ_t^S is an MBS supply shock. In practice, the outstanding supply of MBS depends partly on the history of past mortgage rates. However, the net supply of new mortgages each period primarily depends on the most recent mortgage rates. This suggests that we should estimate the model in changes.

The MBS supply shock ϵ_t^S plays a similar role as the investor demand shock ϵ_t^I. An important example of an MBS supply shock is the rise in demand for housing during Covid due to widespread work-from-home, which contributed to a surge in mortgage originations. This is among the reasons we estimate the model pre-Covid and use the results to construct counterfactuals during the Covid period.

Market clearing: Total demand for MBS must equal supply:

$$F_t + B_t + I_t \;=\; S_t. \tag{4}$$

Notice that the market clearing condition also holds in changes. We can further scale by lagged supply to obtain stationarity for our empirical specifications:

$$\frac{\Delta F_t}{S_{t-1}} + \frac{\Delta B_t}{S_{t-1}} + \frac{\Delta I_t}{S_{t-1}} \;=\; \frac{\Delta S_t}{S_{t-1}}. \tag{5}$$

We refer to these as scaled dollar changes in MBS holdings and supply.

The MBS spread: The market clearing condition pins down the mortgage spread. Substituting for the demand of each type of investor and total supply, the MBS spread is given by

$$R_t^{MBS} - R_t \;=\; -\frac{1}{\alpha^I + \alpha^S}\left(F_t + \alpha^B D_t\right) - \frac{\alpha^S}{\alpha^I + \alpha^S} R_t - \frac{1}{\alpha^I + \alpha^S}\left(\epsilon^I - \epsilon^S\right). \tag{6}$$

the MBS spread shrinks when the Fed or banks increase their MBS holdings, in the case of banks because they have more deposits. The spread depends on the combined holdings of the Fed and banks, i.e. a dollar purchased by the Fed has the same impact on the cost of mortgage credit as a dollar purchased by banks.

The MBS spread also shrinks when interest rates rise because demand for mortgages falls. From this perspective, the recent widening of MBS spreads during a period of high interest rates is puzzling without accounting for the behavior of the Fed and banks.

Finally, the MBS spread depends on the net demand shock for MBS, $\epsilon^I - \epsilon^S$.

Identification: We are interested in estimating the impact of Fed and bank MBS purchases on mortgage spreads and mortgage originations. This requires identifying the elasticity parameters α^I and α^S. We cannot estimate α^I directly by regressing investor holdings I_t on the spread $R_t^{MBS} - R_t$ because the spread depends partly on the demand shock ϵ^I, which enters I_t as an omitted variable. In words, if investors demand more MBS, then their holdings will rise while the MBS spread falls. This will make them look inelastic even if they are not. Formally, running this regression would lead to a biased estimate of α^I toward zero:

$$\widehat{\alpha}^I_{OLS} = \frac{Cov\left(I_t, R_t^{MBS} - R_t\right)}{Var\left(R_t^{MBS} - R_t\right)} = \alpha^I - \frac{1}{\alpha^I + \alpha^S}\frac{Var\left(\epsilon^I\right)}{Var\left(R_t^{MBS} - R_t\right)} < \alpha^I. \tag{7}$$

The same argument holds for regressing the supply of MBS, S_t, directly on the MBS rate R_t^{MBS}. If the MBS rate rises because homebuyers demand more mortgages, then the supply of MBS will not fall, making homebuyers appear inelastic even if they are not. In this case the supply shock ϵ^S would act as an omitted variable, also biasing α^S toward zero.

We therefore need an instrument for the MBS spread that is plausibly uncorrelated with ϵ^I and ϵ^S. A valid instrument within the model are Fed purchases F_t. Using Fed purchases as an instrument recovers an unbiased estimate of α^I:

$$\widehat{\alpha}^I_{IV} = \frac{Cov\left(I_t, F_t\right)}{Cov\left(R_t^{MBS} - R_t, F_t\right)} = \frac{-\frac{\alpha^I}{\alpha^I+\alpha^S}}{-\frac{1}{\alpha^I+\alpha^S}} = \alpha^I. \tag{8}$$

In practice, the Fed is a price-insensitive buyer driven by macroeconomic conditions. Fed purchases are a valid instrument under the assumption that the macroeconomic conditions the Fed cares about, such as the output gap and inflation, are uncorrelated with the demand and supply shocks for MBS. To the extent they are correlated, we can control for them directly and see if our results change.

A deeper concern would be if the Fed cares about the mortgage market over and above the broad state of the economy. For instance, it could be that the Fed specifically targets mortgage spreads in order to stimulate housing. Notice that in that case we would observe a positive correlation between Fed purchases and mortgage spreads, i.e. our results would "go the other way."

Lastly, we can use survey data on expected Fed purchases from the Survey of Primary Dealers. This is helpful to the extent private forecasters have a better sense of the endogenous — and hence predictable — component of Fed purchases than we do as econometricians. As with the other controls, we can gauge the plausibility of our identification assumption by checking whether the results are sensitive to controlling for expected Fed purchases.

Identifying α^S: There is an additional challenge in identifying the supply elasticity α^S. Notice that MBS supply equation (3) depends on the level of mortgage rates, R_t^{MBS}, not the spread. This makes sense because mortgage borrowers pay the full mortgage rate, not just the spread. Yet instrumenting for the level of interest rates is much more challenging than a spread because the level of interest rates equilibrates saving and investment for the whole economy, not just the MBS market. Moreover, the Fed engages in QE precisely when it wishes to reduce the equilibrium level of interest rates and is unable to do so through conventional policy due to a binding zero lower bound.

We address this challenge as follows. First, we run the (potentially biased) OLS regression of mortgage originations on the mortgage rate pre-Covid. This removes the large mortgage demand shock associated with the rise of work-from-home. We also extend the sample back to 1990 to see if the elasticity estimates are stable. This is helpful if other mortgage demand shocks are clustered during specific periods, e.g. the early 2000s housing boom.[14]

We also use our framework to go a step further. Under the assumption that Fed MBS purchases are a valid instrument for the MBS spread, the first-stage coefficient recovers a combination of α^I and α^S:

$$\widehat{\beta}^{First\ Stage} = \frac{Cov\left(R_t^{MBS} - R_t, F_t\right)}{Var\left(F_t\right)} = -\frac{1}{\alpha^I + \alpha^S}. \tag{9}$$

Given our IV estimate of α^I, $\hat{\alpha}^I_{IV}$, we can use this relationship to back out an implied IV estimate of α^S:

$$\widehat{\alpha}^S_{IV,Implied} = -\frac{1}{\widehat{\beta}^{First\ Stage}} - \widehat{\alpha}^I_{IV}. \tag{10}$$

The implied IV estimate identifies α^S under the additional assumption that the model is well-specified. For instance, a key model assumption is that banks are rate-insensitive. If they are not, then the first-stage coefficient would pick that up. Thus, while $\hat{\alpha}^S_{IV,\ Implied}$ has the advantage of correcting for OLS bias, it is potentially sensitive to model misspecification. For this reason, we rely on both our OLS (biased but model-free) and implied IV (unbiased but model-specific) estimates of α^S.

5. Data Sources

We use a variety of price and quantity data to estimate our framework. Unless otherwise noted, all data was downloaded from the Federal Reserve Bank of St. Louis' FRED database, starting in 1990.

MBS holdings: Our main data source is the Financial Account of the U.S., also known as the "flow of funds" or the Z.1 release. We use Table L.211, "Agency- and GSE-Backed Securities" at the quarterly frequency to measure the holdings of Agency MBS of different types of investors. Total MBS holdings are line 5, "Total Assets". Fed holdings (F_t) are line 10, "Monetary Authority". For banks (B_t), we take the sum of lines 11 ("U.S.-chartered depository institutions"), 13 ("Banks in U.S.-affiliated areas"), and 14 ("Credit unions"). We define investor holdings (I_t) as total holdings minus Fed holdings and bank holdings. In some tests we split investors into households ("Household sector," line 6), asset managers (the sum of "Property-Casualty Insurance Companies," "Life Insurance Companies," "Private Pension Funds," "Federal Government Retirement Funds," "State and Local Government Employee Defined Benefit Retirement Funds," "Money Market Funds," and "Mutual Funds;" lines 16–21), rest of the world (the sum of "Rest of the World," line 27, and "Foreign banking offices in U.S.," line 12), and others (all remaining categories). We use Table L.210, "Treasury Securities," to obtain the Fed's Treasury holdings from line 21, "Monetary Authority".

Deposits: For bank deposits (D_t), we use the Fed's H.6 release, "Money Stock Measures". We focus on checking and savings deposits because they are the low-beta deposits banks invest in MBS. For checking deposits, we use "Demand Deposits [DEMDEPSL]" (FRED code in brackets). For savings deposits, there is a discontinuity in the reporting in May 2020. Prior to this date, we use "Savings Deposits: Total [SAVINGSL]" plus "Other Checkable Deposits: Total [OCDSL]" (also known as transaction savings deposits). After May 2020, we use "Other Liquid Deposits [MDLM]". We subtract reserves from deposits to avoid double-counting QE (see Acharya and Rajan, 2022). We measure reserves using table L.109, "Monetary Authority" of the flow of funds, specifically line 24, "Depository Institution Reserves [MADIRL]". We then subtract the reserves of foreign banks, which we obtain from Table L.112 "Foreign Banking Offices in U.S.," line 3, "Reserves at Federal Reserve [FBOUSDIRA]." This ensures consistency across our asset holdings and deposits series.

Rates: For the mortgage rate, we use the "30-Year Fixed Rate Mortgage Average in the United States [MORTGAGE30US]" from Freddie Mac's Primary Mortgage Market Survey, which is reported weekly. For the mortgage spread, we subtract the weekly yield on the 10-year Treasury note, "Market Yield on U.S. Treasury Securities at 10-Year Constant Maturity, Quoted on an Investment Basis [WGS10YR]." We also download the (monthly) Fed funds rate, "Federal Funds Effective Rate [FEDFUNDS]," and the (daily) lower limit of the Fed's target range for the Fed funds rate, "Federal Funds Target Range — Lower Limit [DFEDTARL]". We aggregate all of these rates up to the quarterly frequency by taking their end-of-quarter values.

Macro variables: We construct a zero-lower bound (ZLB) indicator variable equal to one when the lower limit of the Fed's target range for the Fed funds rate is zero, and zero otherwise. We construct the output gap as "Real Gross Domestic Product [GDPC1]" minus "Real Potential Gross Domestic Product [GDPPOT]" divided by "Real Potential Gross Domestic Product [GDPPOT]" and multiplied by one hundred (the underlying source are the National Income and Product Accounts of the U.S.). We construct the inflation gap as the year-over-year percentage change in "Personal Consumption Expenditures: Chain-type Price Index Less Food and Energy (JCXFE)," less 2%.

Mortgage originations: We obtain mortgage originations from the Mortgage Bankers Association. We use "Mortgage Originations: 1–4 Family: Total (Bil.$)" at a quarterly frequency. We multiply originations by 4 to convert to annual rates. This data includes all mortgages, not just MBS. The implicit assumption is that mortgage borrowers have the same interest rate sensitivity whether their mortgage gets securitized or not. The data also includes refinance originations, which tend to be more interest rate-sensitive than purchase loans.[15]

We scale mortgage originations by total mortgages, which we obtain from the flow of funds, Table L.218 “Home Mortgages,” line 5, “One-to-Four-Family Residential Mortgages; Asset, Level [ASHMA].” Using this series ensures consistency with the originations data.

Expected Fed purchases: We construct series for the expected Fed MBS and Treasury purchases one quarter ahead using data from the Survey of Primary Dealers (SPD) conducted by the Federal Reserve Bank of New York (NY Fed). The data is available for the period 2011–2018. The surveys are filled out by primary dealer firms about a week before each Federal Open Market Committee (FOMC) meeting. Results from the survey for January 2011 and onward are provided on the NY Fed’s website. The questionnaires from January 2011 until January 2015 and from March 2020 onward contain questions about the expected future size of either the Fed’s balance sheet or its asset purchases. We use expected changes in the size of the balance sheet to measure purchases when not directly available. Starting in August 2011, the SPD provides a breakdown between MBS and Treasury securities. For periods prior, we apply the breakdown from the Fed’s actual purchases in the last period before the current one. We obtain actual purchases from the NY Fed’s SOMA holdings dataset. Additional details on the construction of our expected Fed purchases measure are provided in Appendix A. Our approach is similar to Kim et al. (2020), except we focus on MBS purchases (versus total) at the quarterly frequency (versus annual).

Summary statistics: Table 1 presents summary statistics for all variables used in the analysis. We report means and standard deviations separately for the longer sample, 1990–2019, and the shorter recent sample, 2010–2019.

6. Estimation and Results

We estimate our model pre-Covid and use the results to conduct counterfactuals during the Covid period. We use two main estimation samples, 1990–2019, and 2010–2019. The longer sample gives greater statistical power, while the shorter one is more current and allows us to use Fed MBS purchases as an instrument. The extent to which the two samples yield similar results establishes robustness of our estimates.

We estimate the model in scaled dollar changes, as shown in equation (5). We take these changes over four quarters to remove seasonality and allow for gradual adjustment of portfolios. For instance, for Fed MBS purchases, we calculate

$$\Delta \text{Fed MBS}_t = \frac{\text{Fed MBS}_t - \text{Fed MBS}_{t-1}}{\text{Total MBS}_{t-1}}, \tag{11}$$

where $t-1$ is one year (four quarters) prior to t. We do the same for banks and investors. We similarly take price and macro variables in changes over four quarters. For example, for the change in the mortgage spread we take

$$\Delta \text{Mortgage spread}_t = \left(R_t^{MTG} - R_t^{10Y}\right) - \left(R_{t-1}^{MTG} - R_{t-1}^{10Y}\right), \tag{12}$$

where R^{MTG} is the mortgage rate, R^{10Y} is the ten-year Treasury rate, and $t-1$ is again one year (four quarters) prior to t.

6.1 Fed MBS Purchases and the Mortgage Spread

We begin by testing whether Fed MBS purchases are associated with a decline in the mortgage spread as predicted by equation (6) in our framework. This test also serves as the first stage for our instrumental variables regressions. We run

$$\Delta \text{Mortgage spread}_t = \gamma + \beta^{First\ Stage} \times \Delta \text{Fed MBS}_t + X_t + \varepsilon_t^{First\ Stage}, \tag{13}$$

where Fed MBS are Fed MBS purchases and X_t are the following control variables: Fed Treasury purchases (Δ Fed Treasury), a zero-lower bound indicator variable (ZLB), and the changes in the Fed funds rate (Δ Fed funds), output gap (Δ GDP gap), and inflation gap (Δ Inflation gap). As a final control, we use the expected Fed purchases of MBS relative to Treasuries (Δ Expected Fed Net MBS). The sample is from 2010 to 2019 (there are no Fed purchases prior to 2008 hence we cannot use the longer sample for this test). Throughout the paper, we use Newey-West standard errors with three lags to account for the overlap in the data induced by taking year-over-year first differences.

Table 1
Summary Statistics

	2010-2019		1990-2019	
	Mean	St. Dev.	Mean	St. Dev.
Holding of MBS				
Δ Banks MBS	0.013	0.009	0.014	0.012
Δ Fed MBS	0.011	0.033	0.006	0.025
Δ Asset managers MBS	0.001	0.016	0.020	0.026
Δ Rest of world MBS	−0.001	0.010	0.010	0.018
Δ Others MBS	−0.011	0.025	0.015	0.035
Δ Investors MBS	−0.008	0.056	0.053	0.073
Bank's balance sheet				
Δ Deposits	0.072	0.025	0.055	0.042
The Fed's balance sheet				
Δ Fed Treasury	0.022	0.035	0.013	0.024
Expected Δ Fed Net MBS	0.002	0.010		
Mortgage originations				
Δ Mortgage originations	0.002	0.051	0.018	0.112
Rates or spreads (×100)				
Δ Mortgage rate	−0.132	0.597	−0.217	0.758
Δ Mortgage spread	0.001	0.252	−0.005	0.316
Δ Fed funds rate	0.193	0.358	−0.237	1.386
Other variables				
Δ GDP gap	0.544	0.633	−0.000	1.427
Δ Inflation gap	0.072	0.405	−0.084	0.441
ZLB	0.575	0.501	0.225	0.419
Observations	40		120	

Note: This table presents summary statistics at the quarterly level. Deposits are the sum of checking and savings deposits minus reserves. Holdings of MBS are holdings of agency and GSE-backed securities by different investor categories, where Others are all remaining after the first four categories and Investors are all aside from Banks and the Fed. Fed Treasury is the Fed's holding of Treasury securities. Expected Fed Net MBS is the expected Fed purchase of MBS minus the expected purchase of Treasury securities. GDP gap is real GDP minus real potential GDP divided by real potential GDP, multiplied by one hundred. Inflation gap is the year-over-year percentage change in the PCE price index, excluding food and energy, minus 2%. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. All variables aside from ZLB are in changes. For mortgage originations, we take the year-over-year change divided by total mortgages. For rates or spreads, as well as GDP gap and inflation gap, we take the simple difference from one year prior. For deposits, holdings of MBS, and Fed Treasury, we take the change from one year prior then divide by total MBS from one year prior. For expected Fed Net MBS, we take the four quarters trailing sum then divide by total MBS from one year prior.

The identifying assumption in equation (13) is that Fed MBS purchases are uncorrelated with unobserved shocks to the mortgage spread contained in $\epsilon_t^{First\ Stage}$. A plausible counter-example would be if the Fed steps in to shrink spreads when they widen during a crisis. We exclude crises (both 2008–2009 and Covid) from our sample, but also note that this type of endogeneity would produce the opposite sign from our theory ($\beta^{First\ Stage} > 0$ instead of $\beta^{First\ Stage} < 0$), hence we can test for it.

The results of regression equation (13) are reported in Table 2. Column (1) runs a univariate specification with no controls. The coefficient on Fed MBS purchases, –4.233, is negative and strongly significant. Figure 17 shows a scatter plot of the relationship. There is a clear negative pattern. There is a potential outlier in 2010q1, but removing it has only a modest impact on the coefficient.

The economic magnitude of the coefficient is substantial: if the Fed purchases 10% of the MBS market, the mortgage spread is predicted to decline by 42 bps. The MBS market stood at \$10 trillion at the start of Covid, hence this would be a \$1 trillion purchase, similar to the Fed's actual purchases during 2020–2021.

Column (2) controls for the Fed's Treasury purchases. The reason for this control is that if the Fed purchased equal amounts of MBS and Treasuries, we would not necessarily expect the mortgage spread to shrink. Controlling for the Fed's Treasury purchases ensures this is not the case. Interestingly, the coefficient on Treasury purchases is positive and marginally significant. This is consistent with partial segmentation between Treasury and MBS markets. For our purposes, the important finding is that the coefficient on MBS purchases does not change and in fact slightly increases.

Column (3) controls for whether the zero-lower bound (ZLB) binds. The Fed undertook QE at least in part to overcome the ZLB constraint on conventional monetary policy. It is plausible that mortgage spreads tend to be low when rates are at the ZLB, for instance due to lower prepayment risk. In this case we would observe a spurious negative relationship between Fed MBS purchases and mortgage spreads, at least in levels (though not necessarily in changes). Contrary to this interpretation, we find that the coefficient on Fed MBS purchases gets even larger when we control for the ZLB.

Column (3) also controls for changes in the Fed funds rate. If the Fed follows a Taylor rule (away from the ZLB), then changes in the Fed funds rate provide a a sufficient statistic for changes in the macroeconomic conditions that the Fed cares about. Controlling for changes in the Fed funds rate therefore controls for these macroeconomic

Table 2
Fed MBS Purchases and the Mortgage Spread

	Δ Mortgage Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Fed MBS	−4.233***	−4.430***	−5.294***	−4.385***	−5.632***	−4.519**
	(0.985)	(0.899)	(1.039)	(1.317)	(1.287)	(2.125)
Δ Fed Treasury		1.635*				1.319
		(0.864)				(2.457)
ZLB			0.041		0.039	
			(0.085)		(0.076)	
Δ Fed funds rate			−0.218**		−0.246***	
			(0.087)		(0.080)	
Δ GDP gap				0.008	0.015	
				(0.054)	(0.041)	
Δ Inflation gap				0.072	0.115	
				(0.104)	(0.075)	
Expected Δ Fed Net MBS						−7.170
						(4.443)
Constant	0.047	0.014	0.077	0.040	0.071	0.043
	(0.041)	(0.037)	(0.059)	(0.045)	(0.062)	(0.059)
Obs.	40	40	40	40	40	28
R2	0.310	0.362	0.426	0.324	0.459	0.218

Note: This table presents results from first stage regressions of mortgage spread on the Fed's MBS holding:

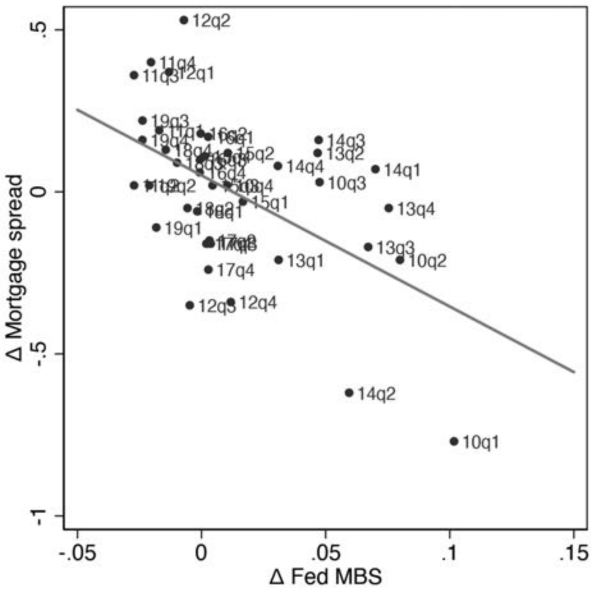
$$\Delta\text{Mortgage spread}_t \quad = \quad \gamma + \beta^{First\ Stage} \times \Delta\text{Fed MBS}_t + X_t + \varepsilon_t^{First\ Stage}.$$

Δ Fed MBS and Δ Fed Treasury are the year-over-year changes in the Fed's MBS and Treasury holding, respectively, scaled by total MBS. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. For expected Δ Fed Net MBS, we take the four quarters trailing sum of expected Fed purchase of MBS net of expected Fed purchase of Treasury securities, then divide by total MBS from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data from 2010 to 2019.

conditions, ensuring that they are not driving the result. The fact that the coefficient is unaffected supports this prediction.

Columns (4) controls for macroeconomic conditions explicitly with the output gap and inflation gap. These have no explanatory power for mortgage spreads and do not significantly affect the coefficient on Fed MBS purchases. Column (5) includes all of the controls so far. The coefficient rises to −6.304, i.e. controlling for economic conditions actually strengthens the impact of Fed purchases on the mortgage spread. This makes sense under the view that the Fed undertakes QE when economic conditions weaken and the mortgage spread widens. This type of endogeneity biases us toward a finding positive coefficient. Controlling for economic conditions has the effect of reducing this bias, recovering an even more negative

Figure 17
Fed MBS Purchases and Mortgage Spreads



Note: This figure plots the relationship between the year-over-year change in the Fed's MBS holding scaled by total MBS (Δ Fed MBS) and the year-over-year change in mortgage spread (Δ Mortgage spread). The diagonal line represents a simple linear fit of the data points. The data points are quarterly from 2010 to 2019.

coefficient. In terms of magnitude, we find that a $1 trillion Fed MBS purchase reduces mortgage spreads by 63 bps.

The final Column (6) controls for the Fed's expected net MBS purchases (MBS purchases minus Treasury purchases). These are available only over 2011–2018, which shrinks the sample. We use net as opposed to gross expected MBS purchases because net purchases turn out to be a stronger predictor of the mortgage spread: they have the correct sign and higher R^2 (22% versus 9%). Given this specification, we also control for the Fed's actual Treasury purchases as in Column (2). Controlling for expected purchases is yet another way of accounting for the potential impact of economic conditions on the Fed's MBS purchases. Economic conditions are largely publicly observed and hence accounted for in primary dealers' forecasts. Since we use expected purchases one quarter ahead, the only economic shocks we could be missing must occur within the quarter, i.e. QE would need to react to them contemporaneously.

Column (6) shows that Fed MBS purchases remain a robust predictor of mortgage spreads after controlling for expected Fed purchases. This supports the empirical strategy of using Fed MBS purchases as an instrument to identify the rate sensitivities of other investors.

6.2 Bank MBS Holdings and Deposits

In our framework (see equation (6)), $\hat{\beta}^{First\ Stage}$ identifies the inverse of the combined elasticities of investors and mortgage borrowers, $1/(\alpha^I + \alpha^S)$. However, this only holds given our assumption that bank purchases $B_t = \alpha D_t$ are rate-insensitive (they depend on deposits).

If banks respond to Fed purchases by selling, then $\hat{\beta}^{First\ Stage}$ would give a downward-biased estimate of $1/(\alpha^I + \alpha^S)$ and hence an upward-biased estimate of $\alpha^I + \alpha^S$. Intuitively, if banks absorb the Fed's buying, then mortgage spreads would not rise much, and this would make investors and mortgage borrowers appear more elastic than they really are (since they are the only rate-sensitive agents in the model). It is therefore important to test if banks are indeed rate-insensitive as our framework assumes.

We do so by running a regression of changes in bank MBS holdings on mortgage spreads with and without controlling for deposits. We run OLS regressions over our longer sample from 1990–2019 and IV regressions using Fed purchases as an instrument over 2010–2019. The IV regression has the form:

$$\Delta \text{Banks MBS}_t \quad = \quad \gamma + \beta_B^{IV} \times \Delta \widehat{\text{Mortgage spread}}_t + \delta \times \Delta \text{Deposits}_t + X_t + \varepsilon_t^B, \quad (14)$$

where ΔBanks MBS is the year-over-year change in bank MBS holdings scaled by total MBS, ΔMortgage spread is the change in the mortgage spread instrumented with Fed MBS purchases as in Table 2, X are controls that include the ZLB indicator and changes in the Fed funds rate, output gap, and inflation gap, and ΔDeposits is the year-over-year change in checking and savings deposits net of reserves, also scaled by total MBS.[16] The common scaling on the left and right side of the regression allows us to interpret the coefficients as dollar amounts.

Table 3 presents the results. Column (1) runs a univariate OLS regression of bank MBS holdings on mortgage spreads over 1990–2019. The coefficient on the mortgage spread is –0.004 and less than a standard error from zero. This supports the view that banks do not respond to changes in mortgage spreads, i.e., they are rate-insensitive.

It is plausible that the OLS coefficient in Column (1) is downward biased. If banks experience an unobserved positive demand shock for MBS, then they will increase their MBS holdings while mortgage spreads shrink. This will push down the OLS coefficient even if banks are rate-sensitive. The solution is to use an instrument. Section 6.1 showed that Fed MBS purchases have a robust negative impact on mortgage spreads, one that holds conditional on economic conditions and dealer expectations. This provides support for the exclusion restriction needed to make it a valid instrument: that Fed MBS purchases are unrelated to unobserved shocks to MBS demand and supply. We therefore use Fed MBS purchases as an instrument for the mortgage spread.

Column (2) replaces the mortgage spread with the instrumented mortgage spread. The coefficient rises slightly to 0.021 but remains less than a standard error from zero. The slight increase, though not significant, is consistent with the hypothesis that the OLS estimate is downward biased. However, even after correcting for this bias we find no evidence that banks' demand for MBS responds to mortgage spreads, i.e. that banks are rate-sensitive.

If not mortgage spreads, what do banks respond to? Column (3) replaces the mortgage spread with deposit growth. Here we see a large positive and significant coefficient of 0.123. This means that since 1990 banks invested $12.3 dollars per $100 of deposits in MBS. This is close to banks' average MBS portfolio share over this period. The R^2 from the regression is 18.7%, suggesting that deposits have significant explanatory power.

Figure 18, Panel A, provides a scatter plot of the relationship between bank deposits and MBS holdings for 1990–2019. There is a clear positive slope. The only potential outliers are during the financial crisis in 2007–2008 but removing them actually improves

Table 3
Bank MBS Demand

	Bank MBS / Total							
	(1) 1990–19	(2) 2010–19	(3) 1990–19	(4) 2010–19	(5) 1990–19	(6) 2010–19	(7) 1990–19	(8) 2010–19
Δ Mortgage spread	–0.004				–0.004		–0.004	
	(0.006)				(0.005)		(0.005)	
Δ Mortgage spread		0.021				0.009		0.009
		(0.022)				(0.020)		(0.015)
Δ Deposits			0.123***	0.211***	0.124***	0.175**	0.141***	0.185***
			(0.037)	(0.046)	(0.037)	(0.081)	(0.047)	(0.066)
ZLB							–0.003	–0.003
							(0.003)	(0.004)
Δ Fed funds rate							0.001	–0.002
							(0.001)	(0.005)
Δ GDP gap							–0.001	0.003
							(0.001)	(0.002)
Δ Inflation gap							–0.003	0.002
							(0.003)	(0.005)
Constant	0.014***	0.013***	0.007**	–0.002	0.007***	0.000	0.007**	–0.000
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.006)	(0.003)	(0.006)
Obs.	120	40	120	40	120	40	120	40
R^2	0.010	0.124	0.187	0.389	0.198	0.404	0.231	0.474

Note: This table presents results from regressions of banks' MBS holding on the mortgage spread, including the instrumental variable regression:

$$\Delta\text{Banks MBS}_t = \gamma + \beta_B^{IV} \times \Delta\widehat{\text{Mortgage spread}}_t + \delta \times \Delta\text{Deposits}_t + X_t + \varepsilon_t^B.$$

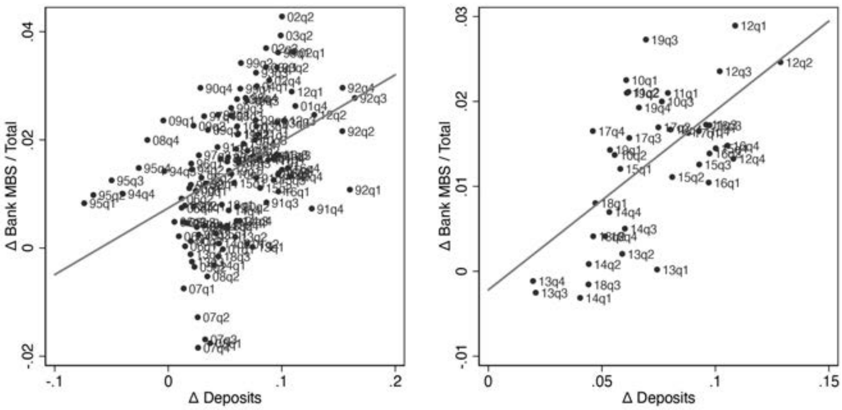
Δ Banks MBS is the year-over-year change in banks' MBS holding scaled by total MBS.
Δ Mortgage spread is the actual change in mortgage spread from a year ago, while $\Delta\,\widehat{\text{Mortgage spread}}$ is the predicted change in mortgage spread from the first-stage regression. Δ Deposits is the change in the sum of checking and savings deposits net of reserves, also scaled by total MBS. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data either from 1990 to 2019 or from 2010 to 2019.

the fit. Panel B shows the same relationship for 2010–2019. The slope is again strongly positive. The coefficient estimate is shown in Column (4) of Table 3: 0.211, higher than the one for 1990–2019. This makes sense because the average share of MBS on bank balance sheets has steadily increased. The fit also increases significantly as the R^2 doubles to 38.9%. Thus, bank deposits and MBS holdings have become even more tightly linked.

Column (5) of Table 3 runs a horse race between mortgage spreads and deposit growth in the 1990–2019 sample using OLS. Both variables retain their coefficients: mortgage spreads continue to have no explanatory power while deposit growth has high explanatory power. Column (6) shows the IV version of the same regression during

Figure 18
Bank MBS Purchases and Deposits

Panel A: 1990–2019 Panel B: 2010–2019



Note: This figure plots the relationship between the year-over-year change in the sum of checking and savings deposits net of reserves, scaled by total MBS (Δ Deposits), and the year-over-year change in banks' MBS holding scaled by total MBS (Δ Banks MBS / Total). The diagonal lines represent a simple linear fit of the data points. The data points are quarterly from 1990 to 2019 (Panel A) and from 2010 to 2019 (Panel B).

2010–2019. The result is the same: bank MBS holdings are insensitive to mortgage spreads but highly sensitive to deposits.

Column (7) runs the OLS regression from Column (5) with additional controls for economic conditions (the ZLB, Fed funds rate, output and inflation gap). There is no change in the coefficients. Finally, Column (8) adds the same controls to the IV regression in Column (6). There is again no noticeable change.

These results support the assumption of our model that banks are rate-insensitive investors. Their MBS holdings are instead driven by deposit growth. This implies that the first-stage coefficient, $\hat{\beta}^{First\ Stage}$, gives an unbiased estimate of $\alpha^I + \alpha^S$, which we can use to validate our direct estimation of these quantities.

It also implies that the large inflows of deposits during 2020–2021 can account for banks' expanded MBS holdings. Deposits (net of reserves) increased from \$9,846 billion in 2019q4 to \$14,557 billion in 2022q2, an increase of \$4,711 billion. Based on the coefficient for the recent sample in Column (4), the predicted increase in MBS holdings is 0.211 × 4711 = \$994 billion. This is extremely close to the actual purchases of \$1 trillion documented in Section 3.3.3.

6.3 Investor MBS Holdings

Our framework shows that the impact of Fed and bank MBS purchases on mortgage spreads and mortgage originations depends on the rate-sensitivity (demand elasticity) of all other MBS investors, α^I. We estimate is with the same approach we used for banks. We run OLS and IV regressions of investor MBS holdings on the mortgage spread, e.g.

$$\Delta\text{Investor MBS}_t \quad = \quad \gamma + \beta_I^{IV} \times \Delta\widehat{\text{Mortgage spread}}_t + X_t + \varepsilon_t^I, \qquad (15)$$

where ΔInvestor MBS is the year-over-year change in investor MBS holdings scaled by total MBS, ΔMortgage spread is the change in the mortgage spread instrumented with Fed MBS purchases as in Table 2, and *X* are controls (the ZLB indicator and changes in the Fed funds rate, output gap, and inflation gap). Investor holdings are those of all other categories besides banks and the Fed. Later we provide a breakdown by investor type (household sector, asset managers, rest of the world, and others).

The results of these regressions are presented in Table 4. Column 1 runs an OLS regression over the full sample, 1990–2019. In contrast to banks, investors appear strongly rate-sensitive. The coefficient on the mortgage spread is 0.092 and highly significant. Thus, a 100-bps widening of mortgage spreads leads investors to increase their MBS holdings by 9.2% of the total MBS market. This is despite the potential downward bias in the OLS estimate. Column 2 adds in economic controls. These have some impact: the coefficient on the mortgage spread drops to 0.065 but remains significant. Among the controls, the ZLB has the largest effect, perhaps because it picks up the aftermath of the 2008 financial crisis when investor demand for MBS fell.

Columns (3) and (4) repeat the first two for the shorter, 2010–2019 sample. These more recent estimates, which exclude the 2008 financial crisis, are similar to the earlier ones. The coefficient in Column (4), which includes economic controls, is 0.099, i.e. investors

Table 4
Investor MBS Demand

	Δ Investor MBS / Total						
	(1) 1990–19	(2) 1990–19	(3) 2010–19	(4) 2010–19	(5) 2010–19	(6) 2010–19	(7) 2010–19
Δ Mortgage spread	0.092***	0.065***	0.104**	0.099***			
	(0.035)	(0.019)	(0.051)	(0.035)			
Δ Mortgage spread					0.338***	0.210***	
					(0.084)	(0.033)	
Δ Mortgage spread, lag						0.193***	
						(0.034)	
ZLB		–0.113***		–0.057***		–0.043**	–0.059***
		(0.016)		(0.017)		(0.019)	(0.020)
Δ Fed funds rate		–0.012*		0.011		0.035*	0.025
		(0.006)		(0.017)		(0.021)	(0.023)
Δ GDP gap		–0.003		–0.009		–0.005	–0.001
		(0.005)		(0.011)		(0.012)	(0.017)
Δ Inflation gap		–0.016		–0.043*		–0.048***	–0.030**
		(0.016)		(0.022)		(0.013)	(0.013)
Constant	0.054***	0.075***	–0.008	0.031**	–0.008	0.016	0.023
	(0.011)	(0.008)	(0.013)	(0.013)	(0.015)	(0.017)	(0.019)
Obs.	120	120	40	40	40	40	40
R^{agg}	0.161	0.667	0.222	0.644	0.728	0.805	0.805

Note: This table presents results from regressions of investor's MBS holding on the mortgage spread, including the instrumental variable regression:

$$\Delta\text{Investor MBS}_t \;=\; \gamma + \beta_I^{IV} \times \Delta\widehat{\text{Mortgage spread}}_t + X_t + \varepsilon_t^I.$$

Δ Investor MBS is the year-over-year change in investors' MBS holding scaled by total MBS, with investors defined as all investor categories other than the Fed and banks.
Δ Mortgage spread is the actual change in mortgage spread from a year ago, while $\Delta\,\widehat{\text{Mortgage spread}}$ is the predicted change in mortgage spread from the first-stage regression. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data either from 1990 to 2019 or from 2010 to 2019.

buy about 10% more of the MBS market when the mortgage spread widens by 100 bps. Overall, the OLS results appear robust.

Columns (5) and (6) run IV regressions to remove the potential bias in the OLS results. In Column (5), the instrumented coefficient is 0.388 and highly significant. This is triple the OLS coefficient, suggesting significant bias. Column (6) adds in the economic controls. These reduce the coefficient to 0.210, i.e. investors buy 21% of MBS outstanding per 100 bps increase in the mortgage spread.

Figure 19 shows a scatter plot of investor MBS holdings changes against Fed purchases. This relationship is the reduced-form specification corresponding to the IV regression in Column (5) of Table 4. There is a strong downward pattern. The R^2 is very high, 72.8%. There are potential outliers around 2010 but the relationship is not affected by their removal. The figure thus shows clearly that unlike banks, when the Fed buys investors sell.

6.3.1 Delayed Effects on Investor Portfolios

We check for delayed effects of Fed purchases on investor portfolios. It is plausible that the initial adjustment is in part transitory. When the Fed buys MBS, investors might initially sell to the Fed but then buy some of it back as the supply of MBS expands. As we will see in Section 6.4, mortgage originations respond to mortgage rates with a one-quarter lag. Hence, we expect investors' initial portfolio adjustment to revert slightly over that time.

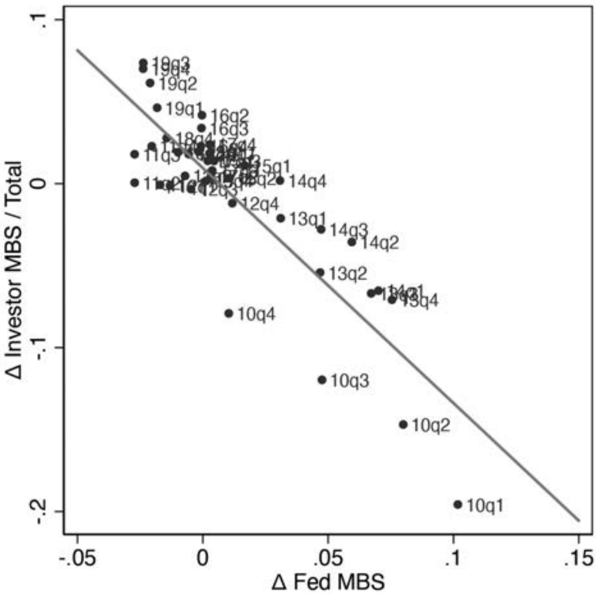
Column (7) of Table 4 tests for this by adding an additional quarter to the change in investor holdings and the mortgage spread while keeping Fed purchases year-over-year. This captures the investors' adjustment over five quarters to Fed purchases over four quarters. The coefficient on the instrumented mortgage spread drops slightly to 0.193 and remains significant. Thus, when the mortgage spread rises by 100 bps, investors increase their MBS holdings by 19.3% of the MBS market over five quarters.

6.3.2 Investor MBS Holdings by Type

Table 5 provides a breakdown by different types of investors. We group them into households (this includes hedge funds, family offices, and non-profits), asset managers (insurance companies, pension funds, and mutual funds), rest of the world (foreign investors and foreign banks), and other investors (mainly broker-dealers, REITS, and holding companies). We run OLS and IV regressions for the full sample and recent sample, respectively. We include the economic controls as in Columns (2) and (6) of Table 4.

The results show that our findings for all investors are robust to each type of investor. The OLS estimates tend to be small and in one case (asset managers), insignificant, but the IV estimates in all cases are large and significant. Thus, all types of investors are rate-sensitive, especially compared to banks. The most rate-sensitive type are other investors with a coefficient of 0.076, followed by households, 0.057, asset managers, 0.051, and rest of the world, 0.026. Note that adding

Figure 19
QE and Investor MBS Purchases



Note: This figure plots the relationship between the year-over-year change in the Fed's MBS holding scaled by total MBS (Δ Fed MBS) and the year-over-year change in the MBS holding of investors scaled by total MBS (Δ Investor MBS / Total). Investors are all investors aside from the Fed and banks. The diagonal line represents a simple linear fit of the data points. The data points are quarterly from 2010 to 2019.

the four coefficients in Table 5 exactly matches the 0.210 coefficient in Table 4. This is by construction given our dollar scaling.

Figure 20 shows the scatter plots corresponding to the reduced-form IV specification. There is a clear downward pattern for each investor type. We conclude that while there is some heterogeneity, the result from Table 4 that investors are rate-sensitive is robust to looking at different classes of investors.

6.4 Elasticity of Mortgage Originations

The final parameter of our framework is the elasticity of total mortgages to the mortgage rate. Estimating this elasticity is more challenging because unlike the mortgage spread, the mortgage rate depends on the general level of interest rates. The general level of interest rates equilibriates saving and borrowing across the whole economy, not just in the MBS market. It is therefore much more

Table 5
Investor MBS Demand By Type

	Households		Asset Managers		Rest of World		Others	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1990–19	2010–19	1990–19	2010–19	1990–19	2010–19	1990–19	2010–19
Δ Mortgage spread	0.031***		–0.001		0.012**		0.023**	
	(0.012)		(0.007)		(0.006)		(0.009)	
$\Delta \widehat{\text{Mortgage spread}}$		0.057***		0.051***		0.026***		0.076***
		(0.020)		(0.016)		(0.006)		(0.015)
ZLB	–0.016**	–0.001	–0.031***	–0.018*	–0.027***	–0.014***	–0.039***	–0.010
	(0.006)	(0.005)	(0.006)	(0.009)	(0.003)	(0.003)	(0.009)	(0.011)
Δ Fed funds rate	0.000	0.013**	–0.010***	–0.003	0.000	0.001	–0.002	0.024*
	(0.003)	(0.005)	(0.002)	(0.009)	(0.002)	(0.003)	(0.004)	(0.012)
Δ GDP gap	0.005**	–0.003	–0.003**	0.001	0.002	0.004**	–0.007**	–0.007
	(0.002)	(0.004)	(0.001)	(0.004)	(0.001)	(0.002)	(0.003)	(0.008)
Δ Inflation gap	–0.010	–0.016**	–0.003	–0.002	0.006*	–0.004	–0.009	–0.026***
	(0.007)	(0.006)	(0.005)	(0.004)	(0.003)	(0.003)	(0.009)	(0.006)
Constant	0.011***	0.003	0.025***	0.011*	0.017***	0.005**	0.022***	–0.004
	(0.004)	(0.004)	(0.003)	(0.007)	(0.003)	(0.003)	(0.006)	(0.010)
Obs.	120	40	120	40	120	40	120	40
R^2	0.318	0.458	0.666	0.571	0.548	0.771	0.428	0.630

Note: This table presents results from regressions of MBS holding by different investor types on the mortgage spread, including the instrumental variable regression:

$$\Delta \text{MBS}_t = \gamma + \beta_I^{IV} \times \Delta\widehat{\text{Mortgage spread}}_t + X_t + \varepsilon_t^I.$$

ΔMBS is the year-over-year change in MBS holding by an investor type scaled by total MBS. Households include hedge funds, family offices, and non-profits. Asset managers include insurance companies, pension funds, and mutual funds. Rest of the world include foreign investors and banks. Others is a residual category that includes broker-dealers, REITs, and holding companies. Δ Mortgage spread is the actual change in mortgage spread from a year ago, while $\Delta \widehat{\text{Mortgage spread}}$ is the predicted change in mortgage spread from the first-stage regression. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data either from 1990 to 2019 or from 2010 to 2019.

likely to be endogenous with respect to Fed purchases and other possible instruments.

We deal with this challenge by proceeding along two tracks. The first is to estimate OLS regressions of mortgage originations on mortgage rates. We use different samples and controls to gauge sensitivity to potential omitted variables. The second track is to use our framework to back out the implied elasticity of mortgage originations from our earlier IV estimates. The advantage of this approach is that it uses IV to correct for endogeneity. The disadvantage is that it could be sensitive to model misspecification. In this way, it is complementary to the OLS approach.

6.4.1 OLS Regressions

Another difference between mortgage borrowers and MBS investors is that mortgage borrowers are likely to respond to interest rates with a lag. It takes time to learn about a change in mortgage rates, shop for a house, or refinance a mortgage. We allow for this by lagging the mortgage rate in our OLS regressions:

$$\Delta\text{Mortgage Originations}_t = \gamma + \beta_S^{OLS} \times \Delta\text{Mortgage rate}_{t-1/4} + X_t + \varepsilon_t^S, \quad (16)$$

where ΔMortgage Originations is the year-over-year change in mortgage originations scaled by total mortgages, ΔMortgage rate is the change in the mortgage rate lagged by one quarter, and *X* stacks the ZLB indicator and changes in the Fed funds rate, output gap, and inflation gap as controls. We also show results without lagging the mortgage rate for robustness.

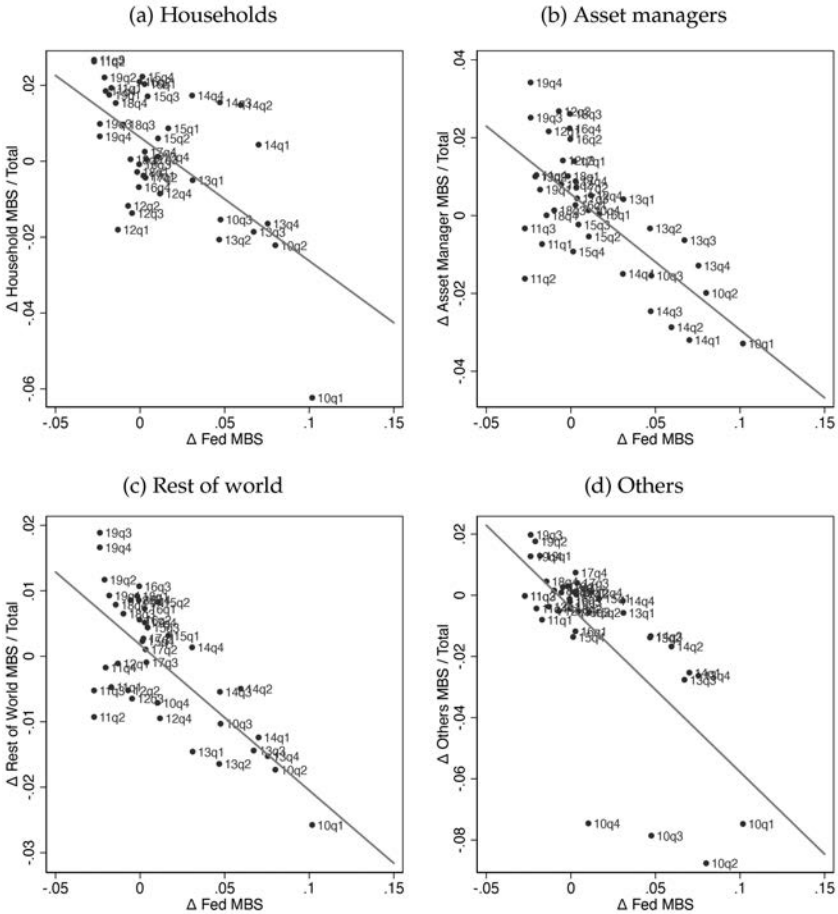
Table 6 shows the results. The first three columns are for the recent sample, 2010–2019, and the last three are for the long sample, 1990–2019. Column (1), which does not lag the mortgage rate, shows a significant coefficient of –0.039, hence a 100-bps increase in mortgage rates is contemporaneously associated with a decline in mortgage originations equal to 3.9% of the stock of all mortgages per year. This comes to about $436 billion at the end of 2019.

Column (2) lags the mortgage rate by one quarter. The coefficient nearly doubles to –0.065, supporting the view that originations slightly lag mortgage rates. The magnitude of this estimate is substantial: a 100-bps increase in mortgage rates leads to a decline in mortgage originations equal to 6.5% of all mortgages or $727 billion in 2019.

Panel A of Figure 21 shows a scatter plot of the relationship in Column (2) of Table 6. There is a clear downward pattern. The fit is good as the regression R^2 is 56.6% and there are no obvious outliers. This suggests that mortgage rates are the primary driver of mortgage originations.

Column (3) of Table 6 adds in the economic controls. The coefficient becomes slightly larger, –0.070 ($783 billion in 2019), and the

Figure 20
QE and Investor MBS Purchases by Type



Note: This figure plots the relationship between the year-over-year change in the Fed's MBS holding scaled by total MBS (Δ Fed MBS) and the year-over-year change in the MBS holding of an investor type scaled by total MBS. Households (Panel A) include hedge funds, family offices, and non-profits. Asset managers (Panel B) include insurance companies, pension funds, and mutual funds. Rest of the world (Panel C) includes foreign investors and banks. Others (Panel D) is a residual category that includes broker-dealers, REITs, and holding companies. The diagonal lines represent a simple linear fit of the data points. The data points are quarterly from 2010 to 2019.

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fit improves further to 73.6%. Of the controls, only the ZLB indicator comes in significant, potentially capturing the fact that mortgage demand was low in the aftermath of the 2008 financial crisis.

Column (4) of Table 6 repeats Column (1) for the full sample 1990–2019. The coefficient is slightly larger, −0.075 (versus −0.039)

Table 6
Mortgage Originations

	Δ Mortgage Originations / Total					
	(1)	(2)	(3)	(4)	(5)	(6)
	2010–19	2010–19	2010–19	1990–19	1990–19	1990–19
Δ Mortgage rate	−0.039***			−0.070***		
	(0.012)			(0.012)		
Δ Mortgage rate, lag		−0.065***	−0.070***		−0.104***	−0.108***
		(0.011)	(0.008)		(0.013)	(0.017)
ZLB			−0.042***			−0.040**
			(0.013)			(0.018)
Δ Fed funds rate			−0.015			0.005
			(0.018)			(0.012)
Δ GDP gap			−0.014*			−0.008
			(0.008)			(0.008)
Δ Inflation gap			0.002			0.009
			(0.011)			(0.021)
Constant	−0.003	−0.005	0.029***	0.003	−0.004	0.007
	(0.010)	(0.008)	(0.009)	(0.012)	(0.010)	(0.012)
Obs.	40	40	40	116	116	116
R^2	0.210	0.566	0.736	0.231	0.506	0.535

Note: This table presents results from regressions of mortgage originations on the mortgage rate:

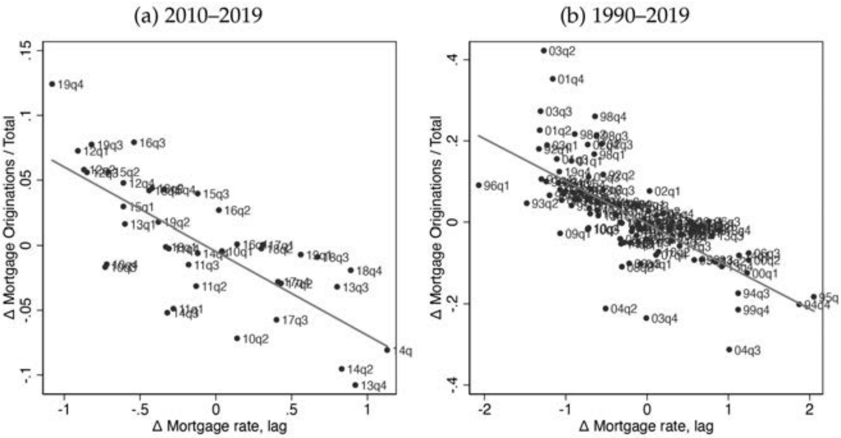
$$\Delta\text{Mortgage Originations}_t \;=\; \gamma + \beta_S^{OLS} \times \Delta\text{Mortgage rate}_{t-1/4} + X_t + \varepsilon_t^S.$$

ΔMortgage Originations is the year-over-year change in mortgage originations scaled by total mortgages. Δ Mortgage rate is the year-over-year change in mortgage rate, lagged by one quarter for columns (2)-(3) and (5)-(6). ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data either from 1990 to 2019 or from 2010 to 2019.

and significant. Lagging the mortgage rate by a quarter (Column (5)) raises it further to −0.104. This relationship is depicted in Panel B of Figure 21. The fit is again very high over this longer sample. The only potential outliers are the housing boom years of the early 2000s. These see a large increase of mortgage originations even accounting for the mortgage rate. In the language of our model (equation (3)), the housing boom can be interpreted as a positive mortgage demand shock ϵ^S. Nevertheless, the relationship is robust to excluding the housing boom.

Column (6) shows our final specification with a lagged mortgage rate and economic controls over the full sample 1990–2019. The coefficient settles at −0.108 and remains significant. The magnitude implies that a 100-bps increase in mortgage rates leads to a decline in mortgage originations of 10.8% or $1,208 billion in 2019.

Figure 21
Mortgage Rates and Originations



Note: This figure plots the relationship between the year-over-year change in the mortgage rate, lagged by one quarter (Δ Mortgage rate, lag), and the year-over-year change in mortgage originations scaled by total mortgage (Δ Mortgage Originations / Total). The diagonal lines represent a simple linear fit of the data points. The data points are quarterly from 2010 to 2019 (Panel A) and from 1990 to 2019 (Panel B).

6.4.2 Implied IV Estimate

Recall from equation (10) that we can back out an implied IV estimate of the sensitivity of mortgage originations to mortgage rates from the first-stage coefficient $\hat{\beta}^{First\ Stage}$ and the IV estimate of investors' rate-sensitivity, α^I_{IV}. Intuitively, the first-stage coefficient identifies the joint elasticity $\alpha^I + \alpha^S$ of investors and mortgage borrowers under the assumption that banks are rate-insensitive (and Fed purchases are a valid instrument). We found support for this assumption in Section (6.2). We therefore now use equation (10) to arrive at an implied IV estimate of borrowers' rate sensitivity.

For the first stage coefficient, $\hat{\beta}^{First\ Stage}$, we use the estimate in Column (1) of Table 2, –4.233.[17] For the rate-sensitivity of investors, $\hat{\alpha}^I_{IV}$, we use the estimate in Column (7) of Table 4, 0.193, because it allows for lagged adjustment of investor portfolios. As we saw in Table 6, mortgage borrowers react to rate changes with a one-quarter lag, hence it important to take this lag into account when estimating their elasticity. This gives us an implied IV estimate of

$$\widehat{\alpha}^{S}_{IV,Implied} \;=\; -\frac{1}{\widehat{\beta}^{First\,Stage}} - \widehat{\alpha}^{I}_{IV} \;=\; -\frac{1}{-4.233} - 0.193 \;=\; 0.043. \tag{17}$$

This number implies that when mortgage rates rise by 100 bps, mortgage borrowers demand 4.3% fewer mortgages as a percentage of total mortgages. Importantly, this elasticity captures the impact of rates on *net* issuance, not gross originations like in Table 2. We expect it to be smaller because net issuance is much smaller than gross originations due to refinancing and the buying and selling of existing homes. From an economic standpoint, both are expected to have an effect.

7. Counterfactual Analysis

We now combine our estimates to construct counterfactual scenarios for mortgage spreads, originations, and net issuance. We compare the actual path of these quantities against our estimates if there had been no Fed MBS purchases (no QE) and no Fed or bank MBS purchases. The implicit assumption is that a dollar of bank purchases has the same impact as a dollar of Fed purchases, as implied by our framework. This is a reasonable assumption because banks and the Fed are both inelastic buyers. As a result, buying by one does not lead to selling by the other. The impact of their combined purchases on rates and issuance then depends on the elasticities of other investors and mortgage borrowers.

7.1 Impact on Mortgage Spreads

Panel A of Figure 22 plots Fed and bank MBS purchases scaled by total MBS at the end of 2019. The series are normalized to zero at the start of 2020. Fed purchases (black line) rise quickly starting in early 2020. They reach 12.2% at the end of 2021 before declining to 6.5% at the end of 2023. Bank purchases (gray line) rise a little more slowly but then accelerate, reaching a similar 12.6% at the end of 2021 and falling to 4.7% at the end of 2023. The combined purchases of banks and the Fed (top line) peak at 24.8%, or about a quarter of the total amount of MBS outstanding, then drop to 11.2% at the end of 2023. The scale of the intervention is only visible when banks are included alongside the Fed.

Figure 22
Impact on Mortgage Spreads

Note: Panel A plots actual purchases of MBS by the Fed, banks, and both in share of total MBS. Values are normalized so that they are zero at the end of 2019. Panel B plots actual mortgage spread along with counterfactual mortgage spreads without Fed purchases and without Fed and bank purchases. We obtain the counterfactual spreads by adding the impact of purchases on spread calculated using estimated elasticities, as shown in equation (18), back in to the actual spread. The data points are quarterly from 2019 to 2023.

We now look at the estimated impact of these purchases on the mortgage spread. From equation (6), this impact depends on the combined elasticity $\alpha^I + \alpha^S$:

$$\Delta\,\widehat{\text{Spread}} \;=\; -\frac{1}{\widehat{\alpha}^{I}+\widehat{\alpha}^{S}} \times (\Delta\text{ Fed MBS} + \Delta\text{ Bank MBS})\,, \tag{18}$$

where Δ Fed MBS and Δ Bank MBS are the scaled Fed and bank purchases from Panel A. For α^{I}, we use the IV estimate in Column (6) of Table 4, $\alpha^{I}_{IV} = 0.210$. For α^{S}, we use the implied IV estimate for net issuance from Section 6.4.2, $\alpha^{S}_{IV,,Implied} = 0.043$. We use net issuance because the equilibrium spread depends on the amount of mortgages outstanding.

Panel B of Figure 22 plots the actual mortgage spread (gray line) against counterfactual mortgage spreads without Fed purchases (black line) and without Fed and bank purchases (top line). We obtain the counterfactual spreads by adding the estimated impact in equation (18) back in to the actual spread.

The actual mortgage spread drops sharply by 113 bps from early 2020 to 2021. We estimate that if the Fed had not purchased MBS, the spread would have declined by 75 bps over this period. This implies that Fed purchases contracted the mortgage spread by 38 bps. If we also take away bank MBS purchases, the mortgage spread declines by just 32 bps and remains relatively flat during the period. Thus, the combined purchases of banks and the Fed contracted the mortgage spread by 81 bps. This is a large impact, equal to about half the average mortgage spread over 2010–2019. Of the 81 bps, banks were responsible for 43 bps and the Fed for 38 bps, both substantial amounts.

7.2 Impact on Net MBS Issuance

All else equal, shrinking the mortgage spread lowers the mortgage rate paid by borrowers. We therefore expect Fed and bank MBS purchases to lead to increased mortgage borrowing and MBS issuance. We note that it is likely that asset purchases (including the Fed's Treasury purchases) lowered mortgage rates over and above their impact on the mortgage spread, i.e. long-term interest rates declined. However, since such an effect is difficult to identify empirically, we do not factor it into our analysis and focus solely on the spread component of the mortgage rate. In this sense, our results are a lower bound on the impact of Fed and bank asset purchases on mortgage activity.

We calculate the impact on MBS issuance as follows. From equation (3), the supply of MBS by mortgage borrowers depends on the mortgage rate. The change in MBS supply therefore depends on the change in the mortgage rate. We take that change to be the change in the mortgage spread as calculated in 7.1. We then calculate

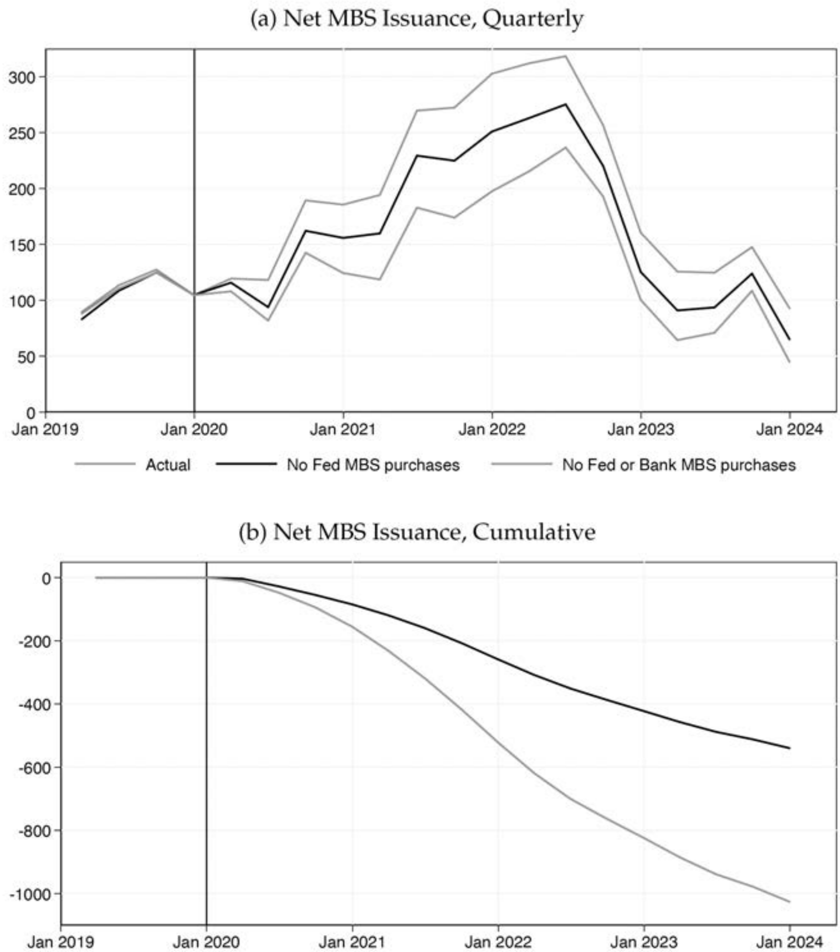
$$\Delta \text{ Net } \widehat{\text{MBS Issuance}} \quad = \quad -\widehat{\alpha}^S \times \Delta \, \widehat{\text{Spread}}. \tag{19}$$

The left-hand side is scaled by total MBS outstanding. We convert it to dollars for interpretability by multiplying by MBS outstanding as of the end of 2019. For the net issuance elasticity $\widehat{\alpha}^S$, we use the implied IV estimate from Section 6.4.2, $\widehat{\alpha}^S = 0.043$.

Panel A of Figure 23 plots the quarterly actual net MBS issuance (top line), estimated net issuance without Fed MBS purchases (black line), and estimated net issuance without Fed and bank purchases (bottom line). Actual net issuance triples from \$104 billion at the end of 2019 to \$318 billion in 2022q2. We estimate that absent Fed MBS purchases, net issuance would have risen to \$275 billion in 2022q2. Thus, Fed purchases led to \$43 billion in additional quarterly MBS issuance at the peak. If we further remove bank MBS purchase, predicted peak issuance drops to just \$236 billion. Thus, banks and the Fed increased peak net MBS issuance by \$81 billion per quarter. This is a large amount compared to the \$108 billion average issuance in 2019.

The quarterly impact adds up over time. Panel B of Figure 23 plots the cumulative reduction in net MBS issuance that we estimate would have occurred if the Fed had not purchased MBS (black line) or if the Fed and banks had not purchased MBS (gray line). We find that cumulative net MBS issuance would have been \$307 billion lower at the end of 2021 and \$563 billion lower at the end of 2023 if the Fed had not purchased MBS. If, in addition, banks had not purchased MBS, cumulative net MBS issuance would have been \$618 billion lower at the end of 2021 and \$1,069 billion lower at the

Figure 23
Impact on Net MBS Issuance



Note: Panel A plots actual net MBS issuance along with counterfactual net MBS issuances without Fed MBS purchases and without Fed and bank MBS purchases. We obtain the counterfactual issuances by subtracting from the actual change in net issuance the impact of change in spread on change in issuance calculated using our estimated elasticity as shown in equation (17). Panel B plots the cumulative reduction in net MBS issuance that we estimate would have occurred if the Fed had not purchased MBS and if the Fed and banks had not purchased MBS. The data points are quarterly from 2019 to 2023.

end of 2023. This represents about a third of the actual cumulative net MBS issuance over this period.

7.3 Impact on Total Mortgage Originations

As a final exercise, we look at the impact of Fed and bank MBS purchases on total (gross) mortgage originations. Total originations are of interest beyond net MBS issuance because there is a large literature showing that mortgage refinancing has a substantial impact on household consumption (e.g., Di Maggio et al., 2017; Eichenbaum et al., 2022; Agarwal et al., 2023). As an illustration, Eichenbaum et al. (2022) find that when the average rate on outstanding mortgages is 50 bps higher than the current mortgage rate, a 25 bps decrease in mortgage rates leads to 0.9% higher consumption. Since, if anything, the mortgage rate gap was higher than 50 bps in 2020, the implied stimulative effect of the 81 bps reduction in mortgage spreads we found in Section 7.1 is at least 0.9 × 0.81/0.25 = 2.9% of aggregate consumption through greater refinancing alone.

Total mortgage originations also expand the analysis beyond the MBS market to include portfolio loans such as jumbo mortgages. The implicit assumption we are making is that mortgage markets are sufficiently integrated so that rates on portfolio loans move in tandem with rates on securitized mortgages. This is a reasonable assumption given that the interest rate spread between jumbo and conforming mortgages (i.e. those eligible for agency securitization) is quite small. If there is segmentation, then the impact of bank balance sheet growth (due to deposit inflows) on portfolio loan rates is likely to be higher than on MBS because there are no other investors in the portfolio loan market.

We calculate the impact of MBS purchases on total mortgage originations similarly to net issuance (see equation 20), except we replace the net supply elasticity with the gross one:

$$\Delta \text{ Total } \widehat{\text{Mortgage}} \text{ Originations} \quad = \quad -\widehat{\alpha}^{S}_{Gross} \times \Delta \widehat{\text{Spread}}. \tag{20}$$

We again convert the left-hand side to dollars by multiplying by total mortgages outstanding as of the end of 2019. For the gross originations elasticity we use the OLS estimate from Column (6) of Table 6, $\alpha^{S}_{Gross} = 0.108$.

Figure 24 plots the results. Panel A shows actual originations (top line) and estimated originations without Fed purchases (black line) and without Fed and bank purchases (gray line). Quarterly originations rise faster than net issuance, from $738 billion at the end of 2019 to $1,357 at the end of 2020. This surge reflects the refinancing boom of 2020. Originations then decline to $994 billion at the end of 2021.

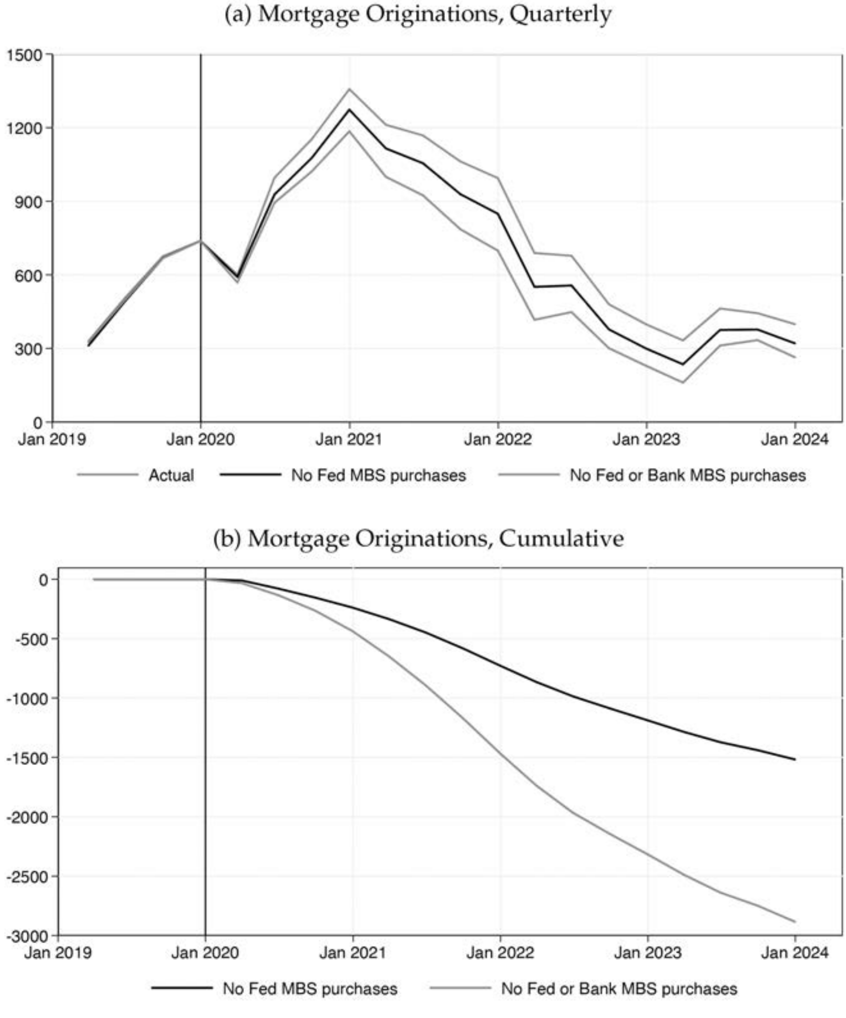
We estimate that without Fed MBS purchases, quarterly mortgage originations would have stood at $1,273 at the end of 2020 and $849 billion at the end of 2021. The impact of Fed purchases on originations was therefore $84 billion and $145 billion per quarter, respectively. This is more than double the impact on net MBS issuance we found in Section 7.2, reflecting the relative quantity of gross versus net issuance.

Without Fed and bank MBS purchases, estimated originations decline to $1,185 billion and $699 billion at the end of 2020 and 2021. Together, the Fed and banks increased mortgage originations by $172 billion and $295 billion on those two dates. Of these, banks were responsible for $88 billion in 2020q4 and $150 billion in 2021q4.

As with net issuance, quarterly total originations add up over time. Panel B of Figure 24 shows the cumulative impact of Fed purchases (black line) and Fed and bank purchases (gray line). We estimate that at the end of 2020 cumulative total originations would have been $727 billion lower without Fed purchases and $1,466 billion lower without Fed and bank purchases (the cumulative impact of banks is thus $739 billion). By the end of 2021, the cumulative impact of the Fed is $1,187 billion and that of the Fed and banks is $2,316 billion (the impact of banks is $1,129 billion).

Over the full cycle ending in 2023q4, we estimate cumulative total originations would have been $1,517 billion lower without the Fed and $2,884 lower without the Fed and banks. Actual cumulative originations stood at $12,428, so the policy impact is about a quarter of the total. Thus, while much of the refinancing wave

Figure 24
Impact on Total Mortgage Originations



Note: Panel A plots actual total mortgage originations along with counterfactual total mortgage originations without Fed MBS purchases and without Fed and bank MBS purchases. We obtain the counterfactual originations by subtracting from the actual change in originations the impact of change in spread on change in originations calculated using estimated elasticity from column (6) of Table 6. Panel B plots the cumulative reduction in total originations that we estimate would have occurred if the Fed had not purchased MBS and if the Fed and banks had not purchased MBS. The data points are quarterly from 2019 to 2023.

would have still occurred in 2020 and 2021 given the drop in rates, Fed and MBS purchases contributed significantly by compressing mortgage spreads.

8. Conclusion

The post-Covid era has seen large fluctuations in monetary policy. Following the onset of Covid-19, the Federal Reserve cut interest rates to zero and implemented an aggressive Quantitative Easing program in which it bought large amounts of Treasury bonds and MBS. After inflationary pressures emerged, the Fed dramatically tightened policy, raising rates by over 5% in a year and a half, and reducing its treasury and MBS holdings under Quantitative Tightening.

Despite these large moves in monetary policy, there is debate about the extant to which policy impacted some of the main economic targets it is believed to influence, including consumption, unemployment, and inflation. In contrast, there is widespread agreement that monetary policy had a clear and powerful impact on the housing sector through the mortgage market. During 2020–21, when monetary policy was loose, mortgage rates and the mortgage spread fell to historic lows, there was a boom in mortgage originations, and residential investment surged. Once the Fed tightened policy, these trends quickly reversed. Mortgage rates and the mortgage spread rose dramatically, and mortgage issuance all but ground to a halt.

In this paper, we show that monetary policy had an outsized impact on the mortgage market because it exerted a powerful influence on the supply of mortgage credit by the two largest holders of mortgages, banks and the Federal Reserve. When monetary policy loosened, banks and the Fed accumulated a large quantity of MBS, which made mortgage credit historically cheap. Once the Fed started tightening, banks and the Fed reversed course and significantly reduced their MBS holdings, which reduced mortgage supply and made mortgage credit expensive.

In the case of the Fed, monetary policy had this impact due to QE and QT, which change the amount of MBS the Fed buys and hence the amount of mortgage credit it supplies. In the case of banks, we show that monetary policy works through the deposits channel. Under this channel, when the Fed lowers rates, banks receive inflows of low-beta deposits, which they invest in long-term fixed-rate assets, particularly mortgages.

Due to the deposits channel, when the Fed lowers rates, banks become aggressive buyers of mortgages. Since banks are the largest investors in mortgages (with a roughly 50% share of all mortgage holdings), and their deposit inflows are large, banks' mortgage buying causes a significant expansion in mortgage credit supply. The opposite happens when the Fed raises rates: low-beta deposits flow out and banks need to reduce their mortgage holdings, which contracts mortgage credit supply.

Our empirical analysis quantifies the impact of monetary policy on the mortgage market during the 2020–24 monetary policy cycle. We find that banks and the Fed were each responsible for about a 40-bps reduction in the mortgage spread during 2020–21. Our estimates imply that this led to a cumulative increase in mortgage originations of about $3 trillion, and net MBS issuance of about $1 trillion, with banks responsible for roughly half of this increase. Estimates from the macro literature imply that these effects had a large impact on consumer spending and residential investment.

Looking ahead, our findings suggest that the combined effects of QE and the deposits channel on the mortgage market will continue to be important for the transmission of monetary policy.

Appendix

A. Expected Fed Purchases

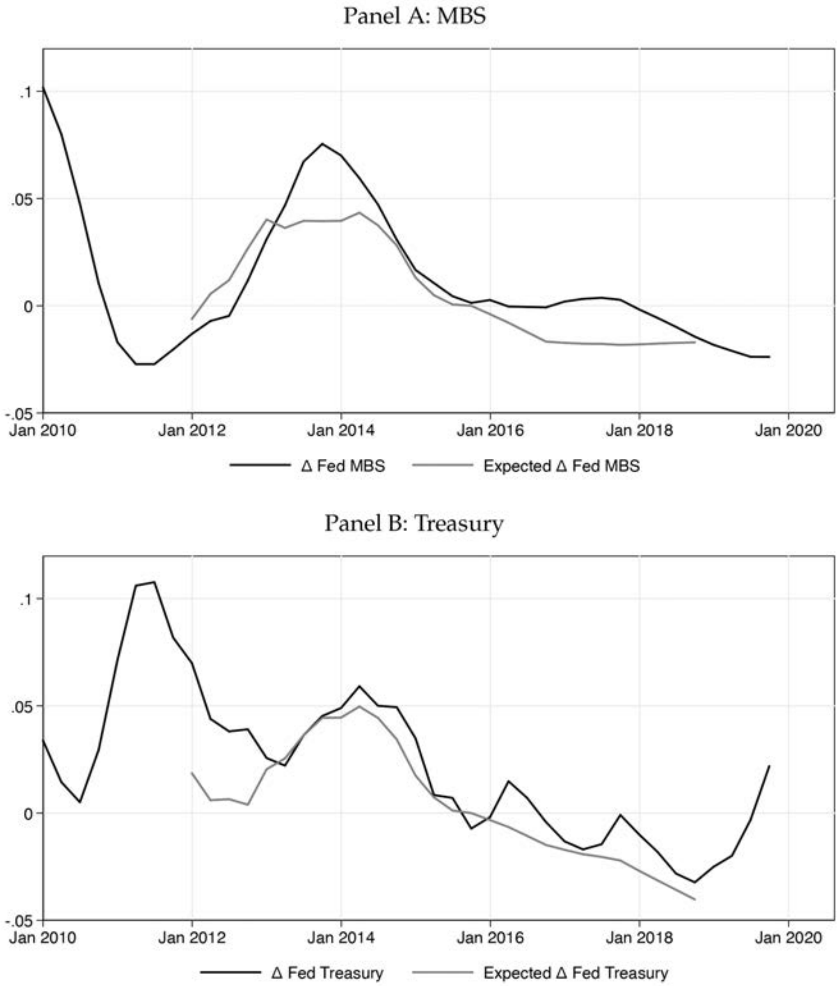
We explain how we construct quarter-ahead expected Fed purchases from the SPD data. Our methodology broadly follows Kim et al. (2020). The main differences are that we focus on MBS and use a quarterly frequency.

For a given period, there are multiple values of expected purchase from different preceding survey months. In principle, we use the expectation value from the closest available survey before the period of interest. For example, the expectation of the Fed's purchase for the second quarter of 2011 is calculated using responses to the March 2011 SPD. This gives us expectations one quarter ahead until after the first quarter of 2015, where the latest survey with our question of interest is from October 2014. Starting from this period, the gap between the period of expected purchase and the time of survey lengthens.

For January 2011 to September 2012, the questionnaires ask respondents their expectations for "the amount of domestic securities held outright in the SOMA portfolio at year end for each of the next five years." Since we are interested in expected purchase, we take this year end value and compare it with the actual outstanding securities holding, taken from NY Fed's SOMA holdings dataset, right before the period of interest to deduce the expected purchase. If the gap between the period of interest and end of year is over a quarter, we take a linear interpolation to get the quarterly value.

For October 2012 to January 2015, the questionnaires inquire expectations for the purchase in two ways. First, they ask expectations for "the most likely change in the amount of domestic securities held in the SOMA portfolio during each of the periods below", where the periods are either half-years or full-years up to three or four years ahead. Second, they ask about the expected "monthly pace of purchases that will be in effect after each of the below FOMC meetings". For each survey month, they ask this for up to nine meetings or about one year ahead. We prioritize using responses from the second question due to its time granularity. Since the dates of

Figure A.1
Realized and Expected Fed Purchases

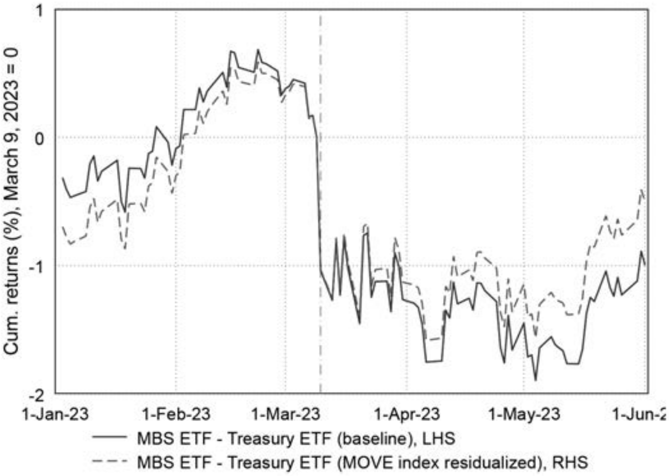


Note: Panel A plots the expected Fed MBS purchase (Expected Δ Fed MBS) and the actual Fed MBS purchase (Δ Fed MBS). Panel B plots the same series of expected and actual Fed purchases but for Treasury securities. The data points are quarterly, from 2010 to 2019 for actual purchases and from 2012 to 2018 for expected purchases.

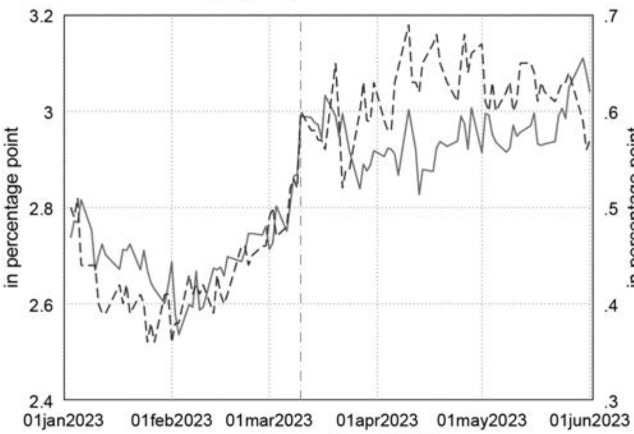
reference for this question vary within a month depending on the FOMC schedule, we round them up or down depending on whether it is before or after the 15th. As this question asks for expectations up to one year ahead and the question is no longer asked after January 2015, for expected purchases January 2016 onwards we switch to the

Figure A.2
Mortgage Market Around the Collapse of Silicon Valley Bank

Panel A: MBS Excess Returns: Robustness to Controlling for the MOVE Index



Panel B: Mortgage Spread and MBS Index OAS



Note: Panel A plots the return of the MBS ETF MSS without adjustment and after adjusting for pre-payment risk, daily from 1 Jan 2023 to 1 Jun 2023. MBS ETF — Treasury ETF is the difference in cumulative returns between iShares MBS ETF (MBB) and iShares 7–10 Year Treasury Bond ETF (IEF). We adjust MBS ETF — Treasury ETF by the MOVE index by computing a residual from a regression of the MBS ETF excess returns on the MOVE index changes. The mortgage spread is the spread between the 30-year fixed rate conforming mortgage rate and the 10-year U.S. Treasury yield. MBS Index OAS is an option-adjusted spread constructed by Bloomberg for the entire portfolio of outstanding MBSs. Vertical line denotes March 10, 2023, when SVB collapsed.

first question on expected yearly purchases. Again, we apply linear interpolation to get quarterly amounts.

In all cases, we use the median value of expectations.

Figure A.1 plots the expected Fed MBS and Treasury purchase series against the Fed's actual purchases. The expected and actual series track each other well but not perfectly. As argued by Kim et al. (2020), this suggests that there is a significant unexpected component to Fed purchases.

B. Regional Bank Crisis Event Study: Controlling for Prepayment Risk

Figure A.2 Panel A plots the return of the MBS ETF MSS after adjusting for prepayment risk by controlling for changes in the MOVE index. Panel B plots the option-adjusted spread (OAS) for the existing stock of MBS.

Endnotes

[1]Other factors behind the origination boom were the decline in long-term rates and increased demand for housing due to work-from-home. We provide an estimation to isolate the impact of MBS purchases on mortgage originations and find they played a large role.

[2]We measure deposits as checking and savings accounts net of reserves. We exclude reserves to avoid double-counting QE. When the Fed buys a security from an investor, it issues reserves, which banks must hold. Banks then credit the deposit account of the investor, which increases deposits by an equal amount.

[3]We provide causal evidence of the impact of banks on MBS pricing using an event study around the collapse of Silicon Valley Bank in March 2023. This collapse triggered concerns about large deposit outflows at regional banks. Investors also became concerned that banks' deposit betas would rise. Under the view that banks invest low-beta deposits in MBS, this shock represents a downward shift in banks' willingness to hold MBS. Consistent with this prediction, we find that MBS prices fell and MBS spreads rose relative to Treasury benchmarks immediately following SVB's collapse. This shows that banks are important for MBS pricing, and hence the supply of mortgage credit via the MBS market.

[4]There is no evidence that an increase in long-term inflation expectations contributed to the rise in the yield, as inflation expectations (measured using the yields of inflation-protected Treasury bonds) remained around 2%.

[5]Krishnamurthy and Vissing-Jorgensen (2013) also find that QE shrinks OAS. Interestingly, they find that the production-coupon OAS turns slightly negative, as we do in Figure 2. Boyarchenko et al. (2019) examine the factors behind variation in mortgage spreads over time and across securities.

[6]We formally estimate the price-sensitivity of banks in Section 6.2. Our results confirm that banks are price-insensitive MBS investors.

[7]Additional factors likely amplified deposit growth during the recent cycle. The government's large stimulus program provided economic support to households and businesses, increasing deposit inflows during the early part of the pandemic. A flight-to-safety may have further increased deposits.

[8]We net out reserves to avoid double-counting QE. When the Federal Reserve purchases MBS from an investor, it creates reserves which it transfers to the investor's bank. The bank then credits the investor's deposit account and this is how the investor gets paid. QE thus creates deposits in an amount equal to the increase in reserves. Netting them out removes this impact and ensures we are measuring non-QE deposit flows. See Acharya and Rajan (2022) for further discussion of QE-driven deposit growth.

[9]The remaining category, time deposits (i.e., CDs), have deposit betas close to one. Supera (2021) shows that because of this, banks tend to invest time

deposits in floating-rate assets, such as commercial and industrial (C&I) loans, rather than MBS.

[10]These quantity responses were also likely influenced by other factors such as demand for housing due to the rise of work-from-home. We provide a quantitative estimation of the impact of Fed and bank MBS purchases on gross and net mortgage originations in Section 6.

[11]We use the iShares MBS ETF (MBB) and the iShares 7–10 Year Treasury Bond ETF (IEF). The duration of MBB and IEF were similar: around 6 and 7 years, respectively. Our results are robust to using a portfolio of IEF and cash that exactly matches the duration of MBB.

[12]A potential concern is that the decline in the MBS ETF relative to the Treasury ETF could be driven by an increase in mortgage prepayment risk rather than banks' demand for MBS. In particular, the expected volatility of long-term rates, as measured by the MOVE index, increased (MOVE is similar to VIX but for Treasury bonds). Higher rate volatility raises the value of the prepayment option and this could be why the MBS ETF declined. To alleviate this concern, we perform a robustness analysis, where we account for the changes in prepayment risk by controlling for changes in the MOVE index in our event study. We obtain a residual from a regression of the MBS ETF excess returns on changes in the MOVE index changes prior to the regional bank crisis. The resulting adjusted (hedged) MBS ETF excess return exhibits a similar pattern to the raw one and also falls sharply after SVB's collapse. We also look at the option-adjusted spread (OAS), which removes the estimated value of the prepayment option. We use OAS constructed by Bloomberg for the entire portfolio of outstanding MBS, which matches the holdings of the MBS ETF. OAS increases by about 10 basis points following the collapse of SVB. These robustness results are presented in Appendix B.

[13]In the deposits channel, deposits depend on the short-term interest rate but since our framework is static there is no distinction between short- and long-term rates.

[14]As one more check, we also compare our estimates to micro elasticities identified in the literature.

[15]A large literature (e.g., Di Maggio et al., 2017; Eichenbaum et al., 2022; Agarwal et al., 2023) finds that mortgage refinancing has a big impact on household consumption.

[16]We net out reserves from deposits to avoid double-counting QE. Acharya and Rajan (2022) argue that QE led to a large expansion of deposits. The reason is that when the Fed buys MBS, it issues reserves that banks must hold. Banks then issue a deposit to whoever sold the MBS to the Fed. We can therefore net out the impact of QE on deposits by subtracting reserves.

[17]Our results are similar if we use the coefficient from the most restrictive specification in Column (7), which controls for expected Fed MBS purchases.

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Commentary: The Transmission of Monetary Policy Through Bank Balance Sheets

Kristin Forbes

1. Introduction

The paper by Drechsler, Savoy, Schnabl and Supera (referred to as DSSS below) is a fantastic reference for anyone seeking to understand developments in the U.S. mortgage market and how it is affected by monetary policy. DSSS explains that the transmission of monetary policy to the mortgage market is not simply the Econ 101 story of monetary policy affecting Treasury yields and therefore general borrowing costs (including mortgage rates). Instead, DSSS focuses on two additional transmission channels through which monetary policy can also affect the spread between mortgage rates and Treasury yields, thereby amplifying the standard transmission of monetary policy through general borrowing costs. These amplifying transmission channels work through the Federal Reserve's balance sheet policies and the deposit channel of banks and can explain why monetary policy has had large and significant effects on mortgage credit and the housing market.

The transmission channels that are the focus of DSSS — and particularly the impact of the Federal Reserve's balance sheet adjustments on the housing market — have previously received minimal attention. Although there is an extensive literature on the effects of quantitative easing (QE) and quantitative tightening (QT), most studies focus on the impact on government bond yields and term premia (Du et al., 2024). Although some papers also assess the impact on MBS yields, only Krishnamurthy and Vissing-Jorgensen (2013) has focused on how balance sheet policies may affect mortgage spreads differently than other financial variables with a similar risk profile. Other literature examines how QE and QT affect bank reserves, repo markets, commercial banks and interbank loan markets, and although a few papers analyze the impact on mortgage refinancing (see summary in DSSS), housing finance is usually treated as a residual affected by changes in relative prices rather than introducing new channels for the transmission of monetary policy (i.e., Kumhof and Salgado-Moreno, 2024).

Theoretical models of the impact of QE and QT focus on central bank purchases of a generic "bond", with no differentiation between Treasuries and housing-related debt. Empirical work also tends to focus on the impact of government bond purchases — a logical focus as these constitute the vast majority of central bank purchases under QE programs and the U.S. is unique in its inclusion of mortgage-backed securities (MBS) as central to its QE and QT programs. The few papers that analyze the impact of programs targeting asset classes other than government bonds generally find a larger effect on the yields of the assets that are eligible for central bank purchases, with meaningful but smaller spillovers on non-eligible assets.[1]

Is this literature missing important mechanisms through which monetary policy is transmitted to the mortgage market? My comments will focus on one of the new transmission mechanisms highlighted in the paper — through Federal Reserve balance sheet policies — as this is the title of this session of the symposium. My comments are divided into four parts. First, I briefly summarize the key channels and results in DSSS. Second, I summarize existing literature and report new empirical results testing if U.S. QE and QT events affected mortgage rates and spreads. I find some support for this channel highlighted in DSSS — but of more modest magnitude than described in the paper. Third, I attempt to draw lessons from advanced economies other than the United States — albeit with limited success. Finally, I consider the implications for U.S. asset purchase programs and conclude that the default should be to only involve U.S. Treasuries. The upcoming framework review could be an opportune time to develop more detailed principles and guidelines on the specific and more limited circumstances when MBS should be included in any future QE programs.

2. Key Insights in DSSS

There is a lot of interesting material and analysis in this paper.

The paper begins with an excellent and informative description of what has happened in the U.S. mortgage market since the pandemic. This includes a striking fall and then rise in the cost of mortgage credit, swings that correspond to a rise and then fall in mortgage originations and MBS issuance. Next, the paper develops a simple framework to understand these patterns, based on changes in the supply of mortgage credit by the Federal Reserve, banks, and other financial institutions. Then the paper reports a series of regressions testing these channels, including estimates of how the Federal Reserve's MBS purchases affect the mortgage spread and what determines bank and investor demand for MBS. The paper ends by using these results in a counterfactual analysis to show the large and meaningful impact of Fed and bank MBS purchases on mortgage originations.

Two graphs from DSSS — their Figures 6 and 14 — provide a useful framework to summarize this wealth of results. Figure 6 breaks down the sources of mortgage financing into four categories (banks' portfolio holdings, banks' MBS holdings, the Federal Reserve's MBS holdings, and holdings by all other investors) and then focuses on how each of these groups responds to and transmits changes in monetary policy. Some of these investor groups respond in ways that are not immediately intuitive. More specifically, the Federal Reserve and banks adjust their MBS holdings due to factors other than relative prices. This is a striking result. Investor groups holding over 50 percent of total mortgage capital at the start of 2023 are price insensitive — in the sense that they buy when prices are low and sell when prices are high. Nonetheless, DSSS explains why the transmission of monetary policy through the mortgage market still works.

Beginning with the investor group that only started buying MBS in response to the 2008 Global Financial Crisis, the Federal Reserve increased its MBS holdings from \$1.4 trillion to \$2.7 trillion over 2020–2022q1 as part of its pandemic QE program aimed at stabilizing financial markets and supporting the broader economy. Starting in April 2022, the Federal Reserve began reducing its MBS portfolio as part of its QT program reducing the size of its balance sheet by allowing its holdings to run-off when they expire (subject to caps), such that it had reduced its MBS holdings by \$300bn in 2024q1. Most important, these changes in the Federal Reserve's MBS portfolio were driven by its mandate to support price stability, maximum employment and financial stability. Portfolio adjustments were communicated well in advance, based on pre-set parameters, and thereby not determined by relative price changes.

Next, banks are the largest MBS investors, holding 30 percent of all MBS in addition to their holdings of portfolio loans. Banks increased their MBS holdings from \$2.2 trillion to \$3.1 trillion over 2020–2022q1 (a 41% increase). DSSS shows that this increase largely resulted from the surge in bank deposits over this period combined with the desire for banks to invest these deposits in long-term fixed-rate assets. This "bank deposit channel" explains why banks meaningfully increased their MBS holdings–despite less attractive pricing. Other investors (such as mutual funds, and pension funds) are price sensitive and sold MBS over 2020–2022q1 and bought afterwards, but their purchases and sales were smaller than those of the price-insensitive Federal Reserve and banks.

The end result is that monetary policy is transmitted to the housing market not just through changes in economy-wide borrowing costs, but by changes in the supply of mortgage credit held by the Federal Reserve and banks. An easing in monetary policy (including Federal Reserve purchases of MBS) causes the Federal Reserve and banks to increase their demand for mortgage credit (and by more than decreased demand by other investors), such that mortgage rates not only fall, but fall by more than Treasury yields, thereby compressing the mortgage spread. A tightening in monetary policy (including reductions in the Federal Reserve's MBS holdings) works in the opposite direction, causing mortgage rates to increase faster than Treasury yields and widening the mortgage spread.

The paper then reports a series of empirical tests over the period 2010–19 to calculate key beta coefficients and see if the patterns in the data are consistent with these transmission channels, before using these estimates to calculate counterfactuals of what would have happened to mortgage spreads, originations and net issuance if there had been no Fed or bank MBS purchases in response to Covid. The resulting estimates of the magnitudes of these two amplifying transmission channels are very large. For example, the counterfactual exercise suggests that of the 113 bps decline in the mortgage spread from 2020 to 2021, Fed MBS purchases explain 38bps and bank MBS 43bps; in other words — these two transmission channels decreased the mortgage spread by 81 bps — equivalent to about half the average mortgage spread over 2010–19. DSSS then links this to mortgage originations and finds that Fed and bank purchases explain just under $3 trillion of mortgage originations over 2020–23 — about one-quarter of the total wave of originations supporting the housing market over this period.

The empirical analysis and counterfactuals are carefully done — but the estimates are so large that a logical question is how well parameter estimates from the period before the pandemic apply. There were a number of unusual macroeconomic developments around the 2008 crisis and subsequent decade (which is the baseline for the estimates), as well as around the pandemic. For example:

- The collapse of the housing market in the 2008 crisis led to unusual strains in housing finance over the subsequent decade, which could lead to larger estimates of the impact of MBS purchases by banks and the Fed over this period than would occur during other windows.

- The increase in bank deposits at the start of the pandemic could reflect the large U.S. fiscal stimulus, combined with restrictions on households' ability to spend their cash due to Covid restrictions, rather than the impact of low interest rates (as occurs through the bank deposit channel in other windows).

- The increase in mortgage spreads after the pandemic could reflect the sharp increase in uncertainty about the future path of interest rates and corresponding increase in the volatility of interest rate futures, unlike during the pre-pandemic QT when it was expected that policy rates would continue to be low for an extended period.

Distinguishing these various effects is not straightforward and suggests any estimates of the magnitudes of these relationships should be interpreted cautiously. Economic relationships during the 2008–2019 period may be meaningfully different than over 2020–23, particularly as there is no good historical precedent for the movements in many key macroeconomic variables around the pandemic cycle (see Forbes et al., 2024).

3. QT Announcements: Impact on Rates and Spreads in Mortgage Markets

To provide a cross-check on some of the empirical estimates in DSSS and better understand these relationships during the 2020–23 period, this section focuses on one of the highlighted transmission channels: from Federal Reserve balance sheet policy to mortgage rates and spreads. More specifically, I summarize the (limited) results in the academic literature and then extend the analysis in Du, Forbes and Luzzetti (2024) to test how Federal Reserve QT announcements impact mortgage and MBS rates, Treasury yields, and the corresponding spreads — both before and after the pandemic.

3.1 A Previous Evidence: Impact of QE and QT Announcements

Although there is an extensive literature estimating the impact of U.S. QE on a range of financial market variables, surprisingly few papers have estimated the impact on mortgage rates, and almost none (to my knowledge) on mortgage spreads. Only one paper, Krishnamurthy and Vissing-Jorgensen (2013), focuses on the impact of QE programs on MBS and mortgages, with detailed empirical and theoretical analysis of the different channels through which asset purchases can have different effects on MBS and Treasury markets.

Table 1
Previous Evidence: Effects of U.S. QE and QT on MBS and Treasury Yields

Research Paper	Episode	30y MBS yields (bps)	10y UST yields (bps)
QE Episodes			
Krishnamurthy & Vissing-Jorgensen (2012, 2013)	QE–1	–107	–107
Gagnon, Raskin, Remache & Sack (2011)	QE–1	–113	–91
Krishnamurthy & Vissing-Jorgensen (2012)	QE–2	–8	–30
Krishnamurthy & Vissing-Jorgensen (2013)	QE–2	–12	–18
Krishnamurthy & Vissing-Jorgensen (2013)	MEP	–23	–7
Krishnamurthy & Vissing-Jorgensen (2013)	QE–3	–15	–3
Casalena (2024)	Pandemic QE	–34	–4
QT Episodes			
Smith & Valcarcel (2023)	Taper 1+ QT–1	+46 /+48	+28 /+29
Casalena (2024)	Taper 1	+7	+7
Casalena (2024)	QT–1	+1	0
Casalena (2024)	Taper 2	+2	+2
Casalena (2024)	QT–2	+5	+5

Notes: Results reported above are coefficient estimates from event studies estimating the effects of U.S. QE and QT announcements on the yields reported on the right. All episodes listed above include Federal Reserve purchases (or roll-off) of both Treasuries and MBS, except QE2 (which only includes Treasuries) and QE3 (which only included MBS).
Sources: Estimates are taken directly from the research papers listed in the left column.

Table 1 summarizes this limited research linking U.S. QE and QT directly to MBS yields. Each of the programs listed on the table include Federal Reserve announcements of net purchases/unwind of both Treasuries and MBS except for QE-2 (which only included Treasuries) and QE-3 (which only included MBS).[2] Krishnamurthy and Vissing-Jorgensen (2012, 2013) and Gagnon et al. (2011) estimate that the cumulative effect of their QE-1 events was to reduce yields on 30-year MBS by a cumulative 107 bps and 113 bps, respectively.[3] Estimates of the impact of other QE programs tend to be much smaller, sometimes close to zero, and usually insignificant. Estimates of the post-pandemic QE are larger than for QE-2, but about one-third that for QE-1.

Estimates of the impact of QT on mortgage rates are reported at the bottom of Table 1 and are even more limited. Smith and Valcarcel (2023) estimates that the impact of QT-1 announcements, which they define as including information on the tapering of QE-1, increased 30-year MBS by an insignificant 46bps; when they only focus on the impact of tapering announcements, however, the estimated impact becomes significant (although only increases by 2bps). Casalena (2024) does not include tapering announcements and finds much smaller effects of QT-1 (2017–2019) and QT-2 (2022–2024) on MBS — an insignificant 1 bps and borderline significant 5 bps, respectively.[4]

The direction and relative magnitudes of these estimates support earlier work; QE corresponds to a reduction in yields on a range of assets and QT corresponds to an increase in yields. These effects would be expected even if the Fed was not purchasing (or unwinding) its MBS holdings due to standard signaling or portfolio rebalancing effects, the which affect demand for a range of bonds and other assets that are not part of Federal Reserve's balance sheet programs. Also, research shows that QE corresponds to a larger reduction in yields during periods of market stress and illiquidity (e.g., during QE-1), and the more muted effects of QT relative to QE (with the sign reversed) at least partly reflect calmer market conditions when central banks shrink balance sheets (Du et al., 2024).

The main contribution of DSSS, however, is not these types of estimates of the impact of balance sheet policies on mortgage or MBS rates, but on the corresponding spreads (i.e., relative to that of U.S. Treasuries). An easing (tightening) of monetary policy should reduce (increase) MBS and Treasury yields, but the key channels laid out in the paper suggest the impact on MBS yields should be greater than for Treasuries, an effect captured in the relative spread. To see if there is evidence supporting this, the right column in Table 1 reports estimates from the same studies of the impact of different QE and QT episodes on U.S. Treasury yields.

The evidence on whether U.S. balance sheet policies affect MBS spreads (instead of simply affecting MBS yields) is mixed. In some cases, the estimated effect of balance sheet adjustments on MBS yields is larger than for Treasuries — such as for QE-1 in Gagon et al. (2011), for the MEP and QE-3 in Krishnamurthy and Vissing-Jorgensen (2013), for the pandemic QE in Casalena (2024), and for QT-1 in Smith and Valcarcel (2023). In other cases, however, there is no clear difference in the effects on MBS relative to Treasury yields, and even in some of the cases where there are modest differences, these are unlikely to be statistically significant. Moreover, one of the examples with the largest impact on the difference between MBS and Treasury yields is for QE-3 — which is not surprising as this is the one episode when QE only involved net purchases of MBS (and not Treasuries).

One final note of caution for this series of results is that most of this literature focuses on the effects of QE in the period immediately after the collapse in the housing market. During this period, Federal Reserve purchases of housing-related assets would be expected to have a larger impact through channels such as the "capital constraint" and "scarcity" channels, as the market for housing finance was more constrained (see Krishnamurthy and Vissing-Jorgensen, 2013).

3.2 New Evidence: Impact of QT Announcements

To test for the impact of U.S. balance sheet policies on MBS spreads more systematically, and to better understand the post-pandemic experience with QT that is the focus of DSSS, I extend the data and framework developed in Du, Forbes and Luzzetti (2024). Du et al. (2024) compiles a timeline of QT events since 2020 for a sample of seven advanced economies and then estimates their impact on a range of financial market variables — but not MBS or mortgage rates. I replicate their framework, and use their U.S. QT announcement dates, but now estimate the impact on the seven variables related to the housing market used in DSSS (kindly provided by the authors):

- *Mortgage Rate:* Primary mortgage rate (daily, 30-year fixed rate, conforming mortgage index).
- *MBS Rate:* 30-year rate (FNCL par coupon index).
- *Treasury Yield:* 10-year market yield on U.S. Treasury Securities (constant maturity, quoted on an investment basis).
- *Mortgage Spread:* Mortgage Rate to Treasury Yield.
- *MBS Spread:* MBS Rate to Treasury Yield.
- *Option-adjusted MBS Spread:* MBS Spread that removes the estimated value of the prepayment option and other components such as mortgage fees.

Next, I adapt the cross-country model in Du et al. (2024) in order to apply the framework to one country (the United States), and use daily data from January 2014 through September 2023 to estimate:

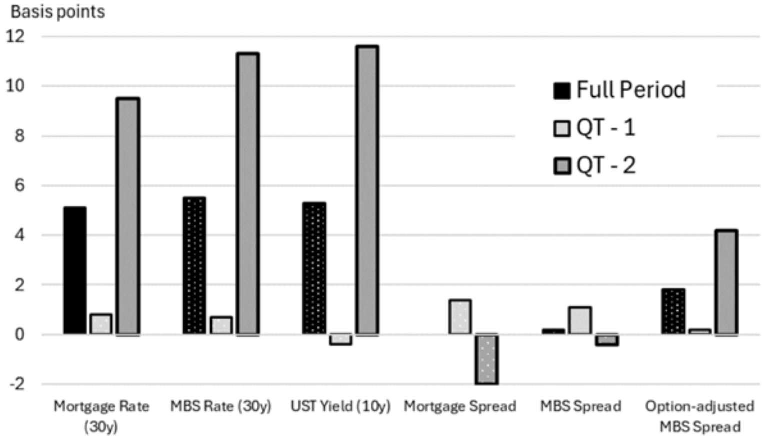
$$\Delta y_t = \alpha + \beta QT_t + \gamma IntSurprise_t + \delta EconSurprise_t + \varepsilon_t \ . \ (1)$$

The Δy_t is the change in the relevant rate, yield, or spread listed above over the two days from $t\!-\!1$ (i.e., the closing price the day before the QT event) through $t\!+\!1$ (i.e., the closing price the day after the QT event). The QT_t is a dummy equal to 1 if a QT event occurs on date t.[5] The other explanatory variables control for monetary policy and economic data at time t that could affect the left-hand side variables; $IntSurprise_t$ is any surprise in the policy interest rate (measured as the difference between the policy rate announced on t relative to Bloomberg median expectations from market analysts on $t\!-\!1$)[6] and $EconSurprise_t$ is other economic data news (measured as the change in the Citigroup Economic Surprise Index over the same two-day window).[7]

The results for all U.S. QT announcements since 2020 (also referred to as QT-2 or the post-pandemic QT) are reported in the top panel of the Appendix Table. Post-pandemic QT announcements are correlated with a significant increase in mortgage and MBS rates of 10–11bps. QT announcements are also correlated with a similar (and significant) increase in Treasury yields, however, such that the impact on the mortgage and MBS spreads is insignificant and basically zero. When the MBS spread is adjusted for the estimated value of the prepayment option and other components, however, the coefficient becomes positive and marginally significant, consistent with the thesis in DSSS. The magnitude suggests individual QT-2 announcements increased the option-adjusted MBS spread by 4 bps, and when aggregated across the three "main announcements" of new or faster QT, aggregates to a total impact of +12 bps.[8]

Next, I extend this analysis to test if QT announcements had different effects after the pandemic as compared to QT-1 or all U.S. QT announcements. Regression results are reported in the Appendix Table, but for ease of reference, Figure 1 compares the key coefficient estimates for the QT dummy in equation 1 for: (1) the full sample

Figure 1
Impact of U.S. QT Announcements on Mortgage Yields and Spreads



Notes: Chart shows coefficient estimates for QT dummy in equation (1) explaining the two-day return of the variables listed on the x-axis. QT dummies are dates of "major announcements" of news related to QT in the United States. Regressions also control for interest rate surprises and other economic data news. Regressions for QT-1 include daily data from 2014–2019 and for QT-2 from 2021–2023 (Sept). Regressions for Full Period include QT-1 and QT-2 windows. Bars have white dots if the coefficient estimate is not significant at the 10% level.
Sources: Based on regression estimates of equation (1) in text. Data for variables listed at the bottom is from DSSS and for other variables from Du et al. (2024).

period; (2) QT-1/before the pandemic; or (3) QT-2/after the pandemic.[9] The estimates suggest that QT events before the pandemic had much smaller effects on each financial variable. In fact, the only significant effects of QT announcements (at the 5% level) on any of the variables occurs during the post-pandemic QT. This more muted effect of QT before 2022 could reflect the more gradual roll out and slower pace of QT-1 — consistent with Chair Yellen's description of it being comparable to "paint drying".[10] This is also consistent with QT-2 being interpreted as providing a stronger signal of central bank commitment to higher interest rates than with QT-1 (as discussed in more detail in Du et al., 2024).

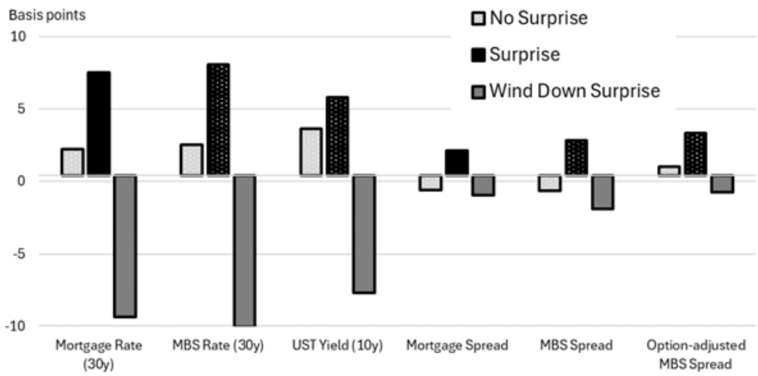
While the effects of QT-2 announcements on mortgage rates and spreads are consistent with the discussion in DSSS of how Federal Reserve balance sheet policies affect mortgage markets, the magnitude appears to be weaker than estimated in DSSS. More specifically, DSSS estimates that the impact of the pandemic QE was to reduce mortgage spreads by about 42 bps.

There are several possible explanations for why the estimates reported above are smaller than those in DSSS. First, the empirical analysis in DSSS focuses on the impact of QE after the 2008 financial crisis, rather than QT, and research suggests QE had a greater impact on a range of variables than QT as it occurred in periods of heightened market stress and reduced liquidity (as discussed above, and particularly in the housing market). Second, the Federal Reserve purchased about $1 trillion of MBS during the pandemic-QE, while it has only reduced its holdings by about $300bn during the post-pandemic QT (with the much slower pace expected to continue given the slow rate of mortgage refinancing). Finally, the QT announcements that are the focus of the event study above may have been expected by investors, such that some of the effects on yields and spreads were incorporated in advance — a standard concern in event studies. Although the negative and significant impact of QT-2 announcements on mortgage, MBS and Treasury yields suggests that there was still some news in the QT announcements, the extent to which these announcements were expected could generate a downward bias in coefficient estimates and underestimate the effects of QT events.

To further explore the extent of any such bias from QT events being priced into yields and spreads in advance, I re-estimate equation 1, but now focus on the longer time period (that includes QT-1 and QT-2) and then examine the impact of the QT announcements that were a *Surprise* compared to those that were not a surprise.[11]

The resulting effects are reported in Figure 2 and should be interpreted cautiously as the number of QT announcements in each group is very limited. With this caveat, the *Surprise* announcements had a larger impact on mortgage and MBS rates (as compared to *non-Surprise* events), but also on Treasury yields, such that the combined effect is an increase in mortgage and MBS spreads of 2–3bps per each QT event, for a cumulative impact of 8–12bps across all four *Surprise* events (including for the option-adjusted spread) — very similar to results when not controlling for the "surprise" component of

Figure 2
Impact of U.S. QT Announcements: "Surprise" versus "non-Surprise" Events



Notes: Chart shows the effect of QT announcements that are a surprise or not a surprise, based on classifications in Du et al. (2024). Each regression includes all QT events that involve information on new or additional QT, except the "Wind Down" surprise, which is the announcement on March 20, 2019 that QT would be ended sooner than expected. Regressions explain the two-day return for the variables listed on the x-axis using daily data from 2014–2023 (Sept) and control for interest rate surprises and other economic data news. Bars with white dots indicate the QT dummy is not significant at the 10% level.
Sources: Based on regression estimates of equation (1) in text. Data for variables listed at the bottom is from DSSS and other data and classifications from Du et al. (2024).

the announcement. The *Surprise* announcement that QT would be ended sooner than expected on March 2019 corresponded to a sharp fall in mortgage and MBS rates (of about 10bps), but also only had a modest impact on the corresponding mortgage and MBS spreads (of 1 to 2 bps). Overall, these results continue to suggest that QT announcements effect mortgage spreads in the direction predicted in DSSS, but the magnitude of the effects may be more modest than of those presented for QE (in reverse) — even when focusing on the smaller number of QT announcements that were more of a surprise.[12]

To conclude, this analysis suggests that QT tends to increase MBS and mortgage rates, but has similar and only slightly smaller effects on Treasury yields, so that the impact on mortgage and MBS spreads is positive but fairly muted. The effects are consistent with the transmission of QE/QT programs to mortgage markets as discussed in DSSS, although the magnitude appears to be smaller than suggested by their analysis. At least some of this difference likely reflects that estimates of the impact of early QE programs tend to be larger as markets were illiquid, particularly for housing-securities after the 2008 crisis. As a result, estimates of relationships between Federal Reserve balance sheet policies and yields (particularly for housing securities) based on the early window (and used for the counterfactual in DSSS) likely overstate the impact of balance sheet policies in other periods. These differences in magnitudes, however, could also reflect the smaller effects generally found in QT programs in general (as compared to the QE that is the focus of DSSS' empirical estimates), as well as the smaller magnitude of QT in the United States to date than in other countries (Du et al., 2024), as well as other shortcomings in the event-study approach used above.

4. Insights from the Cross-Country Evidence?

There has been substantial macroeconomic volatility during periods when the Federal Reserve adjusted its MBS holdings; not only was the period around the 2008 crisis unusual in the collapse of the housing market, but Forbes et al. (2024) documents the many ways in which the pandemic rate cycle was unusual — if not unprecedented — based on the historical experience. Isolating the direct impact of specific policy changes on any macroeconomic variable is extremely challenging during these periods; the relationships between some macroeconomic variables may change meaningfully across different windows, and it can be difficult to identify relationships when multiple macroeconomic variables simultaneous experience large movements. Could some of the effects of Federal Reserve balance sheet policies discussed above and in DSSS reflect other news or events that occurred over the periods when the Federal Reserve adjusts its MBS holdings? Could differences in the macroeconomic environment during the 2010's relative to the early 2020s explain differences in the effects of balance sheet policies in these different periods?

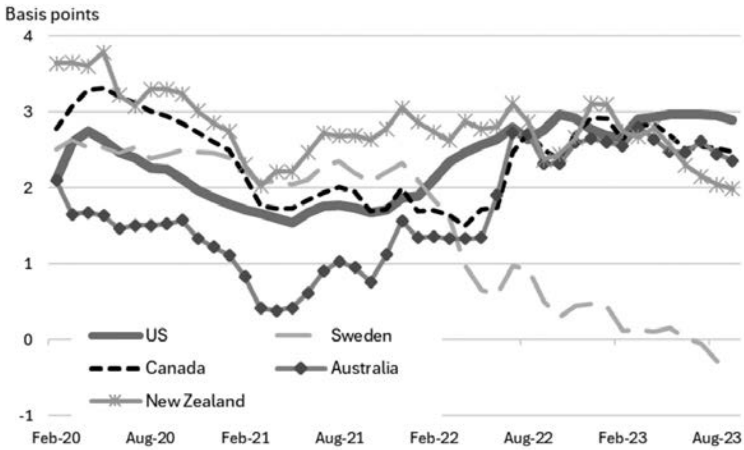
More specifically, as inflation picked up in 2022, Federal Reserve meetings, speeches, and announcements that included information on QT often included guidance (whether formal or not) suggesting monetary policy would be tightened more than previously expected. This also occurred in a macroeconomic environment during which the recovery and inflation was stronger than expected, involving a constant reassessment (usually upward) for the path of interest rates. Could the estimated impact of Fed QT-2 announcements on mortgage markets reflect this increase in interest rate volatility, more uncertainty about the future path of interest rates, or other changes in the macroeconomic environment — rather than the direct impact of balance sheet policy? Could the even more muted effects of QT-1 on the mortgage market reflect the macroenvironment in the 2010s (i.e., low inflation, slow growth, and a lower and flatter expected path for interest rates) rather than any impact of changes in the Federal Reserve's balance sheet policy?

In order to better control for the broader macroeconomic environment and identify the effects of balance sheet policy on the mortgage market, one potentially fruitful approach could be to analyze these transmission channels in economies that did and did not purchase (or unwind) mortgage securities, but which otherwise faced similar macroeconomic backdrops. This cross-country, panel approach to better identify the channels discussed above and in DSSS could be particularly useful during the post-pandemic period as many of the sharp swings in macroeconomic variables (including for inflation, policy interest rates, and term premia) were broadly shared across the major advanced economies.

To explore if this cross-country approach could be useful, Figure 3 graphs mortgage spreads for five advanced economies for which data on at least a monthly basis is available (Australia, Canada, New Zealand, Sweden, and the U.S.) from just before the COVID-19 pandemic through September 2023.[13] Central banks in each of these economies not only raised interest rates sharply, but implemented QT over 2022–2023. The United States, however, is the only one for which the purchase and unwind of MBS has been a major component of their QE/QT programs, with purchases of MBS occurring over March 2020-March 2022, and MBS holdings rolling off the balance sheet (subject to caps) from June 2022.[14]

While it would be dangerous to draw any strong conclusion for a comparison of these mortgage spreads — especially as each is constructed based on different mortgage bonds/contracts — there is not a clear pattern that U.S. mortgage spreads fell more sharply than those in other countries because the Federal Reserve included MBS in its QE programs (with all countries starting QE around March/April

Figure 3
Mortgage Spreads in Advanced Economies



Notes: Chart shows mortgage spreads for each economy, defined as the difference between the mortgage rate and the 10-year government bond yield. The definition of the mortgage rate varies meaningfully across countries based on data availability. In each case, I use the rate for the longest term loan available.
Sources: Data on mortgage rates and yields is from Datastream for all countries except the U.S. Data on mortgage rates for each country is: Australia — bank lending rate for housing loans, 3-year fixed; Canada — conventional mortgage lending rate, 5-year term; New Zealand — new residential mortgage interest rate, 5-year term; Sweden — average mortgage rate for major banks, 10-year term. Data for the U.S. is from DSSS, with the mortgage rate the 30-year fixed rate.

2020). There is also no clear pattern suggesting that these mortgage spreads rose more quickly in the United States than in other countries when the Federal Reserve included MBS in its QT programs.[15]

A closer look at the data underlying Figure 3 however, suggests that the ability of cross-country analysis to better understand the transmission of Federal Reserve balance sheet policy to U.S. mortgage markets is limited. The U.S. mortgage market is unique in many measures. It has a larger share of long-term fixed mortgages, and a much larger and more liquid market for MBS. This reflects a number of historical developments — including government support for the U.S. housing agencies (Fannie Mae and Freddie Mac). Most other countries that have used QE and QT do not even have comparable, public daily data on mortgage or MBS rates — making it impossible to repeat the event studies reported above for other countries.

5. Lessons for Policy: Should Mortgage Bonds be Included in Quantitative Easing Programs?

If adjustments to central bank holdings of MBS affect mortgage markets not just through their effects on general borrowing costs, but also the additional effects discussed in DSSS, there are a number of important considerations for central banks' balance sheet policies. I will discuss two. (1) Should countries that have included MBS as central to their QE programs (i.e., the United States) continue to do so in the future? and (2) Should countries that have not included mortgage securities (i.e., most other countries) do so in the future?

MBS have been a central component of the U.S. Federal Reserve's QE programs and subsequent balance sheet adjustments. In fact, the Federal Reserve has generally included both Treasuries and MBS when it starts a major new QE or QT program, or when it announces plans to taper any ongoing purchases (albeit with different magnitudes to reflect different market sizes). This made sense when the Federal Reserve began its QE program in response to the collapse of the housing market and corresponding financial crisis in 2008. The housing market was at the core of systemic financial vulnerabilities — and supporting the U.S. housing market was central to stabilizing financial markets and supporting a broader economic recovery.

But does this largely symmetric treatment of Treasuries and MBS make sense in other situations that merit QE (or QT)? More specifically, when the Federal Reserve restarted asset purchases from March 2020 through March 2022, should it have purchased MBS as well as Treasuries?

There were a number of reasons to initially include MBS in the QE that was started in 2020 in response to the pandemic. As economic activity collapsed, liquidity dried up, and the "dash for cash" threatened market functioning, there was a case to buy a wide range of assets to stabilize financial markets. Speed and scale were of the essence. Rolling out a program similar to that used in the past was not only fast, but including MBS would support the larger scale believed to be required. By simply repeating the former playbook, there was no discussion of special preference (or not) for a specific market (i.e., housing), which could introduce calls for preferential treatment for specific sectors in the future (such as for climate-friendly bonds or manufacturing). If a larger scale or scope of purchases was needed than could be required with Treasuries, purchasing other assets (such as corporate or municipal bonds) was less attractive than MBS as it would involve developing new programs and introduce a host of additional concerns around corporate governance and moral hazard.

After the initial period of financial turmoil in the spring of 2020, however, the housing market quickly recovered — and then took off. Housing prices picked up to above pre-pandemic highs — spurred by a combination of people prioritizing more space and homes away from urban centers, combined with lower mortgage rates and fiscal support boosting incomes. The housing market appeared to be more at risk of overheating and potentially contributing to future vulnerabilities, rather than of collapsing. If Federal Reserve purchases of MBS further fueled this boom through the channels discussed in DSSS — and in addition to the boost from holding interest rates around zero and purchasing U.S. Treasuries — these MBS purchase should have been ended sooner. Even if uncertainty about the sustainability of the broader economic recovery justified a continuation of highly accommodative monetary policy, it should have been possible to keep policy rates around zero and continue Treasury purchases, but move forward the tapering and then end of MBS purchases (and thereby reduce the risks from an overheated housing market in the future).[16]

Another reason for asymmetric treatment of MBS and Treasuries in any QE program in the future is the greater difficulty unwinding MBS holdings. For most countries (including the United States), the primary method for reducing central bank bond holdings is passive QT — i.e., allowing bond holdings to roll-off central bank balance sheets when they expire. The rate of passive run-off varies meaningfully across countries based on the maturities of their holdings (and any caps/limits on run-off). In the United States, a large volume of Treasuries held by the Federal Reserve expire each month, so that it is straightforward to shrink this portion of the balance sheet gradually over time through passive QT.[17] On the other hand, MBS tend to run off more slowly and irregularly, particularly in an environment of elevated interest rates (such as today), which reduces the incentive for households to move and/or refinance their mortgages. The roll-off of MBS from the Federal Reserve balance sheet is so slow during QT-2 that it has not even met the monthly cap most months. Given this greater difficulty reducing balance sheet holdings of MBS than Treasuries, any future QE programs should prioritize making any balance sheet adjustments through Treasuries (barring a clear reason why the housing market needs support).

Shifting from the U.S. to other economies, should other central banks consider placing more emphasis on MBS or similar housing-related finance as part of any asset purchases programs or balance sheet management? The analysis in DSSS suggests that this could be a powerful transmission mechanism for monetary policy.

As discussed above, however, no country has a deep, liquid market for long-term mortgage securities comparable to that for the United States. This would make it substantially more difficult for other central banks to include large-scale mortgage bond purchases in QE programs aimed at supporting the broader economy. Purchasing bonds of one specific sector — especially in a less liquid market — would introduce a host of additional concerns around corporate governance and distortions to market pricing. In cases where specific support for the housing sector is merited, mechanisms other than central bank asset purchase are likely to be better places to start — such as programs supporting bank lending for mortgages (particularly in countries where banks are the dominant providers of mortgage financing). Moreover, as shown in DSSS, the deposit channel of banks should support housing markets — above and beyond the direct impact of lower policy rates — even in the absence of central bank purchases of mortgage bonds.

6. Conclusions

The paper by DSSS is a useful resource for anyone interested in understanding the channels by which monetary policy is transmitted to the housing market. Easing and tightening monetary policy can affect the housing market not only through the direct impact on general borrowing costs, but also through additional channels related to changes in the demand for MBS by price-insensitive buyers (banks and the Federal Reserve). New empirical results reported in this discussion are consistent with Federal Reserve purchases of MBS reducing mortgage rates meaningfully, and generating a more modest reduction in mortgage spreads (relative to Treasury yields). Identifying the precise magnitude of these effects in this unusual period of heightened macroeconomic and financial volatility, however, is challenging.

This deeper understanding of how monetary policy, and particularly central bank balance sheet policy, is transmitted to the mortgage market raises important questions for the future. If the Federal Reserve is forced to resort to large-scale asset purchases again, should it automatically include mortgage-backed securities? When does the housing market merit the additional support from the channels discussed in DSSS as well as those from changes in economy-wide borrowing costs? This discussion suggests the Federal Reserve should be more judicious about including MBS in any QE programs in the future, especially as it is more difficult to unwind these holdings than for Treasuries. The upcoming Strategic Review could be an opportune time to consider different scenarios and develop general principles to guide exactly what to include if asset purchase programs are required at some point in the (hopefully distant) future.

Endnotes

[1]For example, D'Amico and Kaminska (2019) finds that the U.K. corporate bond purchase program reduced spreads for all types of bonds, but had a greater impact on bonds eligible for the program (and stimulated bond issuance more broadly). Krishnamurthy and Vissing-Jorgensen (2013) finds a greater impact on MBS and Treasury yields when each type of security is included in the QE program, with minimal spillovers to other asset classes.

[2]More specifically, in QE-2 the Federal Reserve used principal repayments from its agency holdings to purchase long-term Treasury bonds (but not MBS). In QE-3 the Federal Reserve made additional purchases of MBS, but not Treasuries. In MEP, the Federal Reserve announced it would reinvest principal payments from its holdings of agency debt and MBS into MBS (leading to a net increase in MBS purchases), as well as extend the maturity of its portfolio by purchasing long-term Treasuries and selling short-term Treasuries. See Krishnamurthy and Vissing-Jorgensen (2013) for details on each program.

[3]Krishnamurthy and Vissing-Jorgensen (2012) also estimates the impact on yields of 15-year MBS and agency debt of a range of maturities. The estimated effects range from –88 to –200bps during QE1 and –8 to –29 for QE2.

[4]Casalena (2024) uses an alternate measure of MBS yields: the MBS yield-to-worst for interest rates on 30-year mortgages.

[5]In the initial analysis reported below, I only focus on QT events classified as "main announcements" in Du et al. (2024). These are events that provide concrete information on the date and/or magnitudes of QT and do not include events defined as "preliminary discussions" (which are more general principles and frameworks for QT programs without specifics). Du et al. (2024) shows that "preliminary discussions" had no significant effect on any financial market variables.

[6]If analyst expectations are not available in Bloomberg (often before 2020), I use the difference relative to the comparable OIS rate on t–1.

[7]All regressions are estimated with robust Newey-West standard errors with 5-day lags to adjust for any serial correlation, including that introduced by the two-day windows. I also exclude the day before the QT announcement and the four days after in order to avoid treating any market news just before the announcement or any lagged effects as being a "non-event" day. These exclusion windows have no impact on key results. See Du et al. (2024) for details and sensitivity tests.

[8]See the appendix in Du et al. (2024) for details on these three events.

[9]The full sample period is from 01/01/14–09/28/23. The subsample used to estimate the effects of QT-1 ends on 12/30/19, and that used for QT-2 begins on 01/01/21.

[10]See the June 2017 Post-FOMC Press Conference by Chair Janet Yellen. Available at https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20170614.pdf

[11]I use the approach and definitions from Du et al. (2024) to classify individual QT events as a “surprise”. As noted in this paper, this classification is not straightforward and requires a fair degree of judgment. Results are similar if I instead estimate the impact of each individual QT announcement and then compare the average impact of the QT surprise events relative to the other QT events.

[12]Du et al. (2024) also finds that adjusting for whether QT events were a surprise only has a modest impact on coefficient estimates.

[13]The mortgage rates used to construct these spreads are not consistent across countries, but in each case the spread is relative to the 10-year yield on government bonds. The mortgage rate is the longest, fixed rate available over the relevant time period on Datastream. This fixed rate is substantially shorter for each country than the 30 years for the U.S. rate. See notes to figure for details.

[14]Other countries have included assets related to housing markets in their asset purchases programs, albeit none to the extent of the Federal Reserve. For example, the ECB has included euro-denominated covered bonds in some of their asset purchase programs and the Bank of Japan has purchased shares in real estate investment trusts (REITs). A number of countries also provided subsidized financing for banks as part of their pandemic response, which could in turn support mortgage lending.

[15]The dates when the other economies in the figure announced the start of QT are: 05/03/22 in Australia, 04/13/22 in Canada, 02/23/22 in New Zealand, 04/28/22 in Sweden.

[16]Granted, this would have required careful communication so that the tapering of MBS purchases was not interpreted as a signal of tapering other asset purchases or an earlier increase in interest rates. This would likely have required advance discussion of why the treatment of MBS and Treasury securities were not automatically symmetric.

[17]See Du et al. (2024) for details and a simulation for the future.

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Appendix Table

Regression Results: Impact of U.S. QT Events

Post-Pandemic QT (2021-2023 (Sept)

	Yields/Rates			Spreads		
	Mortgage Rate (30y)	MBS Rate (30y)	US Treasury Yield (10y)	Mortgage Spread	MBS Spread	Option-adjusted MBS Spread
QT Dummy	0.095***	0.113**	0.116***	-0.020	-0.004	0.042*
	(0.037)	(0.053)	(0.033)	(0.016)	(0.023)	(0.024)
Interest Rate Surprise	-0.154***	-0.852***	-0.719***	0.565***	-0.133***	-0.669***
	(0.043)	(0.064)	(0.045)	(0.023)	(0.028)	(0.028)
Economic Data Surprise	1.922***	2.888***	1.917***	-0.059	0.971***	0.849***
	(0.504)	(0.742)	(0.524)	(0.314)	(0.325)	(0.326)
Observations	358	360	360	357	360	360
R2	0.063	0.063	0.067	0.023	0.026	0.046

Pre-Pandemic QT (2014-2019)

	Yields/Rates			Spreads		
	Mortgage Rate (30y)	MBS Rate (30y)	US Treasury Yield (10y)	Mortgage Spread	MBS Spread	Option-adjusted MBS Spread
QT Dummy	0.008	0.007	-0.004	0.014	0.011*	0.002
	(0.008)	(0.011)	(0.014)	(0.011)	(0.006)	(0.008)
Interest Rate Surprise	-0.095	0.055	0.301	-0.229	-0.246	-0.186
	(0.192)	(0.344)	(0.234)	(0.145)	(0.215)	(0.143)
Economic Data Surprise	0.540*	1.416***	1.589***	-0.645***	-0.173	0.044
	(0.302)	(0.368)	(0.363)	(0.216)	(0.140)	(0.201)
Observations	420	825	825	418	825	823
R2	0.009	0.022	0.030	0.024	0.010	0.003

Full Period (2014-2023, Sept)

	Yields/Rates			Spreads		
	Mortgage Rate (30y)	MBS Rate (30y)	US Treasury Yield (10y)	Mortgage Spread	MBS Spread	Option-adjusted MBS
QT Dummy	0.051*	0.055	0.053	0.000	0.002	0.018
	(0.026)	(0.036)	(0.032)	(0.013)	(0.014)	(0.015)
Interest Rate Surprise	-0.087	-0.370	-0.163	0.202	-0.208*	-0.444***
	(0.102)	(0.316)	(0.307)	(0.213)	(0.109)	(0.151)
Economic Data Surprise	1.374***	2.130***	1.760***	-0.296	0.370**	0.426**
	(0.319)	(0.394)	(0.313)	(0.210)	(0.171)	(0.188)
Observations	778	1,185	1,185	775	1,185	1,183
R2	0.038	0.039	0.037	0.007	0.009	0.020

Notes: Chart shows regression results for equation (1) explaining the two-day return of the variables listed at the top. QT dummies are dates of "major announcements" of news related to QT in the United States. Estimated on daily data over the time period noted above each section of the table, but the day before the QT event and four days after are excluded, as well as periods of heightened market turmoil in 2020 and around the SVB collapse. Newey-West standard errors with 5-day lags to adjust for serial correlation. ***, **, and * denotes significance at the 10%, 5% and 1% levels, respectively.
Sources: Author's calculations. Data for variables listed at the bottom is from DSSS and for other variables from Du et al. (2024).

General Discussion: The Transmission of Monetary Policy Through Bank Balance Sheets

Moderator: Andréa Maechler

Andréa Maechler (Moderator): Thank you very much, Kristin. Clearly it's been very nice how you highlighted MBS. MBS is very specific to the United States. It's central to the transmission mechanism. It is also an asset class on its own. So now it is really time to hear from the floor.

Adriana Kugler: I have two questions for Philipp. One is about the potential future effects on mortgage credit supply through this deposit channel, and I do understand that you say this responsiveness of deposits to monetary policy has been around for a while, but on the other hand, the correlation between deposits and MBS holdings has not always been as high as it was during the pandemic and after the pandemic. It went from 0.8, and it used to be more like close to 0.2, 0.3. So I'm just wondering why you think this will continue to play such a big role. Also, obviously, as you highlighted as well, the non-banking sector has played a greater role in terms of originations, about two-thirds of originations. They come from that sector and also in terms of MBS holdings, so that may mitigate the effects through this deposit channel. And then the second question, I would have really loved to see, and you may be working on a new version of this, but it would be great to know what the effects of these mortgage credit supplies on housing inflation. Obviously, that's something that we care deeply about, but also on the real economy, say, for example, in consumption through mortgage-free financing and through other channels.

Deborah Lucas: I enjoyed the presentation, but I wanted to question the assertion that there is a natural deposit channel to mortgages and that somehow, if banks have sticky deposits, that putting them into mortgages makes sense. There's an important distinction between stable funding and stable value of investments purchased with that funding. We understand from basic finance principles that if you finance long-term mortgages with short-term deposits, you have this huge duration mismatch. That creates real solvency risk. Even if the depositors don't run, the mortgages are much more sensitive in terms of value than are the deposits. That is how Silicon Valley Bank got into trouble. Banks had a lot of excess deposits for the reasons that Kristin mentioned—people were saving a lot. But banks could have put the money into something more appropriate in terms of maturity like T-bills, even if there weren't a lot of commercial loans to be made. So, I think one has to be careful about saying it's natural. We all can remember the savings and loan crisis, and that was exactly the same story. Institutions that depended on stable deposit funding to fund long-term mortgages were fine until interest rates went way up. I also want to point out that another interesting thing about our mortgage market that distinguishes it from other countries is that so much of it is guaranteed by the government-sponsored enterprises, and that guarantee fees are very sticky over the cycle. To some extent, you do get a more direct transmission mechanism from monetary policy to the mortgage market, because in other credit-sensitive markets the spreads go up when the economy gets weaker. Here the government-sponsored enterprise spreads have been very stable. So, there are interesting specifics to our market also through that channel.

Michelle Bowman: Thank you. Others have already raised very important points, but I think what I might ask is each one of these events was very different, and even though there might have been some similarities in the aftermath and some of the decisions and treatments that were made regarding purchases of MBSs and those kinds of things, banks choose to invest in things because there's a regulatory preference for those kinds of investments too. So I think I would be interested to hear your thoughts about high-quality liquid assets and that kind of environment for a bank's choice and what they might hold on their balance sheet as well, and any correlations between future crises that might include the mortgage industry or the mortgage market. I would caution drawing too many assumptions about similarities going forward, because these were extremely different circumstances.

Amir Yaron: Thank you. First of all, Philipp, this great paper and the emphasis is very important on the MBS market and in general I think housing is a big vehicle for the transmission mechanism. But I do want to ask whether we can disentangle the general equilibrium effect of the main event here and the main stylized fact of the fact that QE was going on here. For example, when QE happens, there are other effects beyond the pure QE. You're affecting the risk-taking channel of banks. You're affecting the financial accelerator. It also fits the mortgage points that you made, because as interest rates go up, the collateral value goes down, and so mortgage spreads would naturally go up. So it's just that I think it's related to what Kirsten said. It's a very particular event and the QE has these general equilibrium effects. So that's point one. Point two is just about the inflow-outflow of the deposit channel. I think to me it's more of a composition effect. Until basically the Fed provided reverse repo to non-BFIs, this has to stay in the banking system. So this couldn't play a bigger role before it. So it's more of a composition effect that as the interest rate changes, you go into these large-time deposits through this channel and you don't necessarily change the quantity, but it's a compositional effect.

Philipp Schnabl: OK, thanks. Let's follow up these great questions. Governor Kugler, great question. How does this work in a world where a lot of non-banks originate mortgages and are the betas actually stable, are they changing? So on the origination piece, that's why we had some discussion in there. I think it is important to recognize that non-bank originators do sell almost all mortgages almost immediately to the GSEs and then there's a question of who buys them. And in some sense, that's why I put in this figure that the banks over the last three decades continue to hold roughly the same percentage of the mortgage market. And as such, I think they continue to be very important. On the deposit betas, I actually have a separate paper where we look at this very carefully. I've put up some historical estimates using data over the last 30, 40 years for betas, and now we have new estimates for this cycle. They're sort of in line with the historical evidence. So I refer you to that and I will be happy to send it to you. So we have detailed data on betas both from the past and this cycle around, and they're actually quite consistent.

To Professor Lucas's question, I completely agree that there's an issue of financing long-term deposits with short-term deposits which if they're uninsured, they can run, and the Silicon Valley Bank was a great reminder of that. As you may know, I have actually a paper looking at that very, very carefully. And so I think there's been some discussion around these, and I know a number of people here in the room have worked on it, whether the system should be such and what kind of changes we should make. I would point out as an empirical fact, I think it's true that the significant share goes into long-term assets, but it should be that way. I think that's sort of a discussion we can have, but I think in terms of how it's worked so far, that's why I showed you evidence going back in time. I think that that's very clear in the data.

There was another question about regulatory preferences. I agree. I think it ties into this issue. Obviously, regulation does play a role in terms of what assets banks want to invest in. I would say that if you look at that figure, which I showed in the last slide, that has been a very tight correlation for quite a while. So I think that would be one way to sort of disentangle how important is regulation.

And Governor Yaron, I agree general equilibrium effects are important. We did the best we could in the model. That's why we went to the pre-period, but I agree that there are a number of other factors we can think about. I would say on the reserves, there we're trying to be really careful. So that's why I said when we look at deposit flows, we understand that if they're reserves, you need deposits to hold them. And there was an important paper by Viral, who is here, and

Raghuram Rajan arguing that as the reserves, you create deposits, particularly uninsured deposits. That's why we are netting them out. My point is that even after you're netting them out, you have within two years basically a 45 percent increase of deposits. It's just massive. And so even taking into account the channel, I think that the deposit channel is still operating.

Erik Thedéen: Very good presentation. Just a few words on different markets. So in Sweden, the liquidity is of course very low, so the effects on the spread is very high. I would, though, make the distinction between the spread in the bond market, which is of course tightened a lot, and the spread to the actual mortgage rates paid by households. What happened, and I guess maybe that's true in the U.S. as well, when rates were really low, the spread mortgage rate in market and mortgage rate to household widened. So that's a quite, I think, important issue to have with you. Also on the thing we saw was that we were buying mortgages, and at the same time we were concerned about the effects on housing market in debt in the household sector, which of course was a dilemma. The government bond market was too small. We already had 50 percent of that market, so we had to buy at that time mortgages. From a credibility point of view, it was hard to sell, to say that we were really worried, but we were also buying to bring down, hence rates are going down. So I think that policy dilemma might be true for some other countries as well. Great paper and great discussion.

Robert Holzmann: Great paper, great conference. My main question is to what extent or what is missing is the effect of the transition on the prices of the housing, because what is often claimed is that quantitative easing has an effect on housing inflation, and this is not captured in here. And this goes back to what Kristin Forbes has been saying, then, whether in the future one focuses on mortgages or only on treasuries, and if you have mortgages, then you may have created something which you cannot control, which is not part of the discussion here, but should be because it has implications for the inflationary measurement.

Arvind Krishnamurthy: Kristin, you asked about the evidence relating unconventional policy and mortgage spreads. We show some of this in the 2013 paper that Annette Vissing-Jorgensen and I wrote for the Jackson Hole symposium, and you can really see the effects when you look at the option adjusted spread of the current coupon TBA mortgages, which is what the Fed buys. We see pretty strong effects of the Fed purchases on these spreads, very much in line with what Philipp is saying. But I view Philipp's paper as mostly about conventional policy. That's the new angle here about how traditional conventional policy rates impact mortgages and mortgage spreads. And so, Philipp, I have a question for you, which is, we know from work going back to Bernanke-Kuttner that conventional policy has large effects on risk premia. We've seen this in the impact of conventional policy on corporate bond spreads and term premia. I'd like to know whether there's something different about mortgages relative to these other asset classes. Maybe one way of getting at that is to look at measures like the current coupon spreads or the assets that the banks are particularly buying or the Fed is particularly buying where you can really pick out this asset purchase channel that you describe. That's one comment. Second, can you say a more about your mechanism. Your deposit channel mechanism is about duration. It's not about mortgages per-se. And so that begs the question, why mortgages and mortgage spreads, why not other long duration assets? And relatedly, we saw in the failure of SVB the issue of interest rate risk rising in the banking sector when rates are low, which then suggests a broader duration channel than just a mortgage channel. Is this mechanism optimal and should financial stability concerns, and particularly the prudential regulation of interest rate risk, take this into account?

Pierre-Olivier Gourinchas: I thought this was a very interesting paper. I wanted to make a comment more than a question. In the paper, the focus is on mortgage supply and the different channels through which monetary policy can affect that. But I want to go back to one thing you mentioned, Philipp, in your presentation, and I think also Adriana mentioned in her question, which is the impact on the real activity. We have to think about how the monetary policy broadly defined, whether it's interest rate policy or QE, QT, etc., transmitted to the real economy. And here I think we have a lot of evidence that the transmission of monetary policy is very different across different countries. We tried to do a 360 at the Fund in our most recent World Economic Outlook. One of the key differences we see is the share of fixed-rate mortgages that has a huge impact on whether a tighter monetary policy is going to transmit faster or slower to real activity. That's why we have big differences between countries like Sweden and countries like the U.S. And so I wanted to bring that back and maybe give you a chance to comment on that.

Philipp Schnabl: Okay. I will combine the questions from Erik Thedéen and Pierre Olivier Gourinchas. So we are aware that mortgage markets are very different across countries, and we have tried a bit to understand it, but I have to admit we are still puzzled by all the differences. What I do think is the common denominator, as far as I can tell, is that the deposit channel in particular, these low-beta deposits and deposits' inflows and outflows, quite important across countries. Now exactly where these deposits end up and what assets banks invest in, there seems to be quite a bit of variation, at least based on my conversations with some people here and generally looking at the literature. They may be in fixed-rate assets, maybe because of regulatory preferences, maybe because of other reasons. Maybe they end up in short-term assets. Either way, I would think that they are quite important in terms of determining provision of long-term credit or also having a big effect on banks' net interest margin and returns. I think it would be really interesting to study how that differs. So the common element, I think, is the deposit channel, but where it ends up, I think that differs and may not be the mortgage market.

Governor Holzmann, yes, so I think that also relates to PLDA's question and Governor Kugler's question. Sometimes, what are the effects beyond this? Those are great questions. We had to finish the paper somewhere. That's why in my presentation, I highlighted that I think it affects consumption. There's quite a bit of literature on that, especially refinancing. It affects the expansion of mortgage credit and therefore provides credit for construction. But importantly, we know, and I know a number of people in the room have worked on this, that changes in credit also affect home prices, which come with all other kinds of challenges, especially when you think about affordability. It's a bit outside of the scope of the paper, but if you do believe in the channel, I think it's a very natural question to follow up on. It relates to Kristin Forbes' comment of whether we should do this or not. I think understanding the channel and understanding the effects will help us to inform whether we want to engage in purchasing MBS going forward.

Then the last question I have from Arvind Krishnamurthy. This also relates to the discussion. The one paper which comes to mind is Arvind's paper from 2013 presented here at Jackson Hole. They do look at an event study regarding MBS and they do find an effect on the mortgage spread, if I'm not mistaken. They actually look at the option-adjusted spread. That's somewhat comforting. I should note that the event studies should only pick up half of the effect, but it's not going to pick up the deposit channel. We know that it's hard to control for expectations in this context. I think what we are doing in the paper, we're borrowing this methodology from demand-based asset pricing and estimating these elasticities, looking at it in a different way. I will look more at the studies which Kristin Forbes mentioned. I think Arvind also put his finger on a good point which relates to what Professor Lucas asked earlier. Should banks do that? Arvind and I had some exchanges about that and he has a very interesting paper on this topic. I think that's another thing to look at. Regarding the production coupon, what you mentioned, we could do something similar. I think that's a very good idea. We would like to tease about what's coming from the Fed, what's coming from the banks. There is an event study in the paper where we focus on the Silicon Valley Bank crisis and we think we can identify effects from the banking sector. We actually have some results in the Jumbo spreads as well. They're not in the paper. But we haven't thought about production coupons and that's a very good idea.

Anil Kashyap: Given that you've done all these deposit betas everywhere, can you say anything about what you think your estimates across countries say about whether the liquidity coverage ratio is calibrated sensibly?

Viral Acharya: I have a question each for Kristin and Philipp. My question is even if you net out the deposits because of QE injection of reserves, it's still going to affect the overall multiplier. So while you can get your estimates through the deposit channel, I think the quantum of deposits is still going to matter. The question to Kristin is there were huge differences in fiscal policy across different countries. Is there some way to exploit that in line of Philipp's work, which is do we have in different countries different levels of what Philipp calls "low beta" deposits as a result of the differences in fiscal policy and how would that affect the mortgage markets?

Anusha Chari: I'd like to focus on the relationship between interest rate volatility and spreads. This has to do with contraction risk from duration and alludes to the asymmetric nature of prepayment risk that was brought up. So, I'd like to ask you about how much you think that increases in interest rate volatility have driven up the risk associated with mortgage rates that lenders lock in which creates a lose-lose predicament for mortgage lenders when interest rate volatility goes up. And then if we look at the interest rate volatility estimates that are implied from hedging market insurance premia, such as swaptions on 10-year interest rate swaps, it suggests that we are in a high, if not crazy high, volatility period.

Fatih Karahan: Thank you. It's not obvious to me that the increase in deposits reflects a shift in household preferences, which I think is your argument. So because over the same period, there's also a massive increase in stock market participation, stock market investment. So I think it might make more sense to look at some form of a ratio of deposits to liquid wealth or something like that from other data sources. I think that would be nice.

Philipp Schnabl: A lot of great questions. The answer to Anil is I don't know. Any time I present something to Anil, he sort of asks questions which are like one round or two rounds away, but it's a great question, so we'll all think about it. To Viral, yes, asset composition can matter, and your paper obviously touches upon that. I do think as a first pass, netting out a reserve, and I think you would agree, is sort of important when we think about deposit flows. That's what we have done here, but I'm happy to look into this more, and I think I've gotten a similar comment during the break. There was a question on interest rate volatility. Very briefly, that's why we look at the option adjusted spread, so to sort of take that out, because that will increase if there's more volatility, and we think of the results being robust. If there's more volatility, the option is larger, and that's going to affect mortgage rate. That's exactly right.

To your point, it's not really a change in household preferences, so we explored it in detail in a QG paper we have from a couple of years ago. It's really the change in the price which depositors have to pay. That's what's driving this. I agree with you, there are other changes, and so that's why we have looked during previous periods and tried to isolate these facts in the cross section, so I would be happy to discuss this in much more detail.

Then the last point I have here on my questions, there was some discussion about whether it affects duration rather than MBS, and maybe this was Arvind who asked this. Let me just throw this out. That's going to be somewhat speculative, because as it relates to what Kristen said, she did say maybe we should buy treasuries instead of MBS, and obviously if we didn't, then this particular channel would potentially not go through. I do think, at least it's possible to think about a world where, well, if buying treasuries is what we focus on, and we didn't do this in this paper, it could be that deposit channel affects the term premium, just the way I showed you it affects the mortgage spread. Now, arguably treasury market is much bigger, it's much deeper, so there's a question of how large these effects would be, but if you look at treasury markets, a lot of it is on the short end, and if you look at the long end, a lot of it is held by banks. So we can't show that, we don't really have a good way of identifying it, and I would be much more careful sort of like suggesting that there is an effect, but at least potentially deposit channel may even affect long-term rates, and I'll leave it at that.

Andréa Maechler (Moderator): Alright, thank you, Philipp. Kristin, do you have anything to add?

Kristin Forbes: I can just quickly respond to a Viral's suggestion. I think it's a really nice suggestion, because the arguments in this paper are powerful. It's just really hard to identify anything using 2008–2010 data or what happened during the pandemic. So I like the suggestion, of going to cross-country data, including looking at different degrees of fiscal stimulus, how that affects bank deposits, how that spills over to the mortgage market, etc. There could be something there. I didn't focus on it in my remarks. The challenge is that this wouldn't work through banks buying MBS the same way as in the U.S., because the MBS market is different. But you could do an analysis looking at the additional investor bases that Philipp doesn't focus on as much that provide mortgage credit through other channels related to deposits. That would be a nice avenue for future work.

Panel: The Cash-flow Channel of Monetary Policy — Micro Evidence and Macro Outcomes

Ida Wolden Bache

1. Introduction

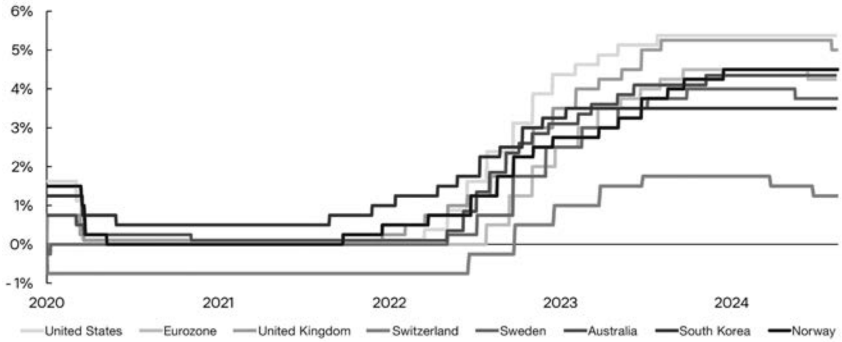
I want to start by thanking the Federal Reserve Bank of Kansas City for the invitation and for giving me the opportunity to be part of this year's policymaker panel. It's a pleasure to be here.

The tightening of monetary policy by central banks over the past few years has been unprecedented in several respects. Chart 1 shows the policy rates for a selection of developed economies. By some measures, the current tightening has been the most globally synchronized of all tightening episodes in the past half century.[1]

And still — the macroeconomic effects of this tightening may vary considerably across countries. My remarks today will focus on one particular aspect of the monetary policy transmission mechanism, namely the cash-flow channel from interest rate changes to household consumption.

I want to make three main points. The first one is that the cash-flow channel is quantitatively important, but its strength varies widely both over time and across countries depending on the composition of household balance sheets and on institutional features of mortgage markets. Second, high quality microdata are essential for gaining insight into this part of the transmission mechanism.

Chart 1
The Tightening was Synchronized Across Countries
Nominal policy rates 2020–2024



Source: LSEG Datastream

And third, the strength of the cash-flow channel has implications for the trade-offs we face as monetary policymakers, especially in small, open economies.

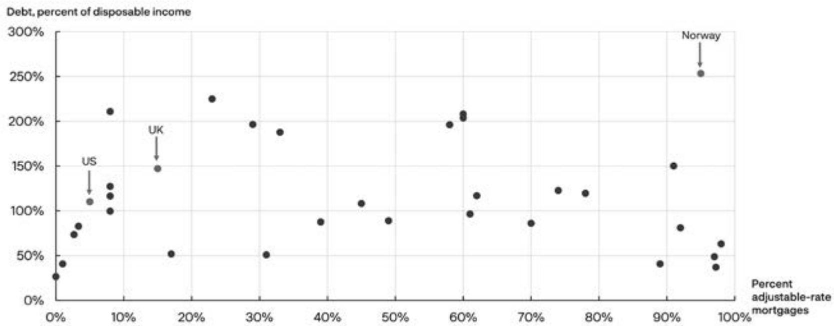
2. The Cash-flow Channel of Monetary Policy

In what follows, I will refer to the cash-flow channel as the direct effect of monetary policy on household spending operating through net interest expenses.[2] The cash-flow channel is likely to be stronger when households are more indebted and when interest rates on outstanding debt are tightly linked to short-term rates. Chart 2 illustrates the extent of variation in the household debt-to-income ratio and the share of adjustable-rate mortgages across countries.[3] In Norway, where 95 percent of home loans have an interest rate that moves in tandem with short-term money market rates and the average household debt-to-income ratio is among the highest in the world, there is a fast and strong pass-through of policy rate hikes to household disposable income.[4] In the United States, where fixed-rate mortgages account for more than 90 percent of home loans, most of them with an initial 30-year fixation period, and the average household is less indebted than in Norway, the pass-through of higher policy rates to borrowing costs can be expected to be much smaller in the short run.

In fact, while the policy rate has increased by more in the United States than in Norway during the current tightening cycle, interest

Chart 2
Large Differences in Pass-through of Monetary Policy to Disposable Income

Household debt/disposable income and fraction adjustable-rate mortgages, by country



Note: Selected countries based on data availability, mostly OECD members. Data from 2022 and 2023. For most countries, mortgages defined as fixed-rate if > 12 months residual fixation period (see IMF World Economic Outlook April 2024, chapter 2).
Sources: OECD, IMF and national statistical agencies.

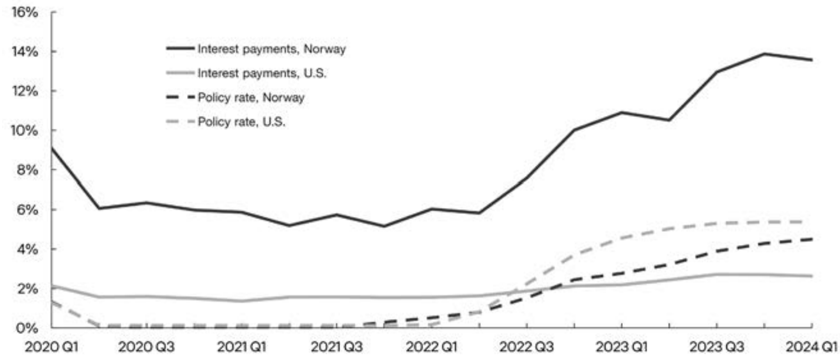
payments as a fraction of income has increased by much more in Norway, as you can see in Chart 3. If we were to subtract interest *income,* the difference would be even more stark.[5]

Looking at these charts, I think it is obvious why it has been a priority for Norges Bank to understand just how strong the cash-flow channel is. And fortunately, new high-quality data has made that possible. We have recently assembled a new and unique dataset that combines rich information on household balance sheets and income from tax returns with directly measured consumption expenditures from individual electronic transactions for all residents of Norway.

Using this dataset, my colleagues have estimated how much the responsiveness of consumption to interest rates varies with household indebtedness.[6] Chart 4 shows the change in consumption following a one percentage point unexpected increase in the policy rate and how that varies with a household's gross debt-to-income ratio. As we can see, the consumption response to a policy tightening increases with indebtedness.[7] These effects set in a couple of months after the interest rate hike and increase over the course of the first year. If we compare a household with a debt-to-income ratio of three to a

Chart 3
Faster Pass-through to Interest Payments in Norway than in United States

Policy interest rates and personal interest payments in percent of disposable income



Sources: Norges Bank, Statistics Norway and Bureau of Economic Analysis.

household with no debt, the indebted household will cut spending by around 1.5 percentage points more after one year.[8]

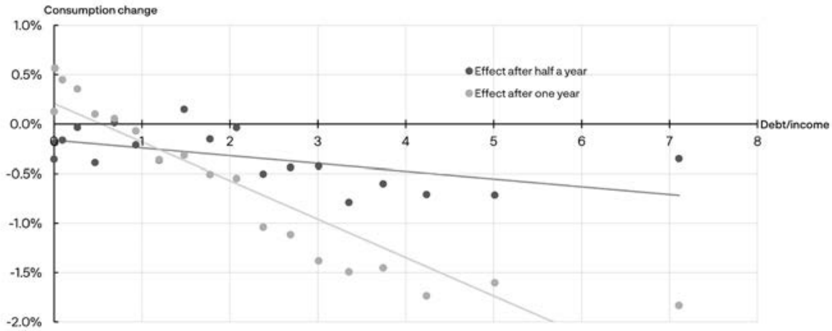
We can also see from Chart 4 that the consumption response increases almost linearly with a household's debt-to-income ratio. The implication is that the strength of the *aggregate* cash-flow channel only depends on the *total* debt-to-income ratio for all households in the economy, not on the distribution of debt *across* households.[9] This begs the question: does a central bank need to know how monetary policy transmission works at the micro level? After all, we already have plenty of evidence on the macroeconomic effects of monetary policy.[10] I will argue that the kind of evidence I have presented is still valuable.

First, it is important for policymakers to understand — and communicate to the wider public — how actual people, not just macroeconomic aggregates, are affected by our actions.[11]

Second, while it is true that the average effects of monetary policy over a historical period can be estimated based on macroeconomic data, they are a poor guide to how transmission works today if relevant states of the economy are very different from the past. And in

Chart 4
More Indebted Households Respond More Strongly to Interest Rate

Effect of 1 percentage point increase in interest rate on consumption, by debt/income of household



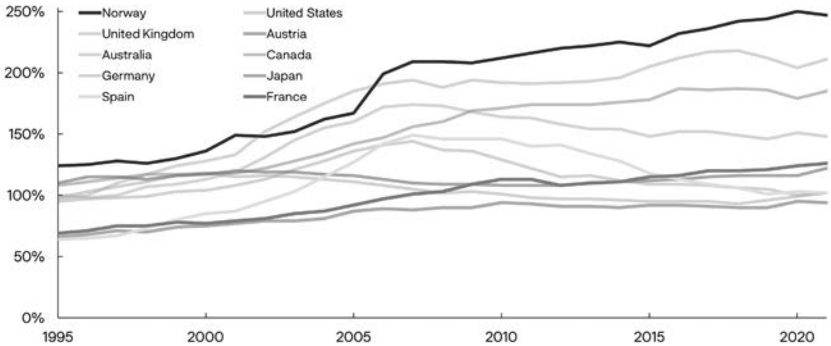
Note: Short-run interest rate instrumented with high frequence monetary policy shocks. Separate regressions for 20 quantiles of debt/income. Effect in percent of after-tax income.
Source: Ahn, Galaasen & Maehium, 2024. *The Cash-flow Channel of Monetary Policy: Evidence From Billions of Transactions.*

fact, those states have changed quite a lot in recent decades. As illustrated in Chart 5, households' debt-to-income ratios have increased markedly in many countries over the past quarter century.[12] In Norway, household debt increased from around 120 percent of disposable income in 1995 to almost 250 percent in 2021. A back-of-the-envelope calculation based on our microdata estimates suggests that, due to this increased indebtedness alone, aggregate consumption will fall by around 50 basis points more in reaction to a one percentage point contractionary monetary policy shock now than in the 1990s.[13] That amounts to as much as a two thirds increase in the interest rate effect on household spending.[14]

Research on microdata can also help us to understand how the transmission of monetary policy is affected by the types of mortgages households have. In the decade or so following the end of the Great Financial Crisis, fixed-rate mortgages became more common around the world.[15] When fixed-rate mortgages are the norm, the cash-flow channel is asymmetric. A *lower* policy rate can pass through relatively quickly to average mortgage rates, at least when there are no prepayment penalties and when most people save money by refinancing

Chart 5
Households Around the World Have Become More Indebted

Household debt in percent of disposable income, 1995–2021



Note: Selected OECD member countries.
Sources: OECD.

at the lower rate.[16] A *higher* policy rate, on the other hand, has a more muted effect on average mortgage rates in the short run. So, as fixed-rate mortgages become more common, the cash-flow channel becomes weaker for contractionary monetary policy. How much weaker obviously depends on the fraction of mortgages that are fixed-rate and how long the average fixation period is. But the microdata estimates I showed you earlier indicate that if a country with a household sector debt-to-income ratio of 100 percent were to go from having only floating-rate debt to only long-term fixed-rate debt, then all else equal, a one percentage point contractionary monetary policy shock would lower consumption by around 40 basis points less in the short run.[17]

3. Policy Consequences of a Strong Cash-flow Channel

Now, a third reason why it is essential to know the details of how transmission works is that it can have implications for how we conduct policy. That is particularly the case in small, open economies.

In open economies, monetary policy affects inflation both through the *aggregate demand channel* and through the *exchange rate* channel. A higher interest rate lowers demand directly, and lower demand leads to lower domestic inflation. A higher interest rate normally also leads to an exchange rate appreciation and thereby lower *imported* inflation. The relative strengths of these channels affect the monetary policy trade-offs.

Let us take the example of a small, open economy that is hit by an inflation shock. According to the textbook theory, the central bank should increase the interest rate to bring inflation gradually back to target. A higher interest rate dampens aggregate demand, which might be necessary to bring inflation down. If the aggregate demand channel is strong compared with the exchange rate channel, for instance because cash-flow effects on consumption are important, a larger reduction in output is needed to achieve a given disinflation.[18] That is because more of the disinflation will come through lower output and employment and less through lower imported inflation. In countries where the effects of monetary policy on aggregate demand are weaker, the central bank gets more help from the exchange rate in bringing inflation down, and inflation can be stabilized at lower employment costs.[19]

So, let me end with this. The fact that we have a relatively strong cash-flow channel in Norway does affect the monetary policy trade-offs. And while a strong cash-flow channel can prove beneficial in some situations, in others it can make stabilizing inflation more costly. These costs matter for how fast we aim to bring inflation back to target. But let there be no doubt: these costs do *not* prevent us from setting an interest rate consistent with bringing inflation back to target within a reasonable time horizon.

Endnotes

[1]Forbes, Ha and Kose (2024).

[2]Flodén et al. (2021) and International Monetary Fund (2024) use similar definitions.

[3]Debt net of deposits more accurately captures how much a given change in policy rates affect disposable income, at least when both lending rates and deposit rates closely follow short-term rates. Chart 2 shows gross debt because we do not have extensive cross-country data on deposits.

[4]This does not take into account cross-country variation in the tax system and the particular structure of adjustable-rate and fixed-rate mortgage contracts, both of which can affect pass-through. First, long-term mortgages (e.g. 30 years) are more common than shorter-term (e.g. 2–5 years) in some countries than in others. Second, in some countries, households are allowed to deduct mortgage interest payments from taxable income. How much this deduction amounts to varies substantially across countries (Cerutti, Dagher and Dell'Ariccia, 2017). A high tax deduction reduces pass-through of the policy rate to disposable income. Third, under the terms of annuity loans — such as the ones common in Norway — principal payments are automatically reduced in the short run when the lending rate increases. This might also lower pass-through to consumption.

[5]Interest payments net of interest income for the private sector has been negative in the U.S. and positive in Norway for every quarter of available data, respectively since 1947 for the U.S. (Bureau of Economic Analysis, Personal Income and its Disposition) and 1999 for Norway (Statistics Norway, quarterly non-financial sector accounts).

[6]See Ahn, Galaasen and Mæhlum (2024). Confidence intervals as well as estimates for other horizons are included in the paper. Cloyne, Ferreira and Surico (2020) and Flodén et al. (2020) also estimate how the effect of monetary policy varies along this dimension.

[7]Ahn, Galaasen and Mæhlum (2024) also provide estimates of the consumption response along the dimension of (debt-deposits)/income.

[8]The estimated marginal propensity to consume out of interest expenses is around 30 percent, which is within the range of MPC estimates out of other types of income shocks.

[9]Obviously, the strength of monetary policy transmission to consumption will also depend on other aspects of household balance sheets than those mentioned here. We know, for example, that households with very low levels of liquid assets relative to income are especially vulnerable to income losses. These so-called "hand-to-mouth" households have a particularly high marginal propensity to consume out of changes in disposable income, and their consumption responds more strongly to monetary policy. Fagereng, Holm and Natvik (2021) and Fagereng, Onshuus and

Torstensen (2024) provide evidence from Norwegian microdata that the MPC out of income shocks due to, respectively, lottery winnings and job loss is higher for households with low liquid assets-to-income. Holm, Paul and Tischbirek (2021) find evidence that consumption following an interest rate hike drops more for households with low liquid assets-to-income.

[10]McKay and Wolf (2023) argue for a version of this view.

[11]There is a growing research literature investigating the distributional impact of monetary policy. See e.g. Amberg et al. (2022), Andersen et al. (2023), and McKay and Wolf (2023).

[12]In the dataset of advanced and emerging economies shown in Chart 5, the median country — when ordering countries by the percentage increase in household debt-to-income over the period — doubled its household sector debt-to-disposable-income ratio between 1995 and 2021.

[13]This number is derived from the equation (% change in consumption due to cash-flow effect) = MPC x (change in lending rate) x (debt/income)/(consumption/income). We assume an MPC of 30% out of interest payments (Ahn, Galaasen and Mæhlum, 2024), close to full pass-through of policy rates to lending rates, an average consumption/income ratio of 0.7 and an *increase* in debt/income of 120 percentage points. This assumes that other parts of the transmission mechanism, as well as the MPC, stay the same.

[14]Estimates based on Norwegian data from the mid-1990s until the early 2020s or late 2010s indicate that the consumption response to a one percentage point monetary policy shock peaks at around one percent after 1–2 years (see Norges Bank's Monetary Policy Report 2/2022, p. 40, and 4/2023, p. 52). Assuming that the increase in debt-to-income has increased this response by 0.5 percentage points over the same sample period, the total response of consumption would have been around 0.75 percent in 1995.

[15]See figure 2.13 in International Monetary Fund (2014).

[16]This dimension of monetary policy pass-through is explored by Eichenbaum, Rebelo and Wong (2022) and Berger et al. (2021).

[17]See the equation from the previous paragraph. We assume that we go from a situation with no short-run monetary policy pass-through to lending rates to a situation with full pass-through.

[18]This argument is made by Romer (1993).

[19]When the exchange rate channel is relatively more important, the *sacrifice ratio* is lower (see Ball (1994) and Romer (1993)).

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Panel: The Effectiveness and Transmission of Monetary Policy in the Euro Area

Philip R. Lane

1. Introduction

My aim in this contribution is to provide a euro area perspective on the effectiveness and transmission of monetary policy.[1] As expressed in the monetary policy statements of the European Central Bank's (ECB) Governing Council, the aim of monetary policy tightening has been to deliver a timely return of inflation to the medium-term two percent target by dampening demand and guarding against the risk of a persistent upward shift in inflation expectations. Even if sectoral shocks had played an important role in trigering the initial 2021–2022 inflation surges, monetary policy tightening was necessary in order to contain domestic demand and to signal clearly to price and wage-setters that monetary policymakers would not tolerate inflation remaining above the target for an excessively-long period.[2]

In this contribution, I will report on the transmission of monetary policy, via financial markets and the banking system, to domestic demand and inflation expectations during this tightening episode. My interim conclusion is that monetary policy has been effective in underpinning the disinflation process, with the transmission of monetary tightening operating to restrict demand and stabilise inflation expectations.

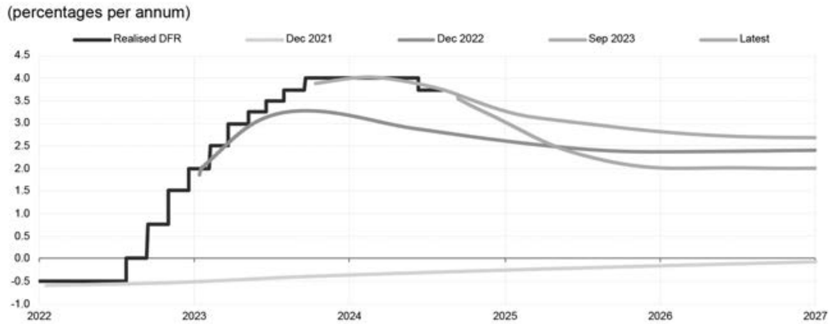
The effectiveness and efficiency of monetary policy has required a data-dependent approach to the calibration of the monetary stance. To this end, I will also discuss the importance for the calibration of monetary policy of fully recognising the asymmetric sectoral nature of the pandemic and energy shocks that triggered the initial inflation surges and the impact of sectoral balance sheets on macroeconomic dynamics. These considerations have shaped the monetary policy reaction function of the ECB during this episode, which has been guided by the incoming evidence on: (a) the unfolding inflation outlook; (b) the evolution of underlying inflation; and (c) the strength of monetary transmission (which, inter alia, depends on sectoral balance sheets).

2. Monetary Transmission

Chart 1 shows the evolution of the euro short-term rate (€STR) forward curve since December 2021. In terms of the adjustment in policy rates, there were several distinct phases. Early in 2022, the yield curve shifted up in anticipation of future rate hikes, with the markets anticipating that the ECB would respond forcefully to the building inflation shock. In the second half of 2022, there was an accelerated campaign of outsized hikes in order to move sharply away from an accommodative stance. In the first nine months of 2023, further hikes brought the policy rate to a level that was assessed to be sufficiently restrictive, if held for a sufficiently long duration, to underpin a timely disinflation process. The policy rate was then held at its peak of 4 per cent from September 2023 to June 2024.

A striking feature of Chart 1 is that the inflation shock triggered a repricing of not only the near-term policy rate path but also the long-term policy rate path. At the end of 2021, the policy rate was expected to remain negative even in 2027 according to market pricing (and expert surveys). The re-pricing occurred in early 2022 and has persisted, with the 2027 (and longer-horizon) policy rate expected to settle in the neighbourhood of two per cent, which is consistent with market views of a near-zero equilibrium real rate and the successful delivery of the inflation target in the medium term.

Chart 1
Policy Rate Path and Risk-Free Curve Over Time

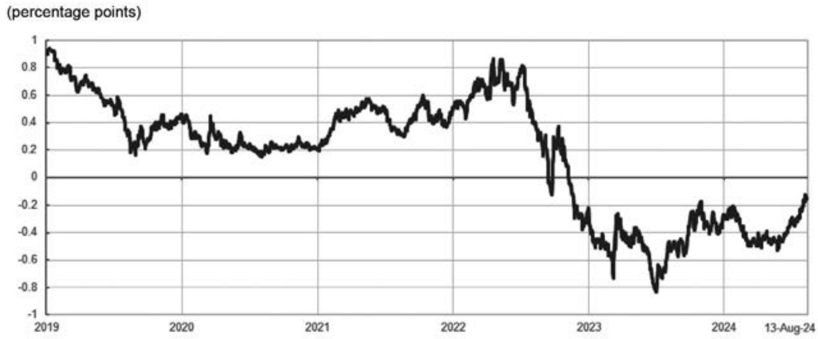


Notes: "DFR" stands for "deposit facility rate". The cut-off dates for the data used for the €STR forward curves are 17 December 2021, 16 December 2022, 15 September 2023, and 13 August 2024.
Sources: Bloomberg and ECB calculations.

This has meant the inflation shock triggered a fundamental re-setting of the interest rate path, with no expectation of a return to the extraordinarily accommodative monetary stance that had been in place since 2014/2015. At the same time, Chart 2 shows the longer–term yields rose by much less than short-term yields. The negative slope of the yield curve reflects the market assessment that inflation would normalise relatively quickly, such that the cumulative increase in policy rates also had a significant cyclical component that would be unwound. At the same time, this inversion of the yield curve also masked a marked increase in the term premium, including due to the significant decline in the bond market footprint of the Eurosystem (Chart 3): since December 2021, quantitative tightening is estimated to have raised the term premium in the overnight index swap (OIS) curve by about 55 basis points.[3]

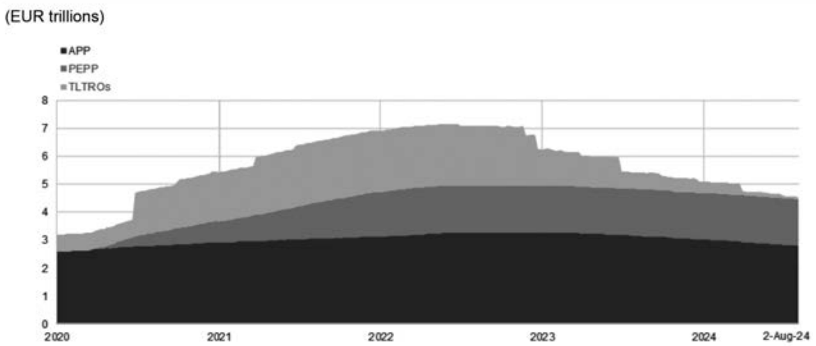
In the bank-based European financial system, the transmission of the restrictive monetary policy stance to bank lending conditions plays a central role.[4] As shown in Chart 4, banks have faced higher funding costs (due to the combination of a rapid increase in bank bond yields and an increase (even if slower) in bank deposit rates) and bank lending rates to firms and households for new loans increased significantly (the prevalence of fixed-rate mortgages has meant that the lending rates facing existing household customers have increased

Chart 2
Slope of the Risk-Free Yield Curve



Notes: The slope of the risk-free yield curve is calculated as the difference between the ten-year and two-year OIS rates. The latest observation is for 13 August 2024.
Sources: Bloomberg and ECB calculations.

Chart 3
Eurosystem Balance Sheet

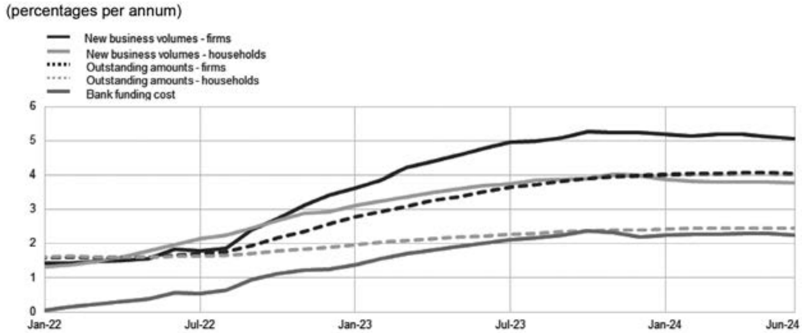


Notes: “APP” stands for “asset purchase programme”, “PEPP” for “pandemic emergency purchase programme” and “TLTROs” for “targeted longer-term refinancing operations”. Purchase programmes are based on book value at amortised cost.The latest observations are for 2 August 2024.
Sources: ECB calculations.

far more slowly).[5] Banks have also tightened their credit standards applied to the approval of loans, as shown in Chart 5.[6] Credit volumes moderated rapidly and nominal credit growth has been very low since 2022, as shown in Chart 6.[7]

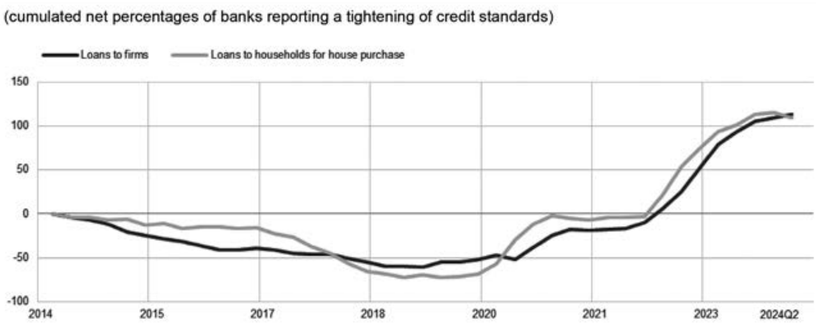
The decline in credit observed so far in the current cycle has been stronger than historical regularities, based on linear models, would have suggested. The particularly large and rapid increase in policy

Chart 4
Bank Lending Rates to Firms and Households, Plus Bank Funding Costs



Notes: The indicators for the total cost of borrowing for firms and households are calculated by aggregating short-term and long-term rates using a 24-month moving average of new business volumes. The bank funding cost series is a weighted average of new business costs for overnight deposits, deposits redeemable at notice, time deposits, bonds, and interbank borrowing, weighted by outstanding amounts. The latest observations are for June 2024.
Sources: ECB (BSI, MIR, MMSR) and ECB calculations.

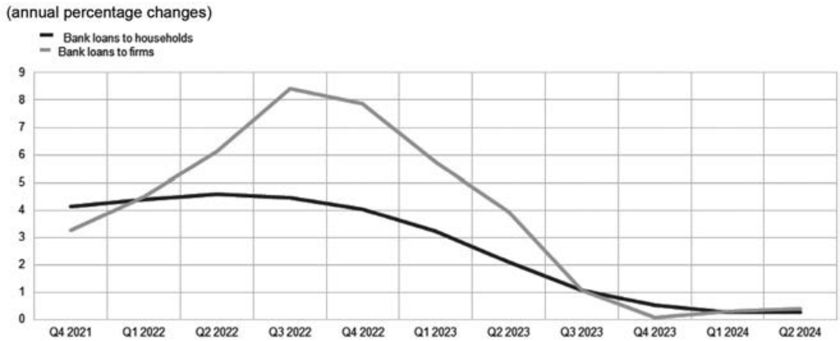
Chart 5
Evolution of Bank Credit Standards



Notes: Net percentages for credit standards are defined as the difference between the sum of the percentages of banks responding "tightened considerably" and "tightened somewhat" and the sum of the percentages of banks responding "eased somewhat" and "eased considerably". Cumulation starts in the first quarter of 2014.
Sources: ECB (BLS) and ECB calculations.
The latest observations are for the second quarter of 2024.

rates may have amplified the tightening impulse. Moreover, the perceived and abrupt end of the "low for long" era reduced the incentives to search for yield, further contributing to a pullback in risk taking by banks and customers.[8] Large policy rate hikes (including a

Chart 6
Credit Volumes to Firms and Households



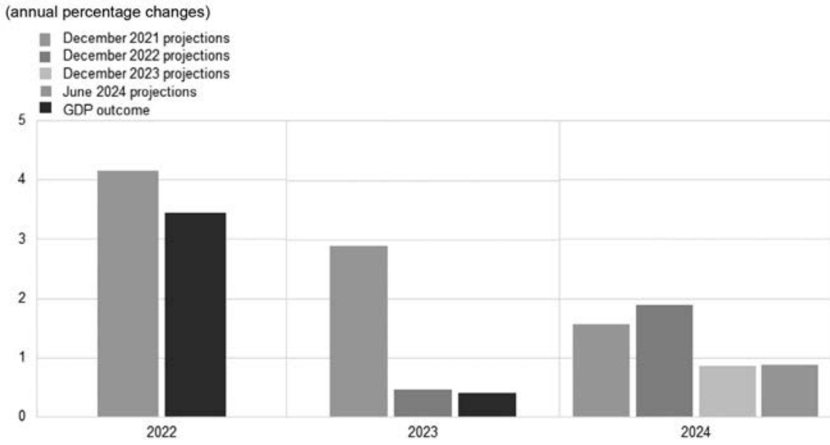
Notes: Bank loans to firms are adjusted for sales, securitisation and cash pooling. Bank loans to households are adjusted for sales and securitisation. The latest observations are for the second quarter of 2024.
Source: ECB (BSI).

persistent component) increased the riskiness of borrowers, reducing the willingness to lend. The combination of the war impact and rapid rate hikes also signalled a less positive economic future, reducing the expected revenues and increasing the expected future funding costs of potential borrowers, leading them to reduce their demand for credit.

3. The Dampening of Demand

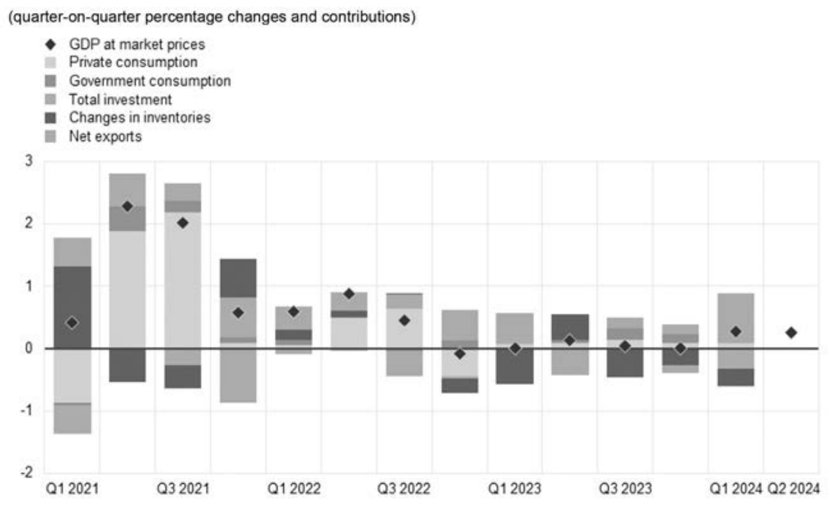
Through the tightening of market-based and bank-based financing conditions, the restrictive policy stance has fed through to economic activity. Chart 7 shows that, the recovery in output over the period 2022–2024 has been much weaker than expected. Despite the impact of the war-related energy shock, the post-pandemic reopening did allow GDP to grow during the first nine months of 2022 (when monetary policy was not yet restrictive). Subsequently, economic activity stagnated between late 2022 and late 2023, with only a limited recovery during the first half of 2024.[9] In terms of demand components, public consumption has been the main consistent driver of growth, while private consumption and external demand have remained subdued in recent quarters (Chart 8). Investment has also been weak: a decline in housing investment has been a persistent drag on growth; while business investment was also hit, the impact

Chart 7
Real GDP Growth and Projections



Notes: The latest observations are for 2023 for GDP and 2024 for projections.
Sources: Eurostat; June 2024, December 2023, December 2022 and December 2021 Eurosystem staff projections; and ECB calculations.

Chart 8
GDP Growth Contributions



Notes: The latest observations are for the second quarter of 2024 for GDP and the first quarter of 2024 for the contributions.
Sources: Eurostat and ECB calculations.

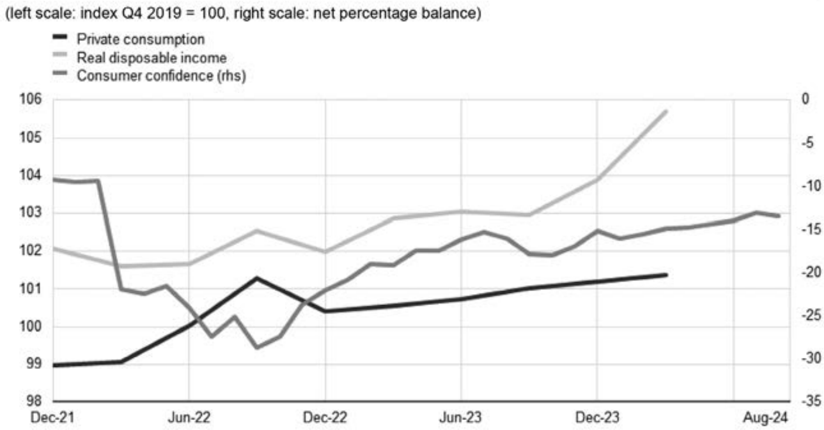
was mitigated during 2022–2023 by past order backlogs that somewhat supported the production of capital goods.[10]

The subdued economic performance is also clearly connected to the uncertainty shock and the energy price and terms of trade shocks triggered by the unjustified invasion of Ukraine by Russia. For instance, Chart 9 shows that, despite the post-pandemic output recovery and strong increase in employment, real disposable income stagnated during 2022 as inflation rose far more quickly than wages. The decline in real incomes would have been more severe in the absence of the countervailing fiscal measures that were widely introduced during 2022 and that boosted transfers to households and suppressed the most intense impact of rising energy prices on households. Indicators of consumer confidence fell at the onset of the war and, despite some gradual improvement, still remain below the pre-war level. Together with the contribution of the restrictive monetary stance, this helps to explain the still-limited response of consumption to the improvement in real disposable income that has been in train since the middle of 2023, due to the recovery in wages, the decline in inflation and the improvement in the terms of trade.

Put differently, the adverse war-related 2022 shocks to household incomes, the terms of trade and confidence indicators for both households and firms served as countervailing influences on demand conditions and thereby reduced the extent of demand dampening that needed to be generated by monetary tightening.

While employment growth also decelerated, it remained above the rate of output growth. Unemployment has remained broadly stable at a historically-low level, with employment growth accommodated by an increase in the labour force through a mix of rising participation and a recovery in immigration. This robust labour market performance (which has also mitigated the impact of rising interest rates on consumption) reflects the composition of activity, with services (including public services) more robust than manufacturing. It also reflects labour hoarding, with the anticipation of future recovery motivating firms to retain workers. In turn, labour hoarding was supported in 2022–2023 by strong profitability levels, the decline in real wages and the rise in interest rates (such that the relative price of

Chart 9
Private Consumption, Real Disposable Income and Consumer Confidence



Notes: The latest observations are for the first quarter of 2024 for private consumption and disposable income, and August 2024 for consumer confidence.
Sources: Eurostat and European Commission.

labour versus capital declined). The moderation in the labour market in 2024 is consistent with a weakening of these forces, with profitability declining, real wages rising and a turn in the interest rate cycle.

Monetary policy affects demand and prices through multiple channels: some are more direct (via inter-temporal substitution) and others are more indirect (via growth and employment). This means that the full impact of changes in monetary policy on aggregate inflation occurs only with long and variable lags. As consumers rein in their spending in response to monetary policy tightening, they start by consuming fewer goods with a high intertemporal elasticity of substitution, such as durables and non-essential items. They also reduce spending on goods that are more interest-rate sensitive, such as durable goods purchased using credit, including housing. Analysis by ECB staff suggests that the peak price response of items most sensitive to monetary policy shocks, which tend to include durables and non-essential items, is around three times larger than for less sensitive items.[11] The price reaction to monetary policy shocks of these more sensitive consumer items has been stronger in the recent tightening cycle than in past episodes of monetary restraint, reflecting the effectiveness of the steep and decisive hiking policy in dampening demand.

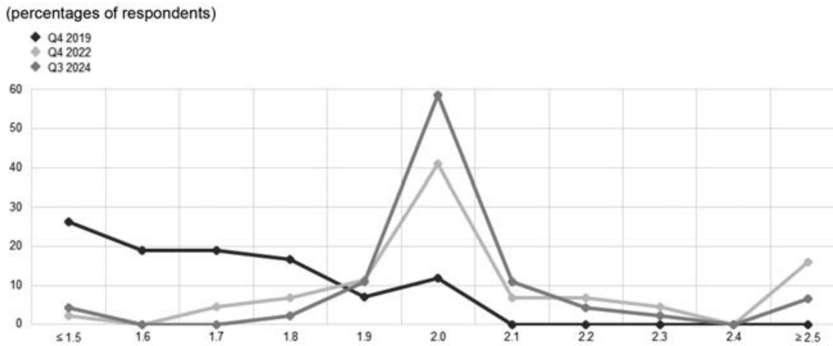
In summary, monetary tightening has restricted domestic demand, especially since late 2022. A dampened-demand environment directly reduces the capacity of firms to raise prices and workers to obtain wage increases. It also contributes to the stabilization of inflation expectations, to which we now turn.

4. The Anchoring of Inflation Expectations

A primary task for monetary policy in the disinflation process has been to ensure that the large pandemic and sectoral shocks did not translate into an increase in the medium-term inflation trend by fostering an upward de-anchoring of inflation expectations that could persist even after the unwinding of the sectoral shocks. In particular, the very sharp rise in actual and projected inflation in the course of 2022 put a premium on guarding against the de-anchoring of inflation expectations and motivated an accelerated approach to monetary tightening between July 2022 and March 2023, with the policy rate hiked by 350 basis points over six meetings.

In the post-crisis years before the pandemic, expectations had become de-anchored to the downside. The pre-pandemic distribution of long-term inflation expectations in the Survey of Professional Forecasters (SPF) was skewed to the left, as shown in Chart 10, and had a median expectation of 1.7 per cent. A similar pattern was evident in market-based indicators.[12] Between the middle of 2021 and early 2022, there was a remarkable shift in long-term inflation expectations, with survey respondents moving away from the long-held views that inflation would remain below two per cent indefinitely.[13] In essence, the majority of respondents assessed that the inflation shock opportunistically served to re-anchor long-term inflation expectations at the target by demonstrating that target risks were two-sided.[14] This is in line with the behaviour of market interest rates shown in Chart 1: the re-anchoring of medium-term inflation expectations has removed the need for an open-ended accommodative underlying monetary stance.

Chart 10
Survey of Professional Forecasters:
Distribution of Longer-Term Inflation Expectations

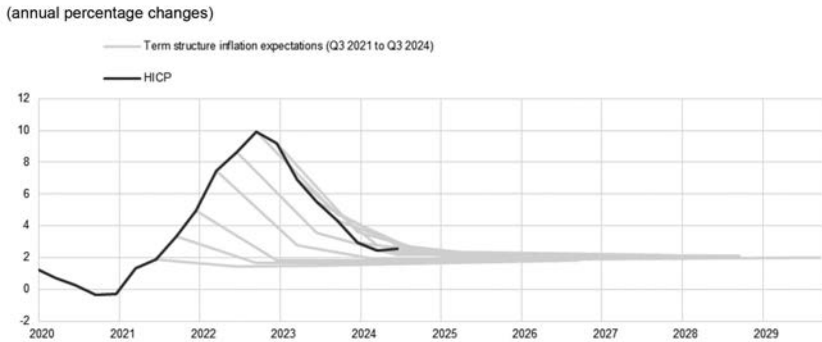


Notes: The vertical axis shows the percentages of respondents; the horizontal axis shows the HICP inflation rate. Longer-term inflation expectations refer to four to five years ahead. The latest observations are for the third quarter of 2024.
Sources: SPF and ECB calculations.

Reinforced by the target-consistent monetary policy decisions during this period, the stabilization of medium-term inflation expectations has provided an important anchor in the disinflation process.[15] The sheer magnitude of the inflation surge, the successive upward price shocks and the shifts in the short-term inflation outlook clearly could have generated upside de-anchoring risks. Instead, as shown in Chart 11, throughout this period the high-inflation phase has been expected to be relatively short-lived, supporting the timely return of inflation to the target. As shown in Charts 12 and 13, there has also been a decline in the medium-term inflation expectations reported by firms in the survey on the access to finance of enterprises (SAFE) and by households in the Consumer Expectations Survey (CES).

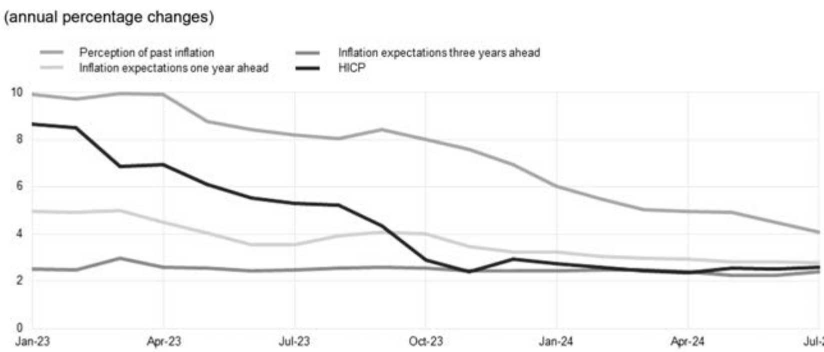
In turn, the anticipation of the monetary policy response helped to reduce the scale and duration of the inflation response to the large shocks. This anticipation effect was plausibly stronger during this episode, since the large shocks in 2021 and especially 2022 triggered an increase in the frequency of price adjustment.[16] A monetary policy stance that is clearly committed to the timely return of inflation to the target is especially powerful under state-dependent pricing.[17] An increase in the frequency of price changes represents both an extra cost from high inflation (since there are economic costs — including

Chart 11
Term Structure of Inflation Expectations from Professional Forecasters



Notes: The term structure of inflation expectations shows expectations for different horizons in past rounds of the SPF.
Sources: Eurostat, SPF and ECB calculations.

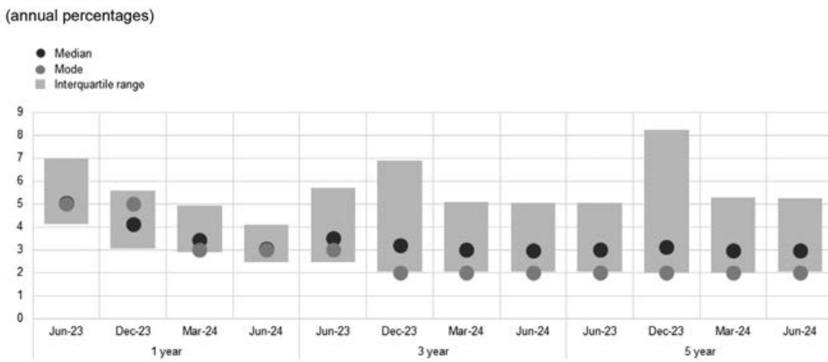
Chart 12
Consumer Expectations Survey



Notes: The series refer to the median value. The latest observations are for July 2024.
Sources: Eurostat and CES.

management costs — from adjusting prices more frequently) but also an opportunity: if price setters understand that the central bank is committed to returning inflation to the target in a timely manner through an aggressive interest rate response to the large shock, the phase of intense inflation will be shorter and the sacrifice ratio in terms of lost output will be lower since price setters only have to focus on adjusting prices to the cost shock rather than also having

Chart 13
Firms' Expectations for Euro Area Inflation at Different Horizons



Notes: Survey-weighted median, mode and interquartile ranges of firms' expectations for euro area inflation in one year, three years and five years. Quantiles are computed by linear interpolation of the mid-distribution function. The statistics are computed after trimming the data at the country-specific 1st and 99th percentiles. Base: all enterprises.
Sources: SAFE and ECB calculations.

to incorporate an excessively-prolonged aftershock phase of second round effects.

In summary, the risk of an upside de-anchoring of inflation expectations has been contained. This has certainly been facilitated by the nature of the initial inflation shocks, with the relative price shifts triggered by the pandemic and the war-related energy shock reversing fairly quickly and disinflation being further supported by the innate demand-dampening characteristics of the war and the terms of trade deterioration. The historical evidence and model-based counterfactual analyses clearly indicate that an insufficiently — vigorous monetary policy response could have resulted in a persistent increase in the inflation trend. At the same time, the calibration of the monetary policy response also needed to contain the risk of returning to the downside-deanchored equilibrium that had prevailed in the euro area before the pandemic.

5. Sectoral Shocks and Disinflation Dynamics

During the disinflation process, the calibration of monetary policy needed to take into account the reversal in energy inflation, the easing of pipeline pressures and the relaxation of supply bottlenecks.

The pandemic and the subsequent energy shock triggered by Russia's unjustified invasion of Ukraine had asymmetric and time-varying effects on different sectors. During 2020 and 2021, the impact of the pandemic on activity was most severe for contact-intensive services, while the goods sector was overwhelmed by the mismatch between a positive global demand shift and a decline in global supply capacity due to pandemic-related shutdowns and supply-chain interruptions. During 2022, the dislocations in the oil and gas sectors due to the Russia-Ukraine war were associated with an extraordinary surge in energy prices, which also constituted a severe terms of trade shock for the euro area as a net energy importer. In Europe, the full relaxation of pandemic-related lockdown measures also occurred only in spring 2022, after the subsidence of the Omicron variant. Accordingly, in 2022, the mis-match in the goods sector was succeeded by a mis-match in the services sector, with demand for contact-intensive services rising more quickly than supply capacity in the immediate aftermath of the full post-pandemic reopening that spring.

Subsequently, the improvement in supply capacity and the unwinding of the adverse terms of trade shock has both supported economic activity and contributed to disinflation. In particular, the normalization of demand and the expansion in supply capacity reduced these sectoral mismatches. After peaking in 2021, supply chain bottlenecks gradually eased during the course of 2022 and 2023, contributing to a decline in the relative price of goods. The decline in energy demand and the increase in energy supply capacity, together with the contribution from the various subsidy schemes that limited the impact of the shocks on retail energy prices, meant that energy prices fell by 14 per cent between their peak in October 2022 and July 2023.

The easing of bottlenecks and the decline in the relative price of energy also helped to calm food inflation and, via lower cost pressures, services inflation.[18] In addition, the reversal of the adverse supply shocks also boosted activity and employment, with the fading of the pandemic in particular supporting activity in 2021 and 2022, and falling energy prices and the receding impact of past bottlenecks boosting activity in 2023 and 2024. Compared to a purely demand-driven inflation episode, the nature of this inflation shock limited the extent to which disinflation would necessarily be accompanied by a severe economic contraction: rather, the aim of monetary policy was to make sure that demand grew more slowly than supply capacity during the disinflation phase.

The euro area implementation of the Bernanke-Blanchard model provides a useful organizing device to represent the contribution of sectoral shocks.[19] The left panel of Chart 14 shows that shocks to energy and food prices, together with pandemic-related shortages, accounted for the largest part of the 2021–2022 inflation surges and the subsequent disinflation can largely be attributed to the fading of these shocks. In contrast, labour market tightness has played a comparatively minor role in inflation dynamics.

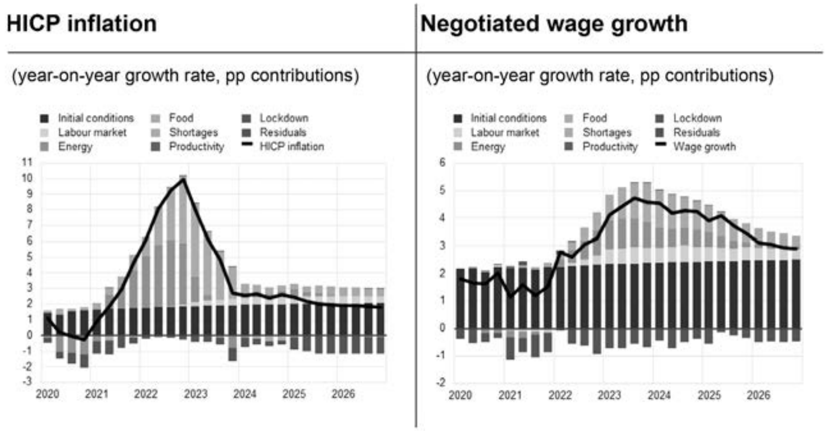
The right panel of Chart 14 shows that the phase of above-target inflation has primarily been prolonged by the lagged adjustment of wages (and prices) to the initial inflation shocks. The aim of monetary tightening has been to contain this adjustment phase by making sure that the post-shock rounds of wage and price adjustments were limited by dampened demand and underpinned by stable longer-term inflation expectations.

According to this analytical framework, the bulk of disinflation could be expected to take place relatively quickly with the fading of the sectoral shocks, but full convergence back to the target would be slower due to the lagged nature of wage adjustments and the staggered pattern of economy-wide price adjustments to cost increases. In turn, these characteristics of the disinflation process (an initial rapid phase, followed by a slower convergence phase) have informed the calibration of monetary tightening.

The nature of the disinflation process has been recognized in the Eurosystem staff projections. For instance, the December 2022 projections foresaw that inflation would decline from the quarterly peak of 10 per cent in Q4 2022 to 3.6 per cent in Q4 2023, 3.3 per cent in Q4 2024 and 2.0 per cent in Q4 2025.

Disinflation turned out to be even more rapid during 2023, with Q4 inflation at 2.7 per cent. The June 2024 projections foresee inflation at 2.5 per cent in Q4 2024 and 2.0 per cent in Q4 2025.

Chart 14
Sectoral Shocks



Notes: The figures show decompositions of the sources of seasonally adjusted annual wage growth and HICP inflation based on the solution of the full model and the implied impulse response functions. The out-sample projection is constructed by performing a conditional forecast starting in Q1 2020, conditional on realised variables between Q1 2020 and Q1 2024 and technical assumptions and inverted residuals between Q2 2024 and Q4 2026 such that HICP in the conditional projection is equal to the seasonally adjusted June 2024 Eurosystem staff projections. Assumptions from the June 2024 projections baseline correspond to energy and food price inflation and productivity growth. Labour market tightness is assumed to remain constant. The "shortages" (measured by the Global Supply Chain Pressure Index) are known up to Q2 2024 and projected according to an AR(3) process thereafter. The historical decomposition treats the projection as data and is carried out from Q1 2020 onwards to compute the contributions of the initial conditions and of the exogenous variables.
Source: ECB calculations based on Arce, O., Ciccarelli, M., Kornprobst, A. and Montes-Galdón, C. (2024), "What caused the euro area post-pandemic inflation?", Occasional Paper Series, No 343, ECB.

In summary, diagnosing the nature of inflation dynamics has been essential in calibrating monetary tightening. Conditional on inflation expectations remaining anchored, the fading out of the initial shocks that triggered the steep rise in inflation could be expected to deliver a two-phase disinflation process, with an initial steep decline followed by a slower convergence phase as wage-price and price-price staggered adjustment dynamics played out.[20] The role of a demand-dampening monetary stance has been to make sure that inflation did not remain too far above the target for too long and to reinforce the commitment to a timely return to the inflation target, such that price and wage-setters could focus on "backward" adjustment dynamics — aimed at recovering lost purchasing power and re-establishing optimal relative prices — without worrying about the "forward" adjustment dynamics that would be generated by any de-anchoring of inflation expectations.

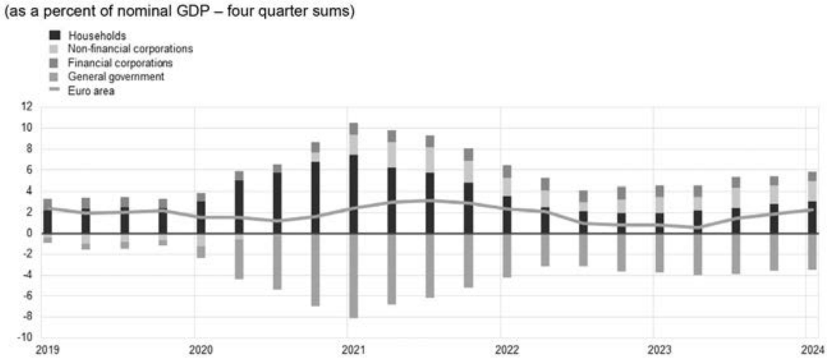
6. Sectoral Balance Sheets

In calibrating the monetary stance, it is also essential to take into account that the impact of monetary policy depends on the condition of sectoral balance sheets. These encompass the balance sheets of firms, households, banks, the public sector and the rest of the world.[21]

Chart 15 shows that households had exceptionally high savings rates in 2020 and 2021. While firms were net borrowers during the initial months of the pandemic in 2020, corporate debt was contained by significant fiscal transfers and de-risked through extensive public loan guarantees. Taking a longer-term perspective, Chart 16 shows that household leverage before the pandemic had declined relative to the 2010 peak but was still elevated compared to the initial years of the euro; although there had been some decline since 2016, the pre-pandemic level of corporate leverage was much higher than at the start of the euro.

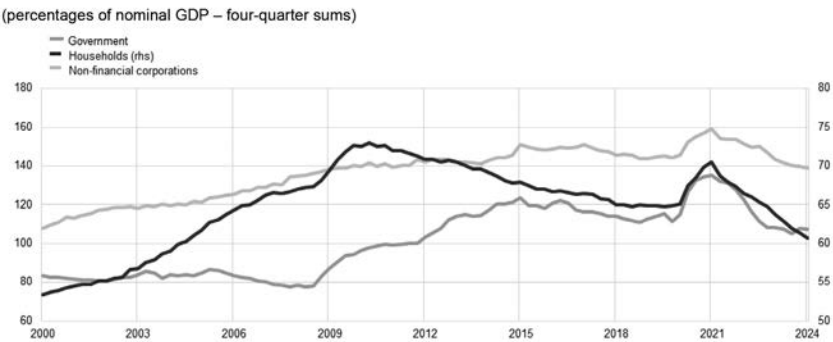
While the collapse of GDP meant that these leverage ratios jumped during 2020, both now stand well below their pre-pandemic levels, also due to the significant rise in nominal GDP. These balance sheet improvements have helped to cushion the financial impact of monetary policy tightening on households and firms. In addition, the trend shift towards fixed-rate mortgages also meant that fewer euro area households faced an immediate cash flow burden due to higher mortgage servicing costs. Moreover, in contrast to an inflation scenario in which the unwinding of a demand shock means that monetary tightening is accompanied by economic contraction, the improvement in supply capacity after the pandemic, the easing of bottlenecks and the 2023–2024 unwinding of the 2021–2022 energy shocks meant that there was underlying positive momentum in employment and output. This further contained credit risk premia, in contrast to tightening cycles triggered by excess demand episodes (often accompanied also by financial excess). One illustration is provided by Chart 17, which shows that corporate profitability was above the pre-pandemic level in 2021 and 2022, also boosted by prices adjusting more rapidly

Chart 15
Euro Area Net Lending / Net Borrowing



Note: The latest observations are for the first quarter of 2024.
Sources: Eurostat and ECB.

Chart 16
Sectoral Leverage

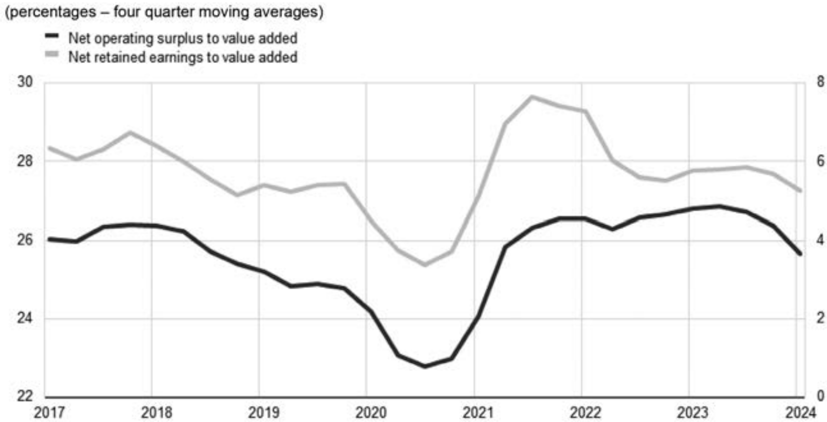


Note: Leverage is defined as total non-equity liabilities divided by the four-quarter sum of nominal GDP. The latest observations are for the first quarter of 2024.
Sources: Eurostat, ECB and ECB calculations.

to the inflation surge than wages. While the monetary tightening and rising labour costs have seen a decline in corporate profitability, it only just returned to the pre-pandemic level in early 2024.

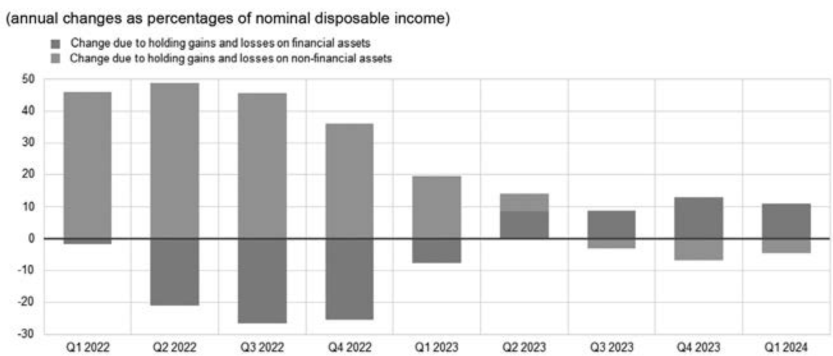
At the same time, the financial exposure to rising interest rates that was embedded in the holdings of non-bank financial intermediaries was ultimately held either by euro area households or the global investor community. Chart 18 shows that housing assets served as

Chart 17
Non-Financial Corporations' Margins and Saving Ratio



Note: The latest observations are for the first quarter of 2024.
Sources: ECB and ECB calculations.

Chart 18
Net Worth of Households



Note: Changes are mainly due to movements in real estate and share prices. The latest observations are for the first quarter of 2024.
Sources: Eurostat, ECB and ECB calculations.

a partial inflation hedge during 2022 even if higher interests rates resulted in some reversal in valuations in 2023. At the same time, there were net capital losses on household financial portfolios during 2022. The sharp increase in inflation also eroded the real value of household deposits. The losses on financial portfolios are likely to have been disproportionately absorbed by higher-income households with relatively low marginal propensities to consume, with cushioning provided by the high share of this group in pandemic-era excess savings.[22]

In the aftermath of the 2008–2012 global and euro area crises, the resilience of the euro area banking system has been improved through a mix of higher regulatory requirements, more intensive bank supervision, the rolling-out of more extensive macroprudential regulations and greater managerial risk aversion. As an illustration, Chart 19 shows the marked improvement in capital ratios in the banking system between 2015 and 2019. Simultaneously, liquidity ratios improved significantly, further increasing the overall resilience of the banking sector. Pandemic-related excess savings by households, extensive fiscal transfers to households and firms, public loan guarantees, the reversal of the pandemic and energy shocks and low-cost funding from the ECB meant that banks did not suffer significant credit impairments during the 2020–2021 period.

The robust state of bank balance sheets meant that the transmission of rate hikes to banks could proceed in an orderly manner. In particular, the increases in risk-free rates were not amplified by an outsized increase in credit risk premia or a severe contraction in credit supply. Moreover, the capital losses on the bonds held by the banking sector were contained by the relatively low bond allocation in the asset holdings of euro area banks.[23] In a related manner, the high share of central bank reserves in the asset holdings of banks meant that the overall duration risk was relatively limited. Bank profitability improved substantially due to the shift to a higher interest rate environment and was further bolstered by the increase in interest paid on central bank reserves.[24] In effect, the resilience of the banking sector, together with the highly-liquid composition of bank assets, has increased the feasible monetary policy space by muting concerns about the financial stability impact of rate hikes.[25] The highly-liquid state of the asset side of bank balance sheets meant that losses from fixed rate mortgage assets were compensated by rising income from central bank reserve holdings.

While the level of central bank excess reserves in the euro area remains high at around €3.1 trillion, these have declined by more

Chart 19
Capital Ratio of the Banking System

Notes: The sample consists of significant institutions under the supervision of the ECB (changing composition). The latest observations are for the first quarter of 2024.
Source: ECB supervisory reporting.

than a third, or €1.7 trillion, since the peak reached in the second half of 2022. This has mostly been the result of the repayment of funding from targeted longer-term refinancing operations (TLTRO), which fell from €2.2 trillion in June 2022 to a mere €76 billion in July 2024 and will reach zero in December 2024.[26] The reinvestment of the asset purchase programme (APP) portfolio stopped in June 2023, with the APP portfolio dropping from a peak of €3.3 trillion in June 2022 to €2.8 trillion in July 2024. The pandemic emergency purchase programme (PEPP) portfolio started to shrink in July, with the intention to discontinue reinvestments altogether at the end of this year.

From a macroeconomic perspective, the transition from a high-reserves environment to a lower-reserves environment can trigger a shift in the risk-taking strategies of banks (vis-a-vis both lending and bond purchasing), in relation to a decline in the stock of reserves that might have been expected to remain in the banking system for an extended period as the funding counterparts to asset purchase programmes or long-term refinancing operations (sometimes described as "non-borrowed" reserves).[27, 28, 29]

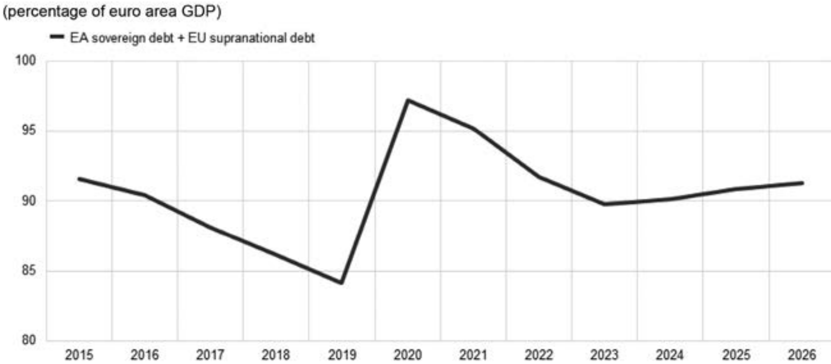
Directionally, this contraction in liquidity may have contributed to the relatively-strong decline in lending volumes in the euro area during this tightening episode. In particular, estimates by ECB staff suggest that banks with lower excess liquidity are more likely to reduce their supply of credit in response to policy rate hikes, and the increase in their lending rates is likely to be larger. This means that, as aggregate liquidity shrinks, the transmission of the restrictive monetary policy stance to bank lending may strengthen further.

The counterpart to the insulation of household, bank and corporate balance sheets during the pandemic was an expansion in sovereign debt (see Chart 20). The surprise inflation, together with the output recovery, has partially offset the increase in debt-output ratios but these remain above their pre-pandemic levels. In addition, the considerable fiscal response to the energy shock in 2022 increased public debt levels, even if many of these temporary measures have now been reversed. Naturally, an integrated view of the consolidated public sector balance sheet should take into account the decline in the net equity position of central banks but any evaluation of the impact of monetary tightening via this channel will depend on the specification of the relevant counterfactual scenario.

Despite some volatility episodes, the combination of higher policy rates, quantitative tightening and an increase in public debt levels has not triggered a substantial increase in sovereign risk premia in the euro area, while so far there has only been a limited increase in term premia. This likely reflects several factors. First, as indicated by the anchoring of longer-term inflation expectations, this inflation episode has been interpreted throughout as a temporary phase, with a sufficient response from central banks to ensure that the initial inflation shocks do not mutate into permanent inflation. In turn, this has meant that longer-term bond yields rose by less than shorter-term interest rates Second, the 2020 launch of the Next Generation EU (NGEU) programme of joint debt and grants caused a reassessment of country-level risk premia by investors, in view of the solidarity demonstrated by EU Member States in the face of a severe tail risk.

Third, the flexible design of the 2020 PEPP and 2022 announcement of the transmission protection instrument (TPI) provided reassurance to investors that unwarranted, disorderly dynamics in sovereign debt markets posing a serious threat to the transmission

Chart 20
Gross Debt



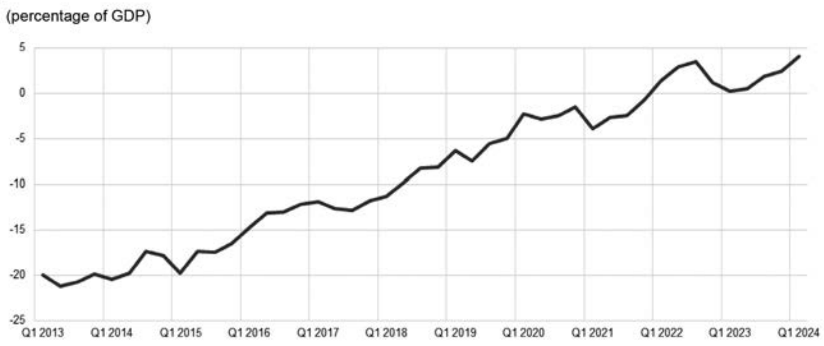
Notes: Supranational EU debt (not reflected in the euro area aggregate) is the gross outstanding debt of the EU institutions, including Next Generation EU financing. Supranational EU debt is not an official statistic, but an internal estimate.
Source: June 2024 Eurosystem staff macroeconomic projections.

of monetary policy would not be tolerated, provided that countries comply with a set of established "prudent policy" criteria.

Finally, it is important to take into account the external balance sheet of the euro area, in view of its role in the international transmission of domestic and foreign monetary tightening. In line with the impact of the severe decline in the terms of trade on import payments relative to export revenues, Chart 15 shows that the current account surplus of the euro area declined between the middle of 2021 and early 2023, which is also reflected in the decline in the net international investment position during this period, temporarily interrupting the rising trend observed since 2013, in Chart 21. Aside from the terms of trade channel, the global nature of the inflation shock and the similar monetary policy responses across countries meant that the composition of foreign assets and foreign liabilities played only a limited role in determining the international impact of monetary tightening. For instance, debt-related international investment income inflows and outflows increased by similar amounts between 2021 and 2024.

Of course, taking a wider perspective, the global element of the inflation shock and the monetary policy response has shaped the

Chart 21
Euro Area Net International Investment Position



Sources: ECB (balance of payments) and Eurostat (national accounts). *Note:* The latest observation is for the first quarter of 2024.

disinflation process and the calibration of monetary policy. All else equal, the tightening moves by foreign central banks limited the required scale of domestic monetary tightening by slowing down global activity, containing globally-determined commodity prices and pushing up the common component in term premia. At the same time, if domestic monetary tightening had been too limited relative to foreign monetary tightening, exchange rate depreciation might have exerted a larger influence on the domestic disinflation process.

7. Conclusions

At the time of writing (August 2024), my interim assessment of the effectiveness of ECB monetary policy in responding to the 2021–2022 inflation surges is that there has been good progress in delivering the overriding goal of making sure that inflation returns to target in a timely manner. Crucially, this disinflation process has been underpinned by the forceful transmission of monetary policy to the financial system, the level of demand and inflation expectations.

This has required the ECB to appropriately calibrate its monetary policy stance to ensure that demand has been sufficiently dampened and the anchoring of medium-term inflation expectations sufficiently protected, while also containing the economic costs of a restrictive monetary stance. Among other factors, this calibration needed to take into account: the "re-anchoring from below" of medium-term inflation expectations and the associated pricing-out of low-for-long rate scenarios; the multiple channels by which the unjustified Russian invasion of Ukraine directly served to moderate demand; the inflation-disinflation cycles generated by the pandemic and the energy shock; the interactions between monetary policy and sectoral balance sheets; and the global dimensions of the inflation shock and the international policy response.

Of course, this assessment is necessarily interim: the return to target is not yet secure. In particular, the monetary stance will have to remain in restrictive territory for as long as is needed to shepherd the disinflation process towards a timely return to the target. Equally, the return to target needs to be sustainable: a rate path that is too high for too long would deliver chronically below-target inflation over the medium term and would be inefficient in terms of minimizing the side effects on output and employment.

The data-dependent challenge for monetary policy will be to chart the sustainable and efficient path to the target.

Endnotes

[1]The views expressed in this contribution are my own and should not be interpreted as representing the collective view of the ECB's Governing Council. In the nature of a panel contribution, I will not try to provide a comprehensive account. For a more extensive discussion, see Lane, P.R. (2024), "The analytics of the monetary policy tightening cycle", speech at Stanford Graduate School of Business, 2 May.

[2]It is beyond the scope of this contribution to review the origins of the inflation shock (including the relative contributions of cost-push shocks, sectoral demand-supply imbalances and aggregate demand dynamics at both domestic and global levels) and the optimal timing of the monetary policy response. Rather, I focus on the response of ECB monetary policy from December 2021 onwards. See also Lane, P.R. (2024), "The 2021–2022 inflation surges and monetary policy in the euro area", *The ECB Blog,* ECB, 11 March (also published as Lane, P.R. (2024), "The 2021–2022 inflation surges and monetary policy in the euro area", in English, B., Forbes, K. and Ubide, Á. (eds.), *Monetary Policy Responses to the Post-Pandemic Inflation,* Centre for Economic Policy Research, 13 February, pp. 65–95).

[3]Our policy tightening has also been reflected in sovereign bond markets, which have coped well with the rapid increase in interest rates. It is plausible that the remarkably smooth transmission of the forceful tightening cycle to the sovereign bond market would not have been possible to the same extent without pandemic emergency purchase programme (PEPP) flexibility and the Transmission Protection Instrument (TPI). The EU-wide solidarity embodied in the Next Generation EU programme has also played a vital role in reducing risk premia.

[4]Given the much shorter average duration of commercial credit in the euro area relative to the United States, the transmission of our policy rate hikes to the lending rates on loans to firms was much more forceful than transmission in the United States, where the average maturity of firm loans is longer and loans are priced off the long-end Treasury curve that has been quick to invert in anticipation of lower inflation and future rate cuts. In other words, the borrowing conditions faced by our companies have evolved in much tighter sync with the ECB's policy intentions.

[5]With some lag, also due to the initial conditions of negative interest rates, time deposit rates — particularly those for firms — have closely followed policy rate hikes. However, the substantial central bank liquidity and low credit demand have reduced the pressure to raise deposit rates. There has been substantial variation in the response of deposit and lending rates across the member countries, driven in part by differences in competition within national banking systems.

[6]This indicator is based on the responses to the euro area bank lending survey. See also Dimou, M., Ferrante, L., Köhler-Ulbrich, P. and Parle, C. (2023), "Happy

anniversary, BLS — 20 years of the euro area bank lending survey", *Economic Bulletin,* Issue 7, ECB.

[7]During the phase of policy rate hikes, the weakening in euro area monetary dynamics was primarily driven by the sharp adjustment in bank lending, while in the United States it reflected other sources of money creation (such as bank purchases of securities, external monetary flows and banks' wholesale funding, as well as quantitative tightening), with bank lending contributing only at a later stage.

[8]One driver of the drop in credit was the significant adjustment seen in the real estate market, exacerbated by an initial condition of exuberance in some residential segments/countries and the structural fall in the demand for some commercial real estate after the pandemic.

[9]Since there were extensive mobility restrictions in late 2021 and early 2022 due to concerns about the Omicron variant, the full pandemic reopening in Europe only took hold around March 2022 (by coincidence at the same time as the Russian invasion of Ukraine). The pandemic reopening was associated with strong demand-supply mismatches in contact-intensive services, as strong demand outpaced initially limited supply. The easing of supply chain bottlenecks and a strong backorder book allowed the manufacturing sector to grow during this period.

[10]In terms of the sectoral impact, monetary policy has had a stronger direct impact on activity levels in interest-sensitive sectors such as construction, capital goods and consumer durables and a slower impact on activity levels in the services sector. Estimates suggest that the peak impact of policy tightening on activity levels is larger for manufacturing than for services, with the peak impact occurring in the fourth quarter of 2023, and larger for business and housing investment than for private consumption, with the transmission to business investment strengthening further in the first quarter of 2024.

[11]Allayioti, A., Górnicka, L., Holton, S. and Martínez Hernandez, C. (2024), "Monetary policy pass-through to consumer prices: evidence from granular price data", Working Paper Series, ECB, forthcoming.

[12]The accommodative policy stance since 2014 indicates that the Governing Council did not consider 1.7 per cent to be sufficiently close to two per cent to meet the goal of delivering inflation "below, but close to, two per cent".

[13]This was also facilitated by the explicit commitment to a symmetric two per cent inflation target in the ECB's monetary policy strategy statement that was published in July 2021.

[14]There was also a marked increase in the proportion of survey respondents that expected inflation to remain above target in the long-term: the evolution of the right-tail of the distribution has been closely monitored throughout the tightening campaign.

[15]The right tail of the distribution of long-term inflation expectations in the SPF has diminished markedly compared with the peak inflation phase in late 2022. The inflation risk premium embedded in five-year-on-five-year inflation swaps has declined by about 40 basis points since last summer. ECB staff have also conducted a model-based exercise on the development of upside de-anchoring risks under the actual interest rate path during the hiking phase, as well as a counterfactual analysis where the rate is assumed to have remained on the path underlying the December 2021 staff projections (Christoffel, K. and Farkas, M. (2024), “Monetary policy and the risks of de-anchoring of inflation expectations”, *IMF Working Papers,* International Monetary Fund, forthcoming). In the anchored regime, the perceived inflation target is in line with the actual two per cent target. In contrast, in the de-anchored regime, inflation expectations are driven by past and current inflation realisations, even though the central bank continues to pursue the unchanged two per cent target. Due to the tightening of monetary policy, the credibility of the central bank has been maintained by containing upside de-anchoring risks. If rates had been kept at the level of December 2021, the risks would have increased considerably.

[16]Cavallo, A., Lippi, F. and Miyahara, K. (2024), “Large Shocks Travel Fast,” *American Economic Review: Insights,* forthcoming; L’Huillier, J.-P. and Phelan, G. (2024), “Can Supply Shocks Be Inflationary with a Flat Phillips Curve?”, mimeo, Brandeis University.

[17]Karadi, P., Nakov, A., Nuño, G., Pasten, E. and Thaler, D. (2024), “Strike while the iron is hot: optimal monetary policy with a nonlinear Phillips Curve”, *CEPR Discussion Papers,* No 19339, Centre for Economic Policy Research.

[18]The notable impact of sectoral shocks on the overall price level via cost channels and relative price rigidities meant that exclusion-type measures (such as core inflation) did not provide a good proxy for properly-measured underlying inflation dynamics. In order to capture the indirect impact of bottlenecks and energy inflation on measures of underlying inflation, ECB staff developed adjusted measures of underlying inflation that “partial out” these indirect influences. See Bańbura, M., Bobeica, E., Bodnár, K., Fagandini, B., Healy, P. and Paredes, J. (2023), “Underlying inflation measures: an analy tical guide for the euro area”, *Economic Bulletin,* Issue 5, ECB; and Bańbura, M., Bobeica, E. and Martínez Hernández, C. (2023), “What drives core inflation? The role of supply shocks”, *Working Paper Series*, No 2875, ECB. See also Lane, P.R. (2022), “Inflation Diagnostics”, *The ECB Blog,* 22 November; and Lane, P.R. (2023), “Underly ing inflation”, lecture at Trinity College Dublin, 3 March.

[19]Arce, O., Ciccarelli, M., Kornprobst, A. and Montes-Galdón, C. (2024), “What caused the euro area post-pandemic inflation?”, *Occasional Paper Series,* No 343, ECB. Important other contributions include Guerrieri, V., Marcussen, M., Reichlin, L. and Tenreyro, S. (2023), “The Art and Science of Patience: Relative Prices and Inflation”, *Geneva Reports on the World Economy,* No 26; Di Giovanni, J., Kalemli-Özcan, Ș., Silva, A. and Yildirim, M.A. (2024), “Global supply chain

pressures, international trade, and inflation", mimeo, Brown University; Dao, M., Gourinchas, P.-O., Leigh, D. and Mistra, P. (2024), "Understanding the International Rise and Fall of Inflation Since 2020", *Journal of Monetary Economics,* in press; Forbes, K., Ha, J. and Kose, M.A. (2024), "Demand versus supply: drivers of the post-pandemic inflation and interest rates", *VOXEU,* 9 August.

[20]The array of fiscal subsidies that were introduced in late 2022 to contain the peak impact of the energy shock on households have been an additional factor in shaping the intensity and duration of the disinflation process in the euro area. Many of these temporary measures are expiring in the course of 2024, which is putting temporary upward pressure on the price level. This process will continue to play out during 2025.

[21]On the role of bank balance sheets, see: Altavilla, C., Canova, F. and Ciccarelli, M. (2020), "Mending the broken link: heterogeneous bank lending rates and monetary policy pass-through", *Journal of Monetary Economics,* Vol. 110, pp. 81–98; Bernanke, B. and Gertler, M. (1990), "Financial Fragility and Economic Performance", *The Quarterly Journal of Economics,* Vol. 105, No 1, pp. 87–114; Bernanke, B. and Blinder A. (1988), "Credit, Money, and Aggregate Demand", *American Economic Review,* Vol. 78, No 2, pp. 435–439; Jiménez, G. et al. (2012), "Hazardous Times for monetary policy: what do twenty-three million bank loans say about the effects of monetary policy on credit-risk taking?", *Econometrica,* Vol. 82, No 2, pp. 463–505; Kashyap, A. and Stein, J. (1995), "The impact of monetary policy on bank balance sheets", *Carnegie-Rochester Conference Series on Public Policy,* Vol. 42, pp. 151–195; Kashyap, A. and Stein, J. (2000), "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?", *American Economic Review,* Vol. 90, No 3, pp. 407–428; Kishan, R. and Opiela, T. (2000), "Bank Size, Bank Capital, and the Bank Lending Channel", *Journal of Money, Credit and Banking,* Vol. 32, No 1, pp. 121–141; Peek, J. and Rosengren, E. (1995), "Bank regulation and the credit crunch", *Journal of Banking & Finance,* Vol. 19, No 3–4, pp. 679–692; Stein, J. (1998), "An Adverse-Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy", *The RAND Journal of Economics,* Vol. 29, No 3, pp. 466–486; Van den Heuvel, S. (2002), "Does bank capital matter for monetary transmission?", *Economic Policy Review,* Vol. 8, No 1, pp. 259–265.On the role of household balance sheets, see: Auclert, A. (2019), "Monetary Policy and the Redistribution Channel", *American Economic Review,* Vol. 109, No 6, pp. 2333–2367; Carroll, C., Slacalek, J., Tokuoka, K. and White, M.N. (2017), "The distribution of wealth and the marginal propensity to consume", *Quantitative Economics,* Vol. 8, No 3, pp. 977–1020; Crawley, E. and Kuchler, A. (2023), "Consumption Heterogeneity: Micro Drivers and Macro Implications", *American Economic Journal: Macroeconomics,* Vol. 15, No 1, pp. 314–341; Jappelli, T. and Pistaferri, L. (2010), "The Consumption Response to Income Changes", *Annual Review of Economics,* Vol. 2, pp. 479–506; Slacalek, J., Tristani, O. and Violante, G.L. (2020), "Household balance sheet channels of monetary policy: a back of the envelope calculation for the euro area", *Journal of*

Economic Dynamics and Control, Vol. 115, No 103879.On the role of firm balance sheets, see: Altavilla, C., Burlon, L., Giannetti, M. and Holton, S. (2022), "Is there a zero lower bound? The effects of negative policy rates on banks and firms", *Journal of Financial Economics,* Vol. 144, No 3, pp. 885–907; Altavilla, C., Gürkaynak, R.S. and Quaedvlieg, R. (2024), "Macro and micro of external finance premium and monetary policy transmission", *Journal of Monetary Economics,* forthcoming; Cloyne, J., Ferreira, C., Froemel, M. and Surico, P. (2023), "Monetary Policy, Corporate Finance, and Investment", *Journal of the European Economic Association,* Vol. 21, No 6, pp. 2586–2634; Caglio, C.R., Darst, R.M. and Kalemli-Özcan, Ṣ. (2021), "Collateral Heterogeneity and Monetary Policy Transmission: Evidence from Loans to SMEs and Large Firms", *NBER Working Papers,* No 28685, National Bureau of Economic Research; Ippolito, F., Ozdagli, A.K. and Perez-Orive, A. (2018), "The transmission of monetary policy through bank lending: the floating rate channel", *Journal of Monetary Economics,* Vol. 95, pp. 49–71; Jeenas, P. and Lagos, R. (2024), "Q-Monetary Transmission", *Journal of Political Economy,* Vol. 132, No 3; Ottonello, P. and Winberry, T. (2020), "Financial Heterogeneity and the Investment Channel of Monetary Policy", *Econometrica,* Vol. 88, No 6, pp. 2473–2502.

[22]There were significant differences across the member countries. See also Pallotti, F., Paz-Pardo, G., Slacalek, J., Tristani, O. and Violante, G.L. (2023), "Who bears the costs of inflation? Euro area households and the 2021–2022 shock," *Working Paper Series,* No 2877, ECB.

[23]For example, in May 2022, credit to the general government constituted approximately 7 per cent of total bank assets.

[24]In terms of bank lending, higher interest payments on central bank reserves exert both income and substitution effects. While the former might boost bank lending by relaxing capital constraints via higher profitability, the latter effect seems to dominate: bank lending in the euro area fell sharply, in part due to the reduced incentive for banks to lend when simply holding central bank reserves offers an increased payoff.

[25]Akinci, O., Benigno, G., Del Negro, G., Queralto, A. (2023), "The Financial (In)Stability Real Interest Rate, r**", *Staff Report,* No 946, Federal Reserve Bank of New York, demonstrate via model simulations that more resilient banking sectors (proxied by higher asset quality and equity ratios) can withstand larger policy rate increases without triggering financial instability events. The transmission of monetary policy tightening is generally stronger for poorly capitalised banks (see for example Peek, J. and Rosengren, E. (1995) "Bank regulation and the credit crunch", *Journal of Banking & Finance,* Vol. 19; Kishan, R. and Opiela, T. (2000) "Bank Size, Bank Capital, and the Bank Lending Channel." *Journal of Money, Credit and Banking,* Vol. 32; Van den Heuvel, S. (2002) "Does bank capital matter for monetary transmission?" *Economic Policy Review,* Vol. 8; Jiménez G. et al (2012) "Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit-risk taking?" *Econometrica;*

Altavilla, C., Canova, F. and Ciccarelli, M. (2020) "Mending the broken link: Heterogeneous bank lending rates and monetary policy pass-through." *Journal of Monetary Economics,* Vol. 110) and illiquid banks (Stein, J. (1998) "An Adverse-Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy", *The RAND Journal of Economics,* Vol. 29; Kashyap, A. and Stein, J. (2000) "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?", *American Economic Review,* Vol. 90; Bernanke, B. and Gertler, M. (1990) "Financial Fragility and Economic Performance", *The Quarterly Journal of Economics,* Vol. 105, Bernanke, B. and Blinder A. (1988) "Credit, Money and Aggregate Demand", *The American Economic Review,* Vol. 78). In this regard, the ample central bank reserves play an important role in maintaining high bank liquidity buffers with lower sovereign-bank nexus, and contribute to decrease the financial vulnerability of the banking system to interest rate hikes (Greenwood, R., Hansen, S. and Stein, J. (2016), "The Federal Reserve's Balance Sheet as a Financial Stability Tool", *Designing Resilient Monetary Policy Frameworks for the Future,* Federal Reserve Bank of Kansas City; Altavilla, C., Rostagno, M., Schumacher, J. (2023), "Anchoring QT: Liquidity, credit and monetary policy implementation", Discussion Paper, No 18581, CEPR).

[26]Whereas the decline in total Eurosystem assets since summer 2022 amounts to around €2.4 trillion, the decline in excess reserves is noticeably smaller than the sum of the decline in monetary policy assets due to partially offsetting changes in autonomous factors, notably the decline in government deposits held with the Eurosystem.

[27]See Altavilla, C., Rostagno, M. and Schumacher, J., op. cit. See also Acharya, V. and Rajan, R. (2022), "Liquidity, liquidity everywhere, not a drop to use — Why flooding banks with central bank reserves may not expand liquidity", *NBER Working Paper Series,* No 29680, National Bureau of Economic Research; Acharya, V., Chauhan, R., Rajan, R. and Steffen, S. (2023), "Liquidity dependence and the waxing and waning of central bank balance sheets", *NBER Working Paper Series,* No 31050, National Bureau of Economic Research.

[28]Of course, the counterpart to the high stock of central bank reserves at the start of the tightening cycle was the high stock of assets held by the central bank. For the ECB, the bond holdings associated with monetary policy peaked at €4.96 billion in June 2022, while the long-term refinancing loans to the banking system peaked at €2.22 billion in June 2021. The gap between the low yields on the purchased bonds and the high interest rate paid out on central bank reserves resulted in negative net income for the Eurosystem. Initially, there were also negative net income flows from the TLTRO programme, since the interest rate received on these loans had been set during the pandemic at a rate of DFR — 50 basis points for banks fulfilling the lending benchmarks. However, this interest rate was adjusted to equal the DFR by November 2022, such that the negative income flows from this programme were limited. Until the recalibration of its conditions that became effective on 23 November 2022, there were also negative

net income flows from the TLTRO programme due to the pricing incentives put in place earlier on to support lending to the economy during the pandemic period. The decision to recalibrate TLTRO-III to align with the broader monetary policy normalization process was made on 27 October 2022. It was determined that, starting from 23 November 2022, the interest rate on all remaining TLTRO-III operations would be indexed to the average of the applicable key ECB interest rates from that date onward.

[29]In relation to asset purchase programmes, the extent of the net fiscal impact depends on whether the maturity structure of government debt would have been different in the absence of a quantitative easing programme. More generally, an accurate assessment would also have taken into account the extent to which the level of GDP and thereby the overall level of tax revenue would have been different in the absence of a quantitative easing programme. See, for example, Del Negro, M. and Sims, C. A. (2015), "When Does a Central Bank's Balance Sheet Require Fiscal Support?" *Journal of Monetary Economics,* No 73, pp.1-19; Reis, R. (2015), "Different Types of Central Bank Insolvency and the Central Role of Seignorage", *NBER Working Paper Series,* No 21226; Belhocine, N., Bhatia, A. V. and Frie, J. (2023) "Raising Rates with a Large Balance Sheet: The Eurosystem's Net Income and its Fiscal Implications", *IMF Working Paper Series,* No 2023/145, Garcia-Escudero, E.E. and Romo Gonzalez, L.A. (2024), "Why a central bank's bottom line doesn't matter (that much)", *Economic Bulletin,* Banco de España, 2024Q2 and Gebauer, S., Pool, S. and Schumacher, J. (2024), "The Inflationary Consequences of Prioritising Central Bank Profits", ECB, mimeo.

Panel: Reassessing the Effectiveness and Transmission of Monetary Policy

Roberto Campos Neto

Introduction

In my talk today, I will explore some issues related to the effectiveness of monetary policy and present my view on the main risks to the global economy.

Covid Pandemic, the Surge of Inflation and the Response of Central Banks

The Covid pandemic was the biggest negative shock that hit the global economy in recent years. Governments and central banks acted in a coordinated manner and were successful in mitigating the economic impacts of the pandemic.

However, the huge fiscal and monetary impulses, combined with labor shortages, logistical problems and production bottlenecks, caused large macroeconomic imbalances and the beginning of global inflation.

In reaction to higher inflation, central banks started raising policy rates, beginning the most synchronized monetary policy tightening cycle ever seen. The expectation was that the increase in interest rates would lead to a decrease in economic activity and a significant and fast reduction in inflation.

Ex-post Assessment

However, ex-post, it seems that monetary policy appears to be less effective than expected:

- Increase in interest rates took a long time to reduce inflation.
- Inflation is still above pre-pandemic levels in many jurisdictions.
- Job market remains strong.
- Economic activity is still resilient.

Possible Explanations

I will explore two possible explanations for this difference between the ex-ante and the ex-post scenarios. First, there was a change in the parameters that measure the effectiveness of monetary policy, making it less effective. Second, monetary policy seems less effective because of successive shocks and government interventions in the economy.

Government Interventions

We had the largest fiscal injection in history worldwide during the pandemic. To reduce the economic impacts of the crisis:

- Advanced Economies (AEs) spent on average about 20% of GDP.
- This was around twice the average spending of Emerging Market Economies (EMEs), which was close to 10% of GDP.
- Low-Income Countries (LICs) spent an average of 4% of GDP.

The fiscal measures provoked a huge impact on the indebtedness of advanced and emerging countries.

Moreover, although fiscal policies were synchronized at the beginning of the pandemic, the same did not happen afterwards. Many countries are still carrying on fiscal support policies and some are still struggling to control their fiscal accounts, partly due to the continuity of some programs.

Even after the pandemic, there has been a growing need for resources to meet demand related to:

- Social policies,
- Climate change,
- Industrial policy, and
- Defense.

All these demands are still adding pressures to public budgets and provided impulse on the economic activity.

Finally, governments also stepped-up interventions in markets that clouded market prices, such as:

- Measures to alleviate the impact of the rise in energy prices on households and businesses, especially in Europe after the start of the Russia-Ukraine war.
- Restrictions on food exports to ensure food safety.
- Interventions in fossil fuels sectors to meet sustainability goals.

Thus, according to the hypothesis, the monetary policy did not achieve the expected results because of the maintenance of strong support policies even after the pandemic, and diverse government interventions.

Change in the Parameters

Another hypothesis is that several of these measures have caused structural changes in the economy and affected the effectiveness of monetary policy. These changes should be reflected, for instance, in the neutral interest rate.

Although there are uncertainties about its level, the natural rate of interest may have increased in the main economies, making the current monetary policy less restrictive than previously thought.

Current Context

There is no definitive answer to the question posed regarding the effectiveness of monetary policy. It may even be a combination of the factors I mentioned earlier. But it is important to discuss the theme, especially because the disinflation process is not complete in many countries.

Currently, central banks remain committed to bringing inflation back to its targets in an environment characterized by less synchrony in monetary policy cycles.

Recently, we have observed greater volatility in the external scenario. In Japan, the undoing of carry-trade operations provided a strong adjustment in financial markets. In the United States, weaker economic data pointing to a risk of a deceleration stronger than the expected also contributed to higher volatility.

Looking ahead, one question seems to be whether the economic slowdown will occur in an organized way (soft landing) or not. The baseline scenario points to a mild deceleration, in an orderly manner. But we should be aware of the risks.

One important risk is related to global trade. In the United States and the European Union, discussions on trade protectionist measures especially against China, have gained momentum.

Recently, the European Union elevated substantial import tariffs on Chinese electric vehicles. In the United States, proposals from the presidential campaign emphasize large tariff increases on Chinese imports. These measures may impact severely the global trade and the global growth. Some of these discussed measures are also inflationary.

It is difficult to estimate the impact of a stronger deceleration on global economies. However, a stronger slowdown in China should have a major effect on the global activity, and potentially the biggest impact should be on EMEs.

Available Policies

In a scenario of a stronger slowdown in activity, there is little room for economic policy. Part of the recent rise in market volatility is related to that.

On one hand, there is little space for fiscal policy. Government debt is at very high levels globally and projected to rise.

I have been mentioning that the combination of high interest rates and high debt, especially in AEs, poses policy challenges and can drain liquidity from corporations, and from EMEs and LICs. In fact, the greatest risk for these countries comes from the possibility that a longer period of high interest rates leads to stronger repricing of assets.

On the other hand, central banks have very large balance sheets. During the last tightening cycle many central banks experienced meaningful losses from changes in the price of assets they had bought. Therefore, there is not much room for purchasing assets, as many central banks did in the recent past.

Thus, the only instrument left for central banks is the traditional monetary channel — interest rate policy.

Conclusion

To conclude, there is no simple and definitive answer to the question of whether monetary policy has been less effective.

However, currently the available economic policy instruments are more restricted than they were before the pandemic. We should work to restore the channels of monetary policy potentially clogged by excessive interventions.

One important challenge is to find a path to sustainable growth with low inflation and controlled fiscal accounts. A factor that could be key to achieving this path is the degree of coordination of global economic policies in the future.

General Discussion: Reassessing the Effectiveness and Transmission of Monetary Policy

Moderator: Andréa Maechler

Andréa Maechler (Moderator): I see many hands being raised. I will start with the middle section. Lots of questions. I'll start with Beth Anne Wilson.

Beth Anne Wilson: As I think about the conversation today and some crowd sourcing I did with my staff, there are a number of factors that would lead directly related to the question of the conference, reduction in effectiveness of monetary policy transmission over the last period. The initial conditions, as you just mentioned, for households and firms and financial institutions were much healthier. They had built up, you know, their balance sheets were healthier going in. They built up a lot of buffers. And in addition, they had a lot of liquidity in the financial sector. You had a lot of fiscal support. The nature of the shock was different. Supply versus demand depends the effectiveness of monetary policy, the capacity of monetary policy to address that. And if you think about the exchange rate channel, the synchronous policy tightening may have muted the exchange rate channel for some countries. But there are also factors that increase the effectiveness, central bank credibility, and as Trish Mosser mentioned, technology, and as Ida mentioned, structural features such as higher debt.

So as you face the last mile and as you assess the effectiveness of monetary policy, how are you thinking in your central banks about balancing these sort of yes more effective versus no less effective? And then what would you want from the academics in this room and beyond to balance, to understand these less effective, more effective? What direction would you give to the academics?

Jay Shambaugh: Thanks. I had a quick question for Philip. I think, Philip, you're talking about how transmission did seem to be effective, and I've heard you say before to remind people that it wasn't necessarily a purely soft landing for Europe, you know, when people sometimes talk about soft landing here. I'm curious why you think maybe there was a difference in that regard. So do you think it's that, you know, going back to Gauti's paper yesterday, the U.S. was in a different spot on the Phillips curve and therefore could kind of reduce labor pressure in a more costless way and Europe wasn't in the same place, or do you think it's not really about monetary policy and it was just you were getting hit with a ton of other shocks, the war, things like that, U.S. had more supportive fiscal policy, so there wasn't really a difference in transmission.

And then just in two seconds I want to say it's not a question, but I just want to thank Roberto for flagging in his last two figures the issues low-income countries are facing in terms of the debt financing challenge. It's not about monetary policy transmission, but many of the central banks in this room have strong governance roles at the IMF and I just want to flag that they should be thinking about this as they're using their governance at the IMF.

Markus Brunnermeier: I have three questions, one to Ida first. So Norway essentially doesn't have to hike the interest rates as much as the neighboring countries because it has this cash transmission much more forcefully through the floating mortgage rates. What are the implications for the exchange rate and how do you handle that? And do you think it's a tension for small open economies that you have a very different mortgage market and then manage the exchange rate at the same time? Or would you even go so far to say I need a similar mortgage market as my main trading partners in order to manage both?

So Philip, I have a quick question on labor hoarding concerning, do you think it's a big problem in Europe, the labor hoarding, or is it just part of a soft lending in the labor market? And can monetary policy do anything on the labor hoarding side? Or many might argue that labor hoarding might lead in the long run to a lower growth rate overall and lower productivity growth.

And finally I was wondering, I was very intrigued by the nonlinearities Roberto mentioned, because there's less room from monetary side and also from the fiscal side to help out if something were to go wrong. Is there also a positive spin to it that there might be less moral hazard that the market recognizes there's less room for bailouts in monetary and fiscal side?

Andréa Maechler (Moderator): All right, that was quite a set of questions. Philip, do you want to start with some of the answers?

Philip Lane: In our articulation of monetary policy, one of the data dependent components is the continuous reassessment of the strength of monetary transmission. We haven't had all that many hiking episodes. And because of all the different specifics about balance sheets, initial conditions, we are taking quite an empirical approach to that. I think throughout, and it's going to be ongoing, we have to have the discipline to have an open mind about the strength of monetary transmission. What is true is we know, unlike in the United States, there's a lot of fixed rate mortgages. But these are short-term fixes in many countries. These are three-year fixes, five-year fixes. Now as we get more into it, every quarter, more and more households have to refinance. So, for any given rate stance policy is getting tighter in that sense, and the cash flow channel will be operating. So, I think in terms of the overall impact, going back to what Roberto said, we think, our staff calculate, that the credit response has been bigger than you might have from a linear model. And again, I think it goes back to the regime change issue: moving away from low for long is just really big. It really leads lots of people to reassess their attitudes to investment, to consumption, and so on. So, in this particular circumstance, you might get bigger transmission.

On labor hoarding, of course, I'm sympathetic to the view that over the medium term, labor hoarding is part of a misallocation we don't like, that we would encourage better matching, all of that. But there's also clearly a cyclical element, which is basically various firms every quarter thinking the recovery is coming, so they say, let's hold on to these workers, it's hard to find workers. And if the recovery doesn't prove to be as strong as expected, they're not going to labor hoard forever. We do think, by the way, because real wages went down a lot in this period, and the interest rates were high, there was an economic incentive to hoard labor. But now that real wages are going up quite quickly, and interest rates are expected to come down, labor hoarding is becoming more expensive. And it's going to be an empirical issue how much firms respond to that change in the relative factor prices.

The soft landing issue, I don't think it's about monetary policy. I think it's a fact that it's been a tougher situation in Europe, coming from the terms of trade shock, the wider disruption of the pandemic. Maybe I will stop there. Ida, did you want to pick up the one on the FX channel?

Ida Wolden Bache: I'm happy to do that. Related to Beth Anne's question — and just repeating what Philip just said — there has to be a continuous assessment of the effectiveness of monetary policy, and initial conditions obviously matter.

I really like the question of what I would like in terms of academic research. I think for open economies, and several others have pointed to this, having cross-country evidence, in particular on the specific open economy channels through which monetary policy operates, on the spillovers, and on the exchange rates over these past few years, would be very beneficial for us at least in terms of gaining more knowledge, because it has created difficult trade-offs in monetary policy for us over the past few years.

So, we have this strong cash-flow channel, as you alluded to, which would make you worry that by tightening too much you would create a large drop in consumption. It could raise financial stability concerns, but that has proven not to be a problem — it turned out to be quite robust. But on the other hand we have seen a significant depreciation of our currency against the major currencies, which in a situation of already high inflation is not welcome. And this is despite the fact that we have raised interest rates more than our neighbouring countries, so this is actually creating some really difficult trade-offs, and will continue to create difficult trade-offs for us going forward. So that is the case.

I would like to add one point to that. That is an interesting question, I think, and Philip, you are right to say that you cannot just look at the cash-flow channel and the household debt and the share of adjustable-rate mortgages and then conclude that transmission is stronger or weaker. Obviously, a lot of other factors will impact that as well. And if you have a mortgage market with only floating rates and large household debt, that does not only affect households, but of course is reflected in the entire structure of the financial system. We have banks with only floating rates on both sides of their balance sheets, so the kind of interest rate risks that many countries face in terms of liquidity issues in 2023 were not a part of the story for Norway. So, you have to look at what we talked about earlier today, the banks' balance sheets and the household balance sheets, and look at them together, and then assess whether that actually means that monetary transmission is stronger or weaker in a floating-rate mortgage system or in another system.

Roberto Campos Neto: On the reduction in effectiveness and increase in effectiveness, I think emerging markets, some emerging markets here, I think Brazil is included, have a very particular thing that is very different, which is when we look in our history, the moments in which we were able to lower rates and keep rates lower for longer, they were 100 percent associated with an expectation of a better fiscal framework ahead. So when we had the ceiling, that happened, and we came with the fiscal framework, that happened. So it's like we have this, what I call this twin anchoring. So we have the expected inflation, but we also have the expected fiscal. When the expected fiscal starts to get worse, it's very difficult for you to control expected inflation in a country like Brazil, and you have some other examples. So I think in terms of the effectiveness, the more coordinated the fiscal and the monetary are, the better, the more effective you are. That has been very easy to do on the way in the pandemic. It's been very difficult to do on the way out. So that's the point.

And then the question of markets, I think that's a great question, and I come from markets. So I think the spin can be very positive, because I think, and I remember in some of the meetings with central bankers, and people would say, oh, Europe is accelerating too much. The markets haven't done that bad. And I always used to say, well, because we are the markets. That's why the markets haven't done. So I think the fact that you have the price discovery being more transparent, I think it improves a lot. So there was a paper yesterday, and it was the case of the U.S. I know the U.S. is a reserve currency. But when you look at emerging markets, for example, and you decide to intervene in one market, basically what you do is you remove the hedging capacity of that market, and you have an immediate spillover to other markets. So I get pressure a lot to intervene more on FX. Really what happens when you intervene in FX and FX loses the ability of being a hedge, people go to the long end of interest rates, and that blows up. And also the CDS. When it happens in the CDS, you have a problem with private credit, because all the private credit and all the recovery value are based on CDS solutions. When the long end goes higher, then you have a problem with the long-dated project. So at the end, I think improving price discovery could be a very, very good thing that will come out of that. So I agree on that.

Andréa Maechler (Moderator): Okay. I'll do another round of questions. Let's start with Laura Alfaro and then we'll go to Barry Eichengreen.

Laura Alfaro: First, let me thank the organizers for putting a global view of the issue. I think as Roberto has highlighted, when you're from emerging markets, you have to do a general equilibrium of the whole world and get into many things. But I wanted the panel to perhaps focus on the role of China. So, as Roberto highlighted, I see three effects. One is this acceleration of the growth, which I think is different from before. The second one is more imports that could be coming at lower prices. So most countries have seen the increase from imports from China except from the U.S., but also a reallocation to other countries that are more expensive. And a third channel is this tariff jumping FDI that Roberto also mentioned. And so I just want to get a sense of your views. Is this going to make fighting inflation harder or easier? And I think this is relevant not only for Brazil and emerging markets, but I think also for Europe. I don't know Norway that well, but it might be relevant for all countries.

Barry Eichengreen: This is the last session and we're quite interested in the combiniation in highlighting the housing market and the mortgage market as a transmission belt for monetary policy. I have an observation about that and a related question. The observation is that not all fixed-rate mortgages are created equal. We have 30-year fixed-rate mortgages in the U.S. because we have GSAs, and other countries have 5-, 10-, 15-year fixed-rate mortgages, and the cash-flow implications might be different amongst them. And the question for Ida is the elements of your presentation all fit together extremely smoothly until you got to your last slide, when there was not a connection between the cash flow implications and the behavior of consumption. So, I want to ask about the elephant in the Norwegian room, which is the sovereign wealth fund. Is there a correlation between the returns on that fund and the level of interest rates? They invest globally, but we've heard repeatedly about how interest rates have been moving in tandem with one another. So, I think the question is still there.

Lesetja Kganyago: Thanks. Roberto, three quick questions for you. One is that you moved rates much earlier, but when I look at the disinflation process, it seems to be sticky. Have you done any work? Have you assessed why was it that in spite of moving so early, inflation remained sticky downwards? And related to that, since you have mentioned the issue of the role of fiscal policy in this stuff, and you talked about the coordination of fiscal and monetary policy, I guess during the pandemic, because you were dishing out money, fiscal would like the coordination. When you have to withdraw, it becomes a different ballgame. How do you coordinate in an environment where there is a clear monetary policy anchor, but there isn't a fiscal policy anchor, unless you have one that I am not aware of?

Then secondly, is the issue of capital flows and how you thought the issue of capital flows interacts with your transmission mechanisms and how you dealt thus with the spillovers from advanced economies. I think that we had yesterday that the issue of capital flows is not a big issue for the U.S., but there are spillovers and there are spillbacks. And then related to the issue of the capital flows is the issue of the exchange rate and how you think about that. I think for a long time we had convinced ourselves that the pass-throughs have come down, and what are you seeing now with the exchange rate pass-throughs, because also the exchange rate relates to capital flows.

Andréa Maechler (Moderator): Great question. I'm going to have a question from Anil Kashyap.

Anil Kashyap: This is for Ida. I wonder if Norway has thought about doing some sort of a macro-prudential thing to calibrate the size of the mortgage pass-through. So one thing you could do is say we're going to have a debt-to-income limit on the percentage of mortgages that could be issued more than, let's say, four or three or something. It seems like the way to solve this is to get another tool, and if it's the mortgage market, then it's pretty straightforward what that tool would be. So I'd like to know more about that.

Andréa Maechler (Moderator): Great. For our panelists, your last chance to respond.

Ida Wolden Bache: The question Barry asked was a very big one related to our sovereign wealth fund, which was set up to insulate the economy from fluctuations in petroleum prices and to save for future generations. Now that it's become so large, of course, fluctuations in international financial markets have a very large impact on our net foreign assets and also through the fiscal policy rule, which is related to the value of the fund on an annual basis. Whether that can explain the consumption response, I think the effect is at best indirect, but you would think over time that having such a large buffer in terms of savings in the pension fund would add to the social security system in terms of providing assurance to our households and could perhaps explain why they have been so willing, actually, to draw down their savings and more so than in many other countries in order to smooth consumption. I guess that's as precise as I can be at the moment, but there are very interesting questions related to that.

In regards to macro-prudential policy, I guess that's related to what Philip was saying earlier. Having a lot of macro-pru in place has, in fact, meant that we have been able to raise rates without risk. We have not seen any significant loan impairments, no risks emerging on banks' books yet, which has enabled us to actually use monetary policy in this cycle to get inflation down without incurring large costs in terms of financial stability risks so far.

Roberto Campos Neto: Yes. On China, I think it's a very important question for EMEs. So we have two effects. We have one effect, which is if it grows less, it's going to have an impact on the price of commodities. And then the question is how that impacts our term of trade and what kind of shock can arrive from there. The other part is so we can import from China at lower prices, so that can contribute to disinflation. I guess here the question is what is the net effect. I think it depends on how much the deceleration is, because then you might create some non-linearity in the price of commodities.

And regarding the fall in the price of commodities, I think there is a big difference whether it's metals or if it's food. Brazil is a big exporter of food. So in the recent years, what we see is the small disappointments in terms of growth in China have affected more mining than food. But that could be different. So that would be the answer.

And just on Lesetja's point, very important points. So we moved very fast, and we were at 2%, which was far from our neutral rate. So for us, we actually had a free option in the beginning because we knew we were so far from the neutral that we could start doing it before. And we did it a lot. And Brazil always has a history of higher inflation than the other EMEs. And at that time, actually, inflation converged faster than most of the EMEs. But then we are at this point right now, which is stalling. Some of it has to do recently with food, but a lot of it has to do and a lot of the uncertainty has to do with how can you continue this process with labor tightness and the service inflation has stalled. And if you look at the core, it started to go up a little bit. So I think that's how to coordinate. I think it's the challenge that we have.

The government is trying to actually approach this, but it's very difficult. And we have many problems that are beyond just executive power. And in terms of capital flow, I think here you have the differential interest rate that I think plays a part. But at the same time, I think there is a perception that the external sector in Brazil is stronger. We are exporting more oil. We are exporting more and more food. The food production is increasing year after year. It's gaining efficiency. And at the end, I think on the FX, we really believe that in Brazil, you can make a strong case from the principle of separation. So interest rate is for monetary policy. Macro-pru is for financial stability. And the FX is floating. When you start intervening in FX, and there is a perception in the market that you are doing that in substitution for monetary policy, there is a big dent in productivity. And we have had that a couple of times. So for us, the question is, what is a dysfunction in FX and when should you intervene? And we try to only intervene when we have dysfunction, understanding that there is a capital flow. And at the end, the FX serves as a good shock absorber.

Andréa Maechler (Moderator): Thank you very much. I think the whole question of global factors and the impact of monetary policy transmission is going to be an area of research going forward.

Philip Lane: Roberto answered well regarding China, a lot of which carries over to Europe. I'll just advertise, pardon me saying so, that in our May Economic Bulletin, there's a pretty long article about China and Europe. So if you are interested in our views of all the different issues related to China, you're better off reading that.

Andréa Maechler (Moderator): Okay. Great. I like these kind of answers. Very, very helpful.

Jacob Frenkel: All the panelists started by observing that monetary policy reaction was similar. Ida called it synchronized. Roberto called it coordinated. And I think that the words mean very different things. Coordinated implies they were sitting together, assessing the situation, and did something in a coordinated way. Synchronized means more of an observation. Correlated is the most detached from the causes and effects. I think that one of the reasons why reactions can be similar is because of commonality of shocks, commonality of frameworks that respond in a similar way to shocks, or market-driven factors that bring about the transmission of the shocks that forces it always to be the same. So I think we should be careful there.

Just a footnote to Philip Lane. Looking at your first graph, I see that as of today, the assessment that in 2027, the policy rate will be around 2%. Does it imply that the real rate that we expect to be would be zero? And does it imply that this is a sustainable situation?

Andréa Maechler (Moderator): Someone had to come up with a question of coming close to the R-star. Let me go a little bit further. Sebnem, please.

Sebnem Kalemli-Özcan: My question is to all of you. Similar to Jacob, you also all said in your presentations that the banking system is healthy, highly liquid, highly capitalized, and that's exactly what you want. You acknowledge the monetary policy transmission through the banking system to lending to firms and households. But you said this is a success. I agree with this, but at the same time, there is this fact that early on, these healthy banks did not lend to SMEs. And SMEs are a very large part of employment in all your countries. In fact, actually, this is also true for the U.S.; the U.S.'s own program, PPP, cost 800 billion dollars. You have different programs in your countries that also added direct lending by central banks. So why do you think that is? Why do you think a very healthy banking system that has a critical role in monetary policy transmission to companies, small firms, did not lend early on?

Francesco Bianchi: Thank you. I want to go even closer to the theme of R-star. Philip talked about regime change. I would like to know where Philip thinks this regime change is coming from, because I think it is going to be very important for monetary policy going forward. Do you think it's related to geopolitical risk, reflation coming from fiscal policy, etc? I would really be curious to know what you think cause this change. And of course, I would also like to hear from the other panelists how they feel about this change.

Pierre-Olivier Gourinchas: Thank you. I have two questions, one to Philip and one to Roberto. To Philip, I'm curious about your views about how the transmission played out across the different countries in the euro area, because you have a common monetary policy, of course, and you've been working tirelessly to make sure that the transmission is common across different jurisdictions within the euro area. We have very different wage indexation mechanisms across different countries. We've had different exposure to, for instance, the Russia-Ukraine conflict in terms of energy prices. So, do you see that showing up in terms of real exchange rates inside the euro area, and is that something that would be a concern going forward?

To Roberto, and maybe others, I have a question that comes back to what Jacob was asking about coordinated versus synchronized. The fact that other countries were raising policy rates at the same time as you were facing inflation pressures, did that lead you to tighten more or tighten less? In other words, were you facing, because other countries were tightening, an appreciation of their currency, a depreciation of yours that would increase inflation pressures and force you to do more? Or was it sort of cooling off aggregate demand in a way that would also help in terms of containing inflation pressures domestically? I'm curious about how you see it from your perspective, especially from the EM side. And looking ahead, now that we heard from Chairman Powell that now almost all advanced economies ex-Japan are embarking on an easing cycle, is it something that will support EMs, or is it something that could create headwinds for them?

Amir Sufi: Thank you very much. My question is for Ida. First of all, I want to commend your research scholars at Norges Bank. I was thumbing through the paper that you cited, and it's really well done. I think people should really look at this paper. It's high-frequency transaction data, which can in very quick real-time see the consumption response to higher interest rates coming directly from monetary policy. I've seen that movie many times, and I usually expect a certain ending. And I'm a little with Barry that I was surprised that the ending was a little bit different when we actually looked at aggregate consumption. The effects they're finding are enormous — 30 cents on the dollar, essentially, in a cut in consumption. And it's on the margin, so it can't be those same households that are drawing on savings, because it is affecting their consumption. So, the thing that kind of struck me is: is there a big distributional issue happening in Norway? Are there some households that are benefiting a lot from higher interest rates and therefore spending more as the debtor households are kind of spending a lot less? Has that shown up anywhere? Has that shown up in the press or anything? This kind of distributional issue.

Andréa Maechler (Moderator): All right, thank you. Clearly, the panelists cannot do justice to all the questions. I will give them one minute each to answer. Ida, why don't you start?

Ida Wolden Bache: Yes. Let me start by saying that I will stick to my choice of words and use "synchronized" rather than "coordinated" when it comes to monetary policy. And to the question of whether the fact that we've had an orderly response, avoided a severe crisis, and avoided de-anchoring of inflation expectations has made policy easier — at least in that sense of whether policy rates would have been tightened more or less — it has certainly helped, particularly for small open economy central banks.

Regarding global common shocks, you have common frameworks, but then, of course, you have the global interlinkages, which means that a small open economy cannot deviate that much from other countries' interest rates because of the exchange rate channel and capital flows affecting it.

As for the last graph chart showing the correlation of consumption and our very crude measure of the strength of the cash flow channel, it's a very simple measure and there are lots of other things going on. But I thought it still was interesting to generate questions that we need to dig into further. We have not seen big distributional effects of the kind you have indicated, but I think there's a lot of other stuff going on as well. We know that the marginal propensity to consume is lower for households with high levels of liquid assets, and we saw a sharp increase in liquid buffers built up during the pandemic alongside other policy interventions that could explain the consumption response. But I think we will need to do a lot more research on this and hopefully our data can help us disentangle this.

Roberto Campos Neto: I agree that "synchronized" is a better choice of words, so we're not going to fight on that. Perhaps "coordination" is better when you think about monetary and fiscal policy at the time, but even there I have some doubts whether it's more synchronized or coordinated. The question on the banking system was very interesting because that was a big fight that we had. In the case of Brazil, we had a lot of reserve requirements. The question I always asked was: yes, the SMEs are not seeing a lot of credit going to them, but if I have a lot of liquidity and the banks are very well capitalized, why don't I give liquidity and capital for the banks in a way that will incentivize them to lend? Very early, in March 2021, we did a 20% of GDP capital injection by releasing capital requirements and a 17% of GDP injection in liquidity. We thought if we give more liquidity and capital to the banks, they will do the job, and we won't need to do it. It's better that they have skin in the game because then they will choose credit better and the chances of having losses in the central bank's balance sheet are lower. So we took a very different approach compared to QE elsewhere.

Philip Lane: Let me make a couple of points. Pierre Olivier Gourinchas raised an important issue about cumulative real exchange rate movements. From 2019 to now, and possibly to the end of 2025 or so, part of this will narrow because wages move more quickly in some countries than others. But some of these movements might actually align with IMF preferences in reducing external imbalances, while others could inhibit convergence among countries. So I think that is a legacy issue.

Regarding regimes, I think there are three regimes: one is chronically below target, another is when there's a loss of trust and inflation is above target, and the third is where the market believes you're going to be around target. We've moved from being chronically below to a regime where people believe we will deliver the target. Recently, there was a shift where spot inflation pricing for the next five years or five-year forward was a bit above two, suggesting potential inflationary shocks. But this narrative seems to be moving. Again, these are just market views. I'm purely data dependent.

Jacob, whether the equilibrium rate is zero or a bit above zero, we will find out. What I showed was just a market view, not my view.

The Attendees

The Federal Reserve Bank of Kansas City hosted its first economic policy symposium in 1978 in Kansas City, Mo. After four years with an agricultural focus, the first monetary policy symposium was in 1982 in Jackson Hole, Wyo. The location is the northwest corner of the Tenth Federal Reserve District, which includes Colorado, Kansas, western Missouri, Nebraska, northern New Mexico, Oklahoma and Wyoming.

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