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Evaluating Quantitative Easing: The Importance of Accounting for Forward Guidance

By Brent Bundick and A. Lee Smith

During the COVID-19 pandemic crisis, policymakers used large-scale asset purchases (LSAPs) along with forward guidance about the future path of the federal funds rate to help stabilize financial markets. However, policymakers and economists have yet to reach a consensus on the efficacy of LSAPs in providing accommodation and improving macroeconomic outcomes. Because announced changes in LSAPs often coincide with changes in forward guidance, the market responses to these two tools can be difficult to disentangle and each tool's efficacy challenging to evaluate.

Brent Bundick and A. Lee Smith attempt to measure the efficacy of the FOMC's previous asset purchase programs during the Great Recession while explicitly accounting for changes in forward guidance. They find that controlling for concurrent changes in forward guidance implies a roughly 25 percent reduction in the accommodative effects of the FOMC's first two asset purchase programs relative to estimates that do not disentangle the two tools. The effects of an asset purchase program could thus be overstated if researchers fail to account for changes in interest rate uncertainty induced by forward guidance occurring at the same time.

Cutting-Edge Methods Did Not Improve Inflation Forecasting during the COVID-19 Pandemic

By Amaze Lusompa and Sai A. Sattiraju

Although central bankers' inflation forecasts tend to be fairly accurate during normal times, they do not perform as well during downturns and periods of extreme uncertainty, such as the COVID-19 pandemic. To improve this performance gap, researchers over the past 20 years have proposed various innovations to a benchmark class of models known as "time-varying parameter models," which allow the relationships between forecasting variables to change over time. However, most research on the efficacy of these innovations was conducted prior to the COVID-19 pandemic, leaving the question of how these "improved" models have performed during recent extreme events.

Amaze Lusompa and Sai A. Sattiraju investigate whether innovations in time-varying parameter models led to improved inflation forecasting during the pandemic. They find that despite their promise prior to the pandemic, forecasting innovations did not improve the accuracy of inflation forecasts relative to a baseline time-varying parameter model during the pandemic. Their results suggest that forecasters may need to develop a new class of forecasting models, introduce new forecasting variables, or rethink how they forecast to yield more effective inflation forecasts during extreme events.

Government Assistance and Moral Hazard: Evidence from the Savings and Loan Crisis

By Padma Sharma

When regulators intervene to rescue failing financial institutions, they may lead banks to expect future assistance and increase their risk-taking. To avoid incentivizing risky behavior, regulators often try to signal that they will not assist banks in a future crisis. Regulations passed during the savings and loan (S&L) crisis in the 1980s provide a rare example of policies that in fact discouraged risk-taking. After a wave of S&L failures, the Federal Savings and Loan Insurance Corporation (FSLIC) liquidated or sold some failed S&Ls but assisted others to keep them in operation. In 1989, however, the FSLIC closed. A new regulatory agency was prohibited from assisting failed institutions, which signaled the suspension of future assistance.

Padma Sharma examines how suspending assistance to failed S&Ls in 1989 affected the balance sheets of operational S&Ls. She finds that S&Ls responded to the change in policy differently depending on ownership structure: stock S&Ls increased their composition of safe assets relative to mutual S&Ls. If government assistance had remained feasible, stock S&Ls likely would have continued taking risks, lending an additional $2.14 billion and reducing their holdings of securities by $4.5 billion. In contrast, mutual S&Ls did not engage in excessive risk-taking even when government assistance was feasible, so they had little incentive to further reduce risk-taking when assistance was suspended.

Evaluating Quantitative Easing: The Importance of Accounting for Forward Guidance

By Brent Bundick and A. Lee Smith

On March 15, 2020, the Federal Open Market Committee (FOMC) lowered the federal funds rate—its primary policy tool—to its effective lower bound in response to the pandemic-induced contraction in economic activity. At the same time, the FOMC began engaging in large-scale asset purchases (LSAPs) and provided forward guidance about the future path of the funds rate. Both LSAPs and forward guidance are less conventional tools that the FOMC also deployed to combat the Great Recession of 2007–09. Although the Great Recession and pandemic crisis were driven by very different factors, policymakers in both periods looked to LSAPs and forward guidance to help stabilize financial markets and promote maximum employment and price stability.

In theory, LSAPs support the economy by putting downward pressure on longer-term interest rates and improving the flow of credit to households and firms. However, policymakers and economists have yet to reach a consensus on how effective LSAPs are in providing accommodation and improving macroeconomic outcomes. One common approach to measuring the effectiveness of these tools is to study how financial markets respond to announced changes in LSAPs and forward guidance. But the market responses to these tools can be difficult to disentangle because announced changes in LSAPs often coincide with

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changes in forward guidance about the future path of interest rates. For example, at the conclusion of its December 2008 meeting, the FOMC announced that it would purchase large quantities of agency debt and mortgage-backed securities and evaluate the potential benefits of purchasing longer-term Treasury securities (Board of Governors 2008a). In the same announcement, however, the Committee also announced that the federal funds rate would remain exceptionally low "for some time." When responding to the pandemic in 2020, the FOMC's adoption of new forward guidance on the funds rate on March 15 occurred at the same time as the announcement of additional asset purchases, again making the policies' outcomes difficult to disentangle.

In this article, we highlight our research in Bundick, Herriford, and Smith (2021) that attempts to measure the efficacy of the FOMC's previous asset purchase programs during 2008–10 while explicitly accounting for changes in forward guidance. We find that controlling for concurrent changes in forward guidance implies a roughly 25 percent reduction in the accommodative effects of the FOMC's first two asset purchase programs relative to estimates that do not disentangle the two tools.

Overall, we argue that forward guidance and asset purchases represent two distinct tools in a central bank's toolkit. This interpretation contrasts with other recent research arguing for a signaling channel of asset purchases, in which changes in asset purchases themselves provide information about the future funds rate and hence directly play a role in communicating the central bank's forward guidance. Our empirical analysis suggests little evidence for the signaling channel, supporting our interpretation of forward guidance and asset purchases as two distinct policy tools that can help stabilize the economy.

Section I reviews the announcements of the FOMC's asset purchase programs in response to the Great Recession and the changes in forward guidance that often occurred at the same time. Section II documents that even prior to the federal funds rate hitting the effective lower bound and the adoption of LSAPs, changes in forward guidance alone affected longer-term interest rates by changing the perceived uncertainty surrounding future policy rates. Section III estimates the efficacy of asset purchase programs adopted during the 2008–10 period, explicitly accounting for concurrent changes in forward guidance.

I. The Federal Reserve's Asset Purchase Programs in Response to the Great Recession

As labor market conditions deteriorated near the end of 2008, the FOMC lowered the federal funds rate to near zero "to promote the resumption of sustainable economic growth and to preserve price stability" (Board of Governors 2008a). With its conventional policy tool exhausted, the Committee then turned to forward guidance and large-scale asset purchases, also known as quantitative easing (QE), to help stabilize the economy as the recession continued. Over the course of the recession and recovery, the FOMC engaged in three subsequent rounds of QE, known as QE1, QE2, and the maturity extension program (MEP).[1]

QE1: Support to the housing sector and broader Treasury markets

In 2006, the housing sector began to contract, and the rapid rise in subprime mortgage delinquencies eventually led to a significant tightening in financing conditions for households and a broader decline in economic activity. To support the housing market and increase the availability of credit, the Federal Reserve announced on November 25, 2008, that it would purchase up to $100 billion in government-sponsored enterprise (GSE) debt and $500 billion in GSE mortgage-backed securities (Board of Governors 2008b). In subsequent communications, Chair Bernanke and the FOMC signaled they were also prepared to engage in purchases of Treasury securities if conditions continued to deteriorate. As the economy continued to lose hundreds of thousands of jobs in early 2009, the FOMC followed through on these intentions by announcing purchases of $300 billion in Treasury securities and an additional $750 billion in mortgage-backed securities over the next six months (Board of Governors 2009). Gagnon and others (2011) argue that these actions led to an economically meaningful reduction in longer-term interest rates, even for securities that were not directly purchased by the FOMC.

QE2: Maintaining and adding to the Fed's holdings of Treasury securities

Despite the policy actions taken by the FOMC to support the economy, the economic recovery slowed during the summer of 2010. As a result, the Committee announced at its August 2010 meeting that it would begin reinvesting principal payments from the maturing securities on its balance sheet into longer-term Treasury securities (Board of Governors 2010c). While the economy continued to shed jobs and bank lending contracted, the Committee stated at its September 2010 meeting that it was prepared to add accommodation if needed to support the economic recovery (Board of Governors 2010b). The pace of the recovery remained slow in the fall of 2010, and the FOMC announced in November 2010 that it would buy about $75 billion of longer-term Treasury securities per month for the next eight months—a total program size of $600 billion (Board of Governors 2010a). Krishnamurthy and Vissing-Jorgensen (2011) show longer-term Treasury yields declined significantly following the initial announcements in August and September 2010. By the time the second asset purchase program was announced in November, market participants largely anticipated the announcement, leading Treasury yields to actually rise slightly following the meeting.[2]

The MEP: Shifting composition to longer-term Treasury securities

In mid-2011, the economic recovery showed signs of stalling, with the unemployment rate stuck around 9 percent. To provide further monetary accommodation, the FOMC again decided to undertake a new asset purchase program, the MEP (Board of Governors 2011a). Unlike the previous two asset purchase programs, the MEP did not increase the size of the balance sheet but instead changed its composition, as the FOMC simultaneously sold short-term Treasury securities and used the proceeds to buy longer-term securities. In its September 2011 statement, the FOMC indicated that by the end of the following June, it would extend the average maturity of its holdings by purchasing $400 billion of Treasury securities set to mature within six and 30 years while selling the same amount of securities set to mature within three years or less.[3] Even though the program did not change the size of the Fed's balance sheet, the announcement of a composition shift toward longer-maturity Treasury securities led to a significant decline in longer-term bond yields.

Contemporaneous changes in forward guidance about the federal funds rate

At first glance, the responses of bond yields to the announcement of these past programs suggest that asset purchases are a potent tool in the central bank's toolkit. However, this casual analysis fails to account for contemporaneous changes in forward guidance about the future path of the funds rate.

Table 1 shows that some of the key announcements regarding asset purchases in fact coincided with simultaneous changes in forward guidance. The announcement on December 16, 2008, coincided with guidance that the federal funds rate would remain exceptionally low "for some time." The announcement on March 18, 2009, coincided with guidance that the funds rate would likely remain low for an "extended period." Other announcements, such as the FOMC's intention to "provide additional accommodation if needed to support the recovery" during its September 2010 announcement of QE2, could apply to either asset purchases or a change in the path of the funds rate. While Krishnamurthy and Vissing-Jorgensen (2011) associate this language with increasing the likelihood of a new asset purchase program, this language may have also led to expectations of a lower future path for the federal funds rate.

The response of bond yields to the August 2011 FOMC meeting illustrates how forward guidance, even in the absence of a change in an asset purchase program, can affect longer-term bond yields. In its statement on August 9, 2011, the Committee specified that economic conditions "are likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013" (Board of Governors 2011b). This statement marked the first use of forward guidance that referenced a specific date, and most market participants interpreted this guidance as an expectation that policy rates would remain near zero for the next several quarters.[4] Even though the FOMC did not make changes to its asset purchase program at that meeting, the change in forward guidance led longer-term bond yields to fall significantly.

Table 1

Announcements of Selected Asset Purchase Programs and Forward Guidance

Announcement date	Purchase program	Asset purchases	Forward guidance
November 25, 2008	QE1	Announcement that Federal Reserve will purchase $100 billion of GSE debt and $500 billion GSE mortgage-backed securities.	None provided.
December 1, 2008	QE1	In a speech, Chair Bernanke suggests FOMC could purchase additional agency securities or Treasury securities.	No discussion of forward guidance.
December 16, 2008	QE1	Committee states it is "evaluating potential benefits of purchasing longer-term Treasury securities."	New guidance that federal funds rate would remain exceptionally low "for some time."
January 28, 2009	QE1	Announces intention to purchase longer-term Treasury securities if circumstances dictate they would be effective in supporting credit markets.	Maintains previous "some time" guidance.
March 18, 2009	QE1	Announces purchases up to $300 billion of longer-term Treasury securities over next six months.	New guidance that funds rate is likely to remain low for an "extended period."
August 10, 2010	QE2	Committee states it will begin reinvesting principal payments from maturing securities.	Maintains previous "extended period" guidance.
September 21, 2010	QE2	Committee states that it will continue reinvestment and provide additional accommodation as necessary.	Maintains previous "extended period" guidance, provide additional accommodation as necessary.
August 9, 2011	None	N/A	Conditions are "likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013."
September 21, 2011	MEP	Announces sale of short-term Treasury securities and reinvestment into longer-term securities.	No actual or expected change.

Sources: Krishnamurthy and Vissing-Jorgensen (2011) and Board of Governors of the Federal Reserve System.

II. How Forward Guidance Affects Longer-Term Interest Rates

Analyzing the effectiveness of any asset purchase program that coincides with forward guidance requires understanding the mechanism through which changes in the announced path of the federal funds rate could affect longer-term interest rates. Our research highlights that changes in forward guidance, by altering the perceived uncertainty around the future path of the funds rate, can significantly affect the compensation an investor requires to hold the longer-term bond (called the "term premium").[5] For example, statements policymakers issue to provide additional clarity about the future path of the federal funds rate often lead to a decline in the perceived uncertainty about the path of future short-term interest rates. This decline typically leads financial market participants to demand less compensation—that is, a lower term premium—for holding a longer-term bond, and thus Treasury bond yields fall. Conversely, more opaque statements that offer less clarity lead to higher perceived uncertainty, which can raise yields on longer-term bonds. Through this uncertainty channel of forward guidance, central bank communication can affect longer-term bond yields.

However, to evaluate the quantitative importance of this potential transmission mechanism, we first must measure the uncertainty about future short-term interest rates. One way to measure this uncertainty from financial markets is to examine prices from options on Eurodollar futures contracts. Eurodollar contracts are financial market instruments whose payoff depends on the London Interbank Offer Rate (LIBOR), a short-term borrowing rate for financial firms that closely tracks the federal funds rate. Options on these Eurodollar contracts are additional instruments that have a positive return only under specific outcomes for future interest rates.

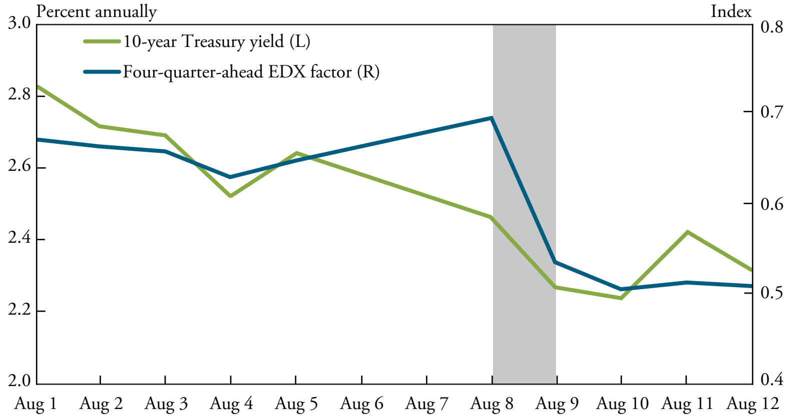
The price of a Eurodollar option today reflects financial market participants' beliefs about future short-term interest rates. For example, a given option may have a positive payoff only if the LIBOR rises above 3 percentage points at the end of the next year. A high price for this option suggests financial market participants believe that short-term interest rates are highly likely to be above the 3 percent threshold in a year. In contrast, a price near zero suggests financial market participants believe this event is quite unlikely.[6]

In Bundick, Herriford, and Smith (2021), we use a variety of different interest rate options to create a measure of uncertainty about future short-term interest rates, which we denote as the Eurodollar Volatility Index (EDX). We construct these measures across different time horizons, which provides measures of interest rate uncertainty over the next one to five quarters.[7] With these measures of interest rate uncertainty, we can attempt to quantify how changes in central bank forward guidance might transmit to longer-term bond yields through interest rate uncertainty.

The adoption of the previously mentioned "at least through mid-2013" guidance at the FOMC's meeting on August 9, 2011, highlights how forward guidance can affect longer-term bond yields by changing perceived uncertainty around the future policy path. Although this announcement lowered expectations for future policy rates, it also lowered the perceived amount of uncertainty around the path of policy in the coming quarters. Chart 1 plots the 10-year bond yield and our four-quarter-ahead EDX measure in the days before and after the August 2011 FOMC meeting. On the day of the announcement (highlighted in gray), Chart 1 shows a large reduction in our four-quarter-ahead EDX (blue line), which measures uncertainty about one-year-ahead short-term policy rates. This decline in uncertainty coincides with a significant decline in longer-term bond yields (green line), consistent with the idea that announcements that provide more clarity about the future path of rates lower both uncertainty about future policy rates as well as longer-term bond yields.

Beyond the single August 2011 announcement, our related research in Bundick, Herriford, and Smith (2021) highlights that this interest rate uncertainty channel of forward guidance is quantitatively important during the 1994–2008 period. During this time, the FOMC made many changes to its forward guidance but did not engage in any asset purchase programs. For example, at its June 2004 meeting, the FOMC stated that "policy accommodation can be removed at a pace that is likely to be measured," which provided additional clarity about the path of the funds rate (Board of Governors 2004). We find evidence that during the 1994–2008 period, policy announcements that provided greater clarity reduced interest rate uncertainty and lowered the compensation investors required to hold longer-term Treasury bonds, on average.

Chart 1
Bond Yields and Interest Rate Uncertainty Fell after Announcement on August 9, 2011



Notes: The blue line is the EDX factor at the four-quarter horizon, and the green line is the nominal 10-year Treasury yield. The chart uses end-of-day data; the shaded area highlights the change in each measure on the day of the FOMC announcement, August 9, 2011.
Source: Authors' calculations.

III. Revisiting the Efficacy of Asset Purchases Accounting for Forward Guidance

Overall, our analysis of the FOMC's August 2011 announcement as well as the earlier 1994–2008 period highlights not only that forward guidance can affect longer-term bond yields but also that it can affect longer-term bond yields independently from changes to the central bank's balance sheet. Thus, any attempt to evaluate the efficacy of an asset purchase program must account for simultaneous changes in forward guidance.

We evaluate the effects of the FOMC's three asset purchase programs while accounting for coincident changes in forward guidance. To do so, we specify a simple statistical model that examines the daily change in 10-year Treasury yields following each announcement.

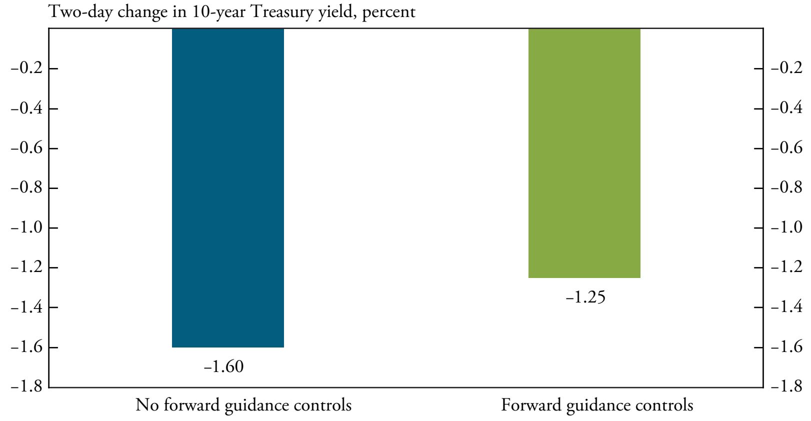
To provide a baseline for comparison, we first study the cumulative change in yields on the eight QE announcement dates relative to non-QE announcement dates. Specifically, we include a dummy variable in the model that takes a value of 1/8 for each of the eight QE announcement dates listed in Table 1. The coefficient on this variable gives an estimate of the cumulative change in yields resulting from the FOMC's first three asset purchase programs, ignoring any contemporaneous change in forward guidance. The blue bar in Chart 2 illustrates the estimated results and shows that the announcements regarding the asset purchase programs reduced the 10-year Treasury yield by a total of 1.60 percent, a statistically significant and economically large effect. This approach, however, fails to account for any contemporaneous changes in forward guidance, which may overstate the estimated efficacy of the purchase programs.

When we control for contemporaneous changes in forward guidance operating through interest rate uncertainty, we find a roughly 25 percent reduction in the cumulative effects of the asset purchase programs. The green bar in Chart 2 shows the results if we include our EDX measures of interest rate uncertainty in our statistical model.[8] Specifically, we include two interest rate uncertainty factors that capture the daily changes in our one-to-five-quarter-ahead EDX measures around the policy announcements. Controlling for interest rate uncertainty shrinks the estimated decline in 10-year yields due to the asset purchase announcements by 35 basis points, from 1.60 percent to 1.25 percent. Thus, the statistical model suggests that part of the decline in longer-term rates is likely attributable to forward guidance, not just asset purchases.

In addition, a statistical test that examines the significance of our interest rate uncertainty measures illustrates that interest rate uncertainty plays an important role in explaining movements in the 10-year Treasury yields following these announcements. These results suggest that forward guidance and asset purchases can both effectively lower longer-term Treasury yields; however, policymakers must account for all their policy instruments in measuring the efficacy of a particular policy tool.

Using a slightly expanded specification allows us to examine the individual effects of the three asset purchase programs and evaluate whether failing to control for forward guidance biased the estimates of some programs more than others. We replace the single asset purchase program summary variable in our previous statistical model with a set of three dummy variables, one for each of the first three asset purchase programs.[9] This expanded specification allows us to decompose the decline in yields into the effects from each program.

Chart 2
Effects of Large-Scale Asset Purchases with Forward Guidance Controls

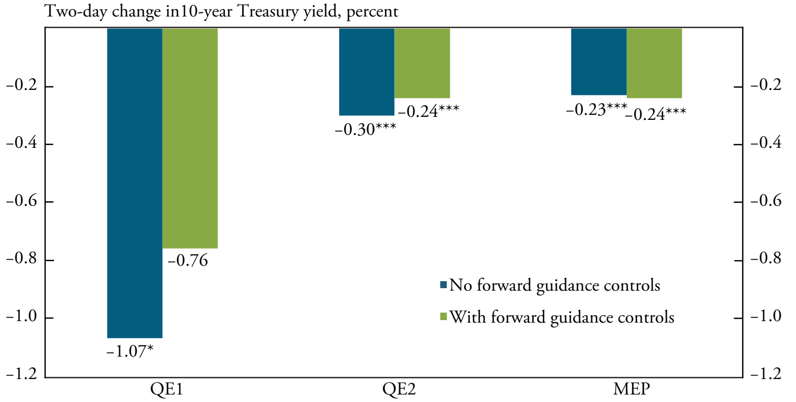


Notes: Each bar reports the coefficient on the asset purchase dummy variable both with and without controls for interest rate uncertainty. The coefficients are statistically significant at the 1 percent level.
Source: Authors' calculations.

Chart 3 illustrates the proportion of the decline in yields attributable to each of the FOMC's first three purchase programs. The blue bars, which do not control for forward guidance, show that QE1 led to a 1.07 percent decline in the 10-year Treasury yield, while QE2 led to a 0.30 percent decline. However, when we account for forward-guidance-induced changes in interest rate uncertainty, the estimated efficacy falls. The green bars show that the estimated efficacy of QE1 falls to only 0.76 percent after controlling for forward guidance, and this estimated effect is no longer statistically different from zero. The estimated efficacy of QE2 drops from 0.30 percent to 0.24 percent while retaining its statistical significance. In contrast, the estimated efficacy of the MEP is unaffected when we include controls for FOMC-induced changes in interest rate uncertainty. These results suggest that failing to control for forward guidance may lead policymakers to overstate the estimated effects of QE1 in particular.

Our finding that contemporaneous changes in forward guidance differentially affected each asset purchase program is consistent with differences in the announcements in each period. For example, the QE1 announcement on December 16, 2008, clearly provided information about the future path of the funds rate ("for some time") and

Chart 3
Effects of Individual Asset Purchases with Forward Guidance Controls



* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level

Notes: Each bar reports the coefficient on a dummy variable for each of the asset purchase programs both with and without controls for interest rate uncertainty. See Bundick, Herriford, and Smith (2021) for more details.
Source: Authors' calculations.

contained information about the FOMC's intended balance sheet policies. Thus, we might expect the estimates of the efficacy of QE1 to be biased upward if we fail to account for this simultaneous change in guidance. However, the QE2 announcement in September 2010, in which the FOMC signaled its intent to "provide additional accommodation," is less clear about the Committee's likely actions for each policy tool; thus, we might expect the bias from not controlling for forward guidance to be smaller for this announcement. Finally, consistent with the fact that the announcement of the MEP was not accompanied by any actual or expected change in forward guidance, we see no effect of controlling for forward guidance with that announcement.

Exploring an alternative explanation: the signaling channel of asset purchases

In this article, we argue that changes in the FOMC's forward guidance that reduce uncertainty about the future funds rate lead to lower longer-term bond yields. If these changes occur at the same time as the announcement of a new asset purchase program, then the estimated efficacy of the program could be overstated if researchers fail to account for the contemporaneous changes in guidance about the funds rate.

However, research by Woodford (2012), Bauer and Rudebusch (2013), and Bhattarai, Eggertsson, and Gafarov (2015) instead argues that changes in asset purchases themselves provide information about the future funds rate and hence directly play a role in communicating the central bank's forward guidance. These papers suggest that through this signaling channel, asset purchases communicate the Committee's intention to keep policy rates low for some time to help the central bank avoid large losses on its asset holdings. For example, suppose a central bank purchases a large quantity of longer-term sovereign bonds. If policymakers then subsequently raise short-term policy rates at a pace faster than what financial market participants anticipated when the central bank acquired the longer-term securities, the price of these securities will fall as longer-term yields adjust to the higher expected path of future policy rates. Therefore, the signaling channel of asset purchases suggests that asset purchases imply a commitment by policymakers to keep short-term rates low (a form of forward guidance) to avoid losses on the central bank's balance sheet.

Unfortunately, precisely identifying the signaling channel is difficult in general, and researchers have failed to reach a consensus on its importance. Gagnon and others (2011) find little support for the signaling channel of asset purchases in QE1. In examining the same program, Krishnamurthy and Vissing-Jorgensen (2011) instead argue that the signaling channel represents an important mechanism through which asset purchases transmit to the economy. A possible factor underpinning this disagreement on the signaling channel is that policymakers have often adjusted their forward guidance and asset purchases at the same time, making it difficult to cleanly separate the mechanisms and effects of their tools.

However, the announcement of the MEP, coupled with our measures of interest rate uncertainty, provides a straightforward opportunity to test for the presence of a signaling channel of asset purchases. The announcement of this program contained no actual or expected changes in the FOMC's forward guidance. If the signaling channel of asset purchases is important, the MEP should reduce uncertainty about future short-term rates through the central bank's implicit commitment to keep future policy rates low and avoid losses on its balance sheet. Thus, we can look at the response of our interest rate uncertainty measures following the MEP announcement to test for the presence of the signaling channel. We find that our measures of interest rate uncertainty remain nearly unchanged following the MEP announcement, which provides evidence against a significant signaling channel in asset purchases (at least for this particular program).

Conclusion

When monetary policymakers cannot lower their short-term policy rate any further, they often turn to asset purchases and forward guidance to help stabilize the economy in the face of adverse shocks. In this article, we argue that the effects of a given asset purchase program—such as the LSAPs announced in response to the pandemic crisis in March 2020 or the Great Recession in 2008—could be overstated if researchers fail to account for the changes in interest rate uncertainty induced by forward guidance occurring at the same time. Although our empirical work attempts to capture the relevant channels of these policy tools, our analysis cannot control for all possible mechanisms through which asset purchases and forward guidance affect the macroeconomy. However, we aim simply to make researchers aware of the difficulty in assessing the efficacy of asset purchase programs when policymakers simultaneously use multiple policy tools, each capable of independently affecting longer-term rates.

Endnotes

[1]We follow Krishnamurthy and Vissing-Jorgensen (2011) in dating and characterizing each program.

[2]See page 245 of Krishnamurthy and Vissing-Jorgensen (2011) for a discussion of the market expectations regarding the announcement on November 3, 2010.

[3]The September 21, 2011, statement also stated that the Committee will reinvest its maturing principal from maturing agency debt and mortgage-backed securities back into mortgage-backed securities.

[4]For example, after the release of the FOMC announcement on August 9, 2011, the two-year bond yield was trading less than 20 basis points.

[5]The yield on a longer-term Treasury bond can be broken down into two components. The first component reflects the expectations for the path of short-term interest rates (such as the federal funds rate) from today until the bond matures. The second component, the term premium, reflects the additional compensation an investor requires to hold the longer-term bond to maturity rather than alternatively investing in short-term securities over the same time horizon. In Bundick, Herriford, and Smith (2021), we show that the forward guidance-induced changes in interest rate uncertainty affect longer-term bond yields through the term premium component. In this article, we focus our discussion for simplicity on the effects of overall yields.

[6]See Bundick and Herriford (2017) for additional details on these instruments.

[7]See Bundick, Herriford, and Smith (2021) for more information on the construction of our EDX measures.

[8]Using a statistical technique known as principal component analysis, we can condense down the daily changes in our interest rate uncertainty measures over the next one to five quarters into two components. These two factors concisely summarize changes in the market-perceived uncertainty about future short-term interest rates that follow changes in FOMC forward guidance.

[9]This exercise closely follows the specification of Krishnamurthy and Vissing-Jorgensen (2011). Thus, our findings without including our EDX controls for this model exactly replicate a subset of the results in Tables 1 and 5 of their paper.

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Cutting-Edge Methods Did Not Improve Inflation Forecasting during the COVID-19 Pandemic

By Amaze Lusompa and Sai A. Sattiraju

Monetary policymakers depend heavily on forecasts about the future state of the economy. Since the beginning of the COVID-19 pandemic, however, the Federal Open Market Committee (FOMC) and economists in general have not been able to accurately forecast inflation. The surge of inflation in 2021–22 caught most experts by surprise, and even economists who predicted a surge in inflation underpredicted the size. Although central bankers' inflation forecasts tend to be fairly accurate during normal times, they do not perform as well during downturns and periods of extreme uncertainty.

To improve this performance gap, researchers over the past 20 years have proposed various innovations to a benchmark class of models known as "time-varying parameter models," which allow the relationships between forecasting variables to change over time. Although these innovations have improved models' forecasting performance during previous recessions, most research on the efficacy of these innovations was conducted prior to the COVID-19 pandemic. A natural question is how these "improved" models have performed during recent extreme events.

In this article, we investigate whether innovations in time-varying parameter models led to improved inflation forecasting during the pandemic. We find that despite their promise prior to the pandemic, forecasting innovations did not improve the accuracy of inflation forecasts relative to a

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baseline time-varying parameter model during the pandemic. Our results suggest that forecasters may need to develop a new class of forecasting models, introduce new forecasting variables, or rethink how they forecast to yield more effective inflation forecasts during extreme events.

Section I outlines different forecasting innovations of the past 20 years. Section II compares the performance of different forecasting models for U.S. inflation during the pandemic and shows that innovative time-varying parameter models did not outperform a baseline time-varying parameter model.

I. Innovation in Forecasting

Many of the time- and computationally intensive innovations in forecasting over the past several years have resulted from time-varying parameter models. These models are very flexible, as they allow for the relationships between forecasting variables to change over time. However, this flexibility comes with costs. Estimating relationships that are not fixed and can change over time is both time- and computationally intensive. Additionally, researchers may not know exactly which variables to include at a given time. As a result, researchers have combined time-varying parameter models with methods like shrinkage, high dimensionality, and variable selection to maintain the flexibility of time-varying parameter models while minimizing the costs.

Time-varying parameter models

Changes in policy, technology, or economic conditions can all lead the relationship between variables in a regression model to change over time, a quality known as "parameter instability." Both Stock and Watson (1996) and Ang and Bekaert (2002) show that many macroeconomic and financial time series models exhibit parameter instability. Accounting for this quality is important, as models that do not consider parameter instability may yield less accurate forecasts. For example, a researcher may attempt to understand or describe how the FOMC responds to changes in output and inflation by estimating a Taylor rule, which relates the value of the federal funds rate to inflation and economic slack. But the Committee's responses to changes in these variables may depend on the individuals that make up the Committee. Thus, when the Committee changes, the estimated parameters in the Taylor rule may need to change as well to better reflect the Committee. As a result, a researcher seeking to estimate the Taylor rule consistent with the Committee's decisions must account for potential parameter instability to avoid misleading forecasts or analysis.

Time-varying parameter models provide a general way to deal with parameter instability by allowing the parameters of the model to change in each time period in the sample. Intuitively, time-varying parameter models work by discounting information over time, giving more weight to recent information about a particular economic variable than past information for any given time period.

Although time-varying parameter models have existed at least since the 1970s, they were not popular initially due to computational difficulties, and the number of variables included in these models was generally limited to five. In the 2000s, however, Cogley and Sargent (2005) and Primiceri (2005) introduced workhorse time-varying parameter models that could be used for forecasting, and other researchers demonstrated that time-varying parameter models could outperform their constant parameter counterparts.[1] Recently, more efficient estimation methods and approximations have been introduced that can lessen the computational burden of these models.

High dimensionality and shrinkage

Forecasters often have to make difficult choices about how much information to include in their models. Generally, forecasters want to include as much relevant information as possible to maximize the accuracy of their forecasts. To do so, they can estimate a high-dimensional model—that is, a model with many independent variables. However, including too much information in a model can lead to imprecise parameter estimates and therefore imprecise forecasts. For example, if a model includes too many variables relative to the sample size, the parameters may not be estimated accurately; this could lead variables that are relatively less important to have disproportionate influence on the forecast, thereby distorting the forecast. A model with too many independent variables is often described as being "overparameterized."

Overparameterization can be dealt with in several ways, including using "shrinkage." Shrinkage is simply a method that "shrinks" an estimate of a parameter toward a pre-specified value. More precisely, shrinkage can be used so that parameters that are less relevant shrink toward zero, while parameters that are more important are left alone (or have minimal shrinkage). Note that shrinkage is not only used in models with many variables. Researchers often use shrinkage to restrict certain parameter values in models with only a few variables. For example, forecast models, including time-varying parameter models, often include past values of a variable, such as inflation, to predict what future values of that variable will be. Because more recent values of inflation are assumed to be more important for predicting future inflation than older values, researchers may elect to shrink the parameters for older values of inflation toward zero so that they are weighted less heavily in the forecast.

Sparsity or variable selection

Shrinkage is often combined with sparsity or variable selection methods to prevent issues such as overparameterization. Despite advances in high dimensional models, computational constraints or practical considerations may still limit the number of variables researchers can include in a model. For example, a time-varying parameter model estimates a different parameter for each period, so for a sample size of T, the model would have T times the number of parameters of a model where the parameters do not change. If a constant parameter model covering 200 periods (for example, 50 years of quarterly data) has 12 parameters, a time-varying parameter model covering the same period would have 2,400.

One way to limit the number of variables in a model is to use sparsity or variable selection methods. As their name suggests, these methods can reduce the number of potential variables in a model to a smaller set that ideally includes enough information to generate accurate forecasts. Although variable selection has been used since at least the early 1990s, algorithms and computing power have only recently evolved to the point where researchers can perform variable selection without a supercomputer.[2]

Dynamic variable selection is a particular form of variable selection that can be especially useful when combined with time-varying parameter models. Dynamic variable selection accounts for the fact that some variables may be helpful in forecasting during certain time periods but not others—as is often the case for macroeconomic and financial variables (see, for example, Korobilis and Koop 2020). For example, expected shipping times are not generally used when predicting inflation, as shipping logjams have historically not been large enough to measurably affect inflation. During the pandemic, however, the increase in expected shipping times is thought to have led to higher shipping costs and hence higher prices, so incorporating an expected shipping time variable could improve inflation forecasts. Dynamic variable selection allows forecasters to incorporate variables in their models only when they are likely to be relevant, thus providing an alternative to estimating high dimensional models.

In general, sparsity can also be used to prevent overfitting of a model. An overfitted model is one that does a good job explaining random variation in one dataset but that performs relatively poorly when used with other datasets. As an analogy, consider a student preparing for a test not by studying the material holistically but by spending too much time on one-off questions used on previous versions of the test. In this case, the student will be prepared only for the one-off questions rather than more general material likely to appear on the test. Similarly, an overfitted model is one that is adapted too closely to "one-off" data (for example, an outlier), which may worsen its ability to forecast. To prevent overfitting, forecasters often use a mechanism such as sparsity or shrinkage that prevents the model from adapting too well to the initial sample.

II. Estimating the Performance of Innovative Time-Varying Parameter Models during the Pandemic

To determine whether the forecasting innovations of the past two decades improved inflation forecasting during the COVID-19 pandemic, we conduct a forecasting exercise that compares the performance of two simple time-varying parameter models generally used in inflation forecasting as well as three newer models that incorporate some of the innovations from the previous section. In particular, we forecast inflation as measured by the price index for personal consumption expenditures (PCE), as PCE inflation is the Federal Reserve's preferred measure (Bernanke 2015). Our two baseline models are the unobserved components model from Stock and Watson (2007), which estimates a time-varying mean of inflation and includes no other predictors, and the time-varying parameter model from Primiceri (2005), which has a small number of variables. Our three newer time-varying parameter models are the model from Carriero and others (2021), which is a moderate-sized dimensional model that incorporates shrinkage and is designed to handle outliers; the model from Chan (2021), which includes many predictors and uses shrinkage; and the model from Korobilis and Koop (2020), which incorporates many predictors, dynamic variable selection, and shrinkage.[3] In summary, the two baseline models have only time-varying parameters, while the three newer models combine time-varying parameters with high dimensionality, shrinkage, or variable selection. Additional details on each of these models as well as their implementation are available in the appendix.

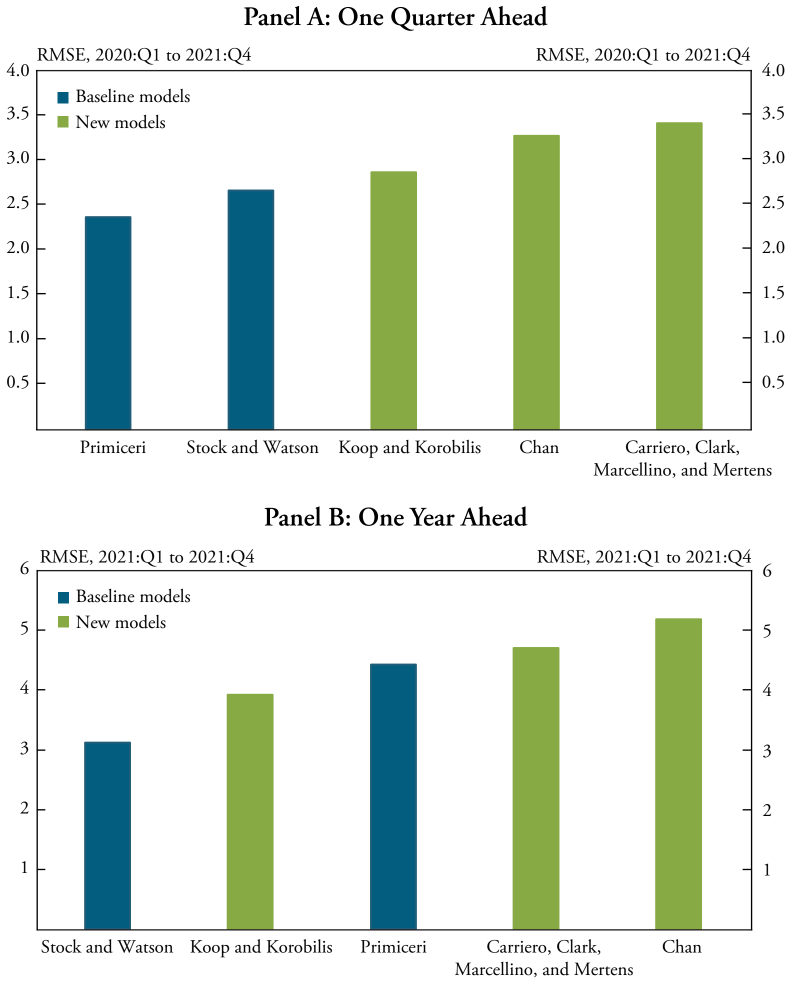
To judge the forecasting performance of the models, we compare their root mean square errors (RMSE). The RMSE quantifies how much a model prediction deviates from the actual data, with smaller RMSEs indicating better forecast performance. In addition, a model's RMSE can help reflect the influence of outliers, in that an inaccurate prediction in one period will have a greater effect on the model's RMSE than an accurate prediction. This quality makes RMSEs especially useful for policymakers. Because one inaccurate inflation forecast can lead to the wrong policy prescription, policymakers may care more about avoiding especially "bad" predictions than about achieving "good" predictions most of the time.

To capture our models' accuracy in forecasting both short-term and longer-term inflation, we examine both one-quarter-ahead and one-year-ahead forecasts. We begin our one-quarter-ahead forecasts in 2020:Q1, at the start of the pandemic, and forecast inflation for the next quarter based on information known up until the previous quarter. For example, our one-quarter-ahead forecast for 2020:Q2 inflation is based on data from up until 2020:Q1. Similarly, our one-year-ahead forecast is based on information known up until the previous year. For this reason, we begin our one-year-ahead forecast in 2021:Q1, as earlier years would not reflect any information from the pandemic.

Panels A and B of Chart 1 show that the baseline models forecast at least as well as the newer models. Panel A shows that the two baseline models (blue bars) have lower RMSEs than the newer models (green bars) for one-quarter-ahead inflation forecasting. Similarly, Panel B shows that

Chart 1

RMSE for Inflation Forecasts during the Pandemic



Sources: Stock and Watson (2007), Primiceri (2005), Korobilis and Koop (2020), Chan (2021), Carriero and others (2021), and FRED (Federal Reserve Bank of St. Louis).

the unobserved components model from Stock and Watson (2007) has the lowest RMSE for one-year-ahead forecasting. Together, the panels suggest that the baseline models yield inflation forecasts at least as accurate—if not more so—than newer models for both time horizons.

The superior performance of the baseline models is somewhat disconcerting. In general, the newer models are more flexible versions of the baseline models; given their increased flexibility, newer models should be able to perform at least as well as the baseline models. Particularly concerning is that the unobserved components model from Stock and Watson (2007), which simply estimates a time-varying mean of inflation and includes no other predictors, outperforms models with a larger number of predictors. The Stock and Watson model has the lowest RMSE for the one-year-ahead forecasts, and the second-lowest RMSE for the one-quarter-ahead forecasts, eclipsed only by the baseline Primiceri (2005) time-varying parameter model. Thus, including additional information does not appear to improve inflation forecasts during the pandemic for the models and data sets we consider.

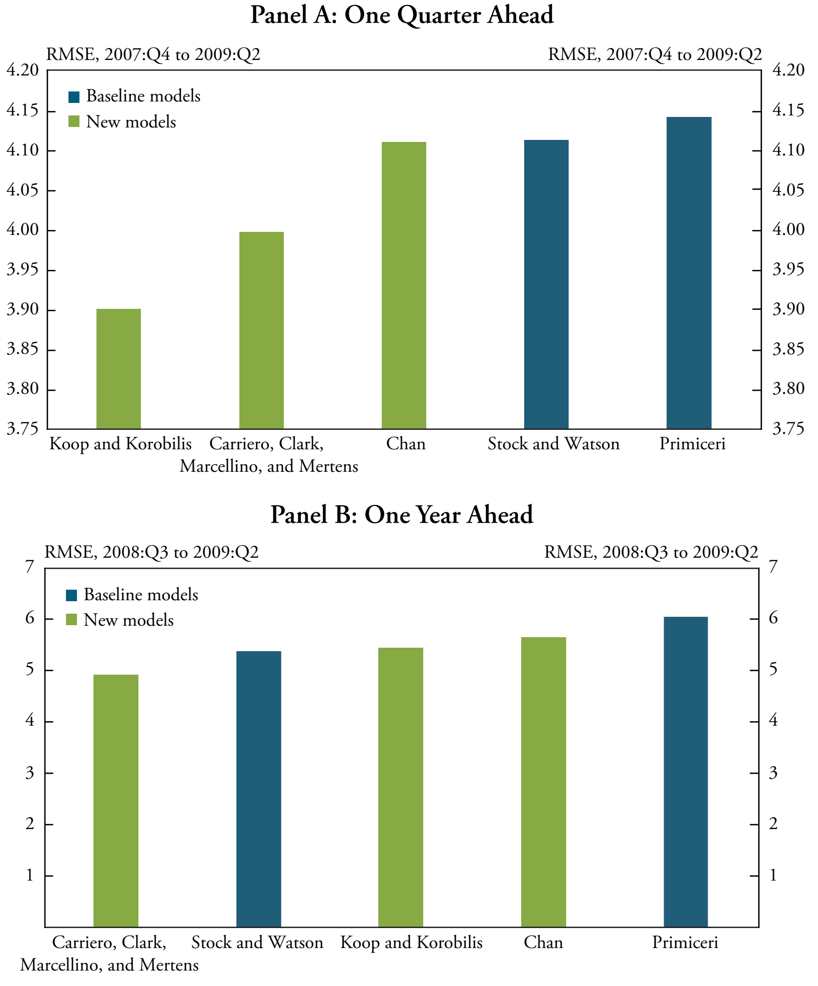
However, these results do not suggest that newer, more sophisticated models should be abandoned entirely. During the Great Recession, for example, these models showed improved forecasting performance against the baseline models. Panel A of Chart 2 shows that for one-quarter-ahead forecasts during the Great Recession, the newer models have a lower RMSE than the baseline models. Although the results are more mixed for the one-year-ahead forecasts during the Great Recession, Panel B of Chart 2 shows that one of the newer models has the lowest RMSE.

To show how the models' forecasting performance evolved over the full Great Recession period, Chart 3 compares the models' forecast errors—the difference between the actual and predicted values of inflation—from 2007:Q4 to 2009:Q2. Values closer to zero indicate a smaller forecast error and therefore better performance. Panel A of Chart 3 shows that no one model dominates for the one-quarter-ahead forecasts. Similarly, Panel B of Chart 3 shows that no one model dominates for the one-year-ahead forecasts, though the relative performance of each model tends to stay consistent across the sample with the exception of the unobserved component model of Stock and Watson (2007). Together, the results from Charts 2 and 3 show that newer models outperformed baseline models during the Great Recession, suggesting they may yet have some benefits in times of distress outside of the pandemic.

Moreover, it may be the case that additional information would have improved inflation forecasts during the pandemic, but that our newer models included the wrong information. Macroeconomic forecasting models in general use macroeconomic and financial variables to forecast. During the COVID-19 pandemic, however, the standard

Chart 2

RMSE for Forecasts during the Great Recession

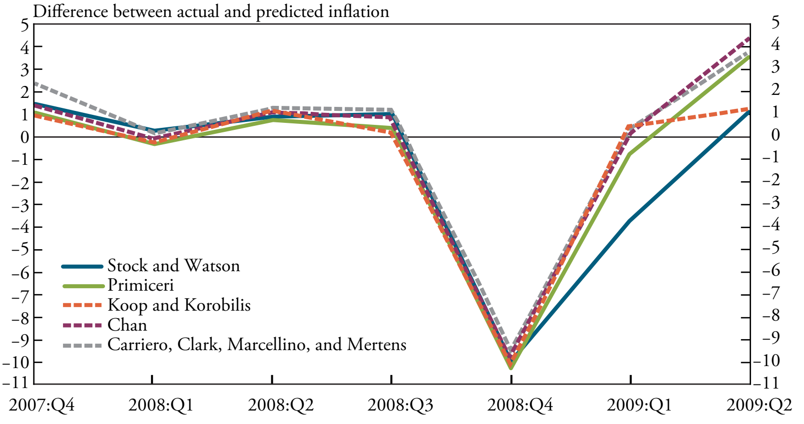


Sources: Stock and Watson (2007), Primiceri (2005), Korobilis and Koop (2020), Chan (2021), Carriero and others (2021), and FRED (Federal Reserve Bank of St. Louis).

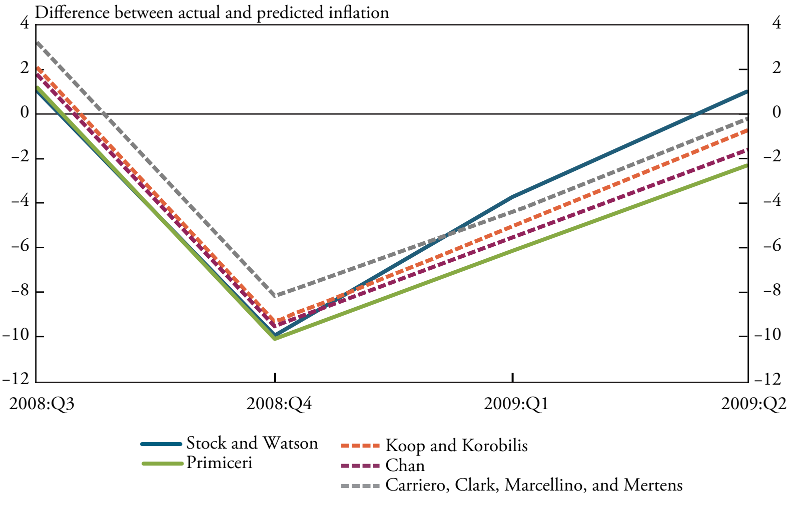
Chart 3

Forecast Errors during the Great Recession

Panel A: One Quarter Ahead



Panel B: One Year Ahead



Note: Solid lines represent baseline models and dashed lines represent new models.
Sources: Stock and Watson (2007), Primiceri (2005), Korobilis and Koop (2020), Chan (2021), Carriero and others (2021), and FRED (Federal Reserve Bank of St. Louis).

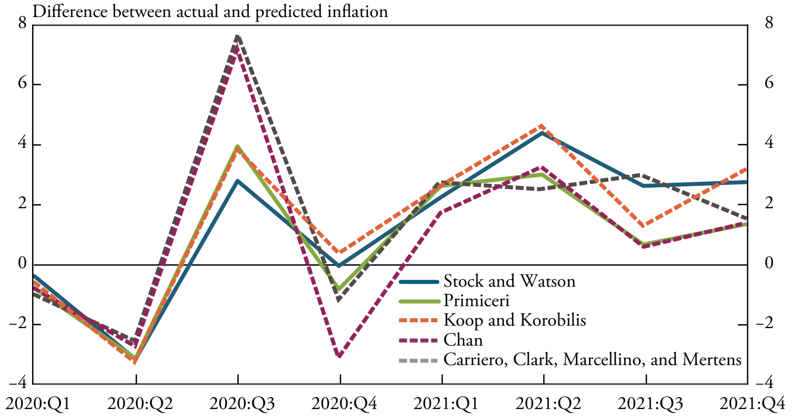
macro and financial variables may have been less useful in forecasting inflation due to the unique combination of strong demand and persistent supply shocks; instead, variables such as U.S. hospitalization rates for COVID-19, expected shipping logjam times at U.S. ports, and some type of production indicator for the countries exporting to the United States may have been more relevant to inflation and thus may have improved inflation forecasts.

Finally, our comparison only accounts for the performance of these models in forecasting inflation—newer models may offer improvements over the baseline models during the pandemic for other variables of interest. Even though the baseline models perform slightly to somewhat better overall, no one model dominates every period. Indeed, Panels A and B of Chart 4, which plot the difference between actual inflation and predicted inflation for the different forecasting models, show a wide variation in the performance of these models across different periods.

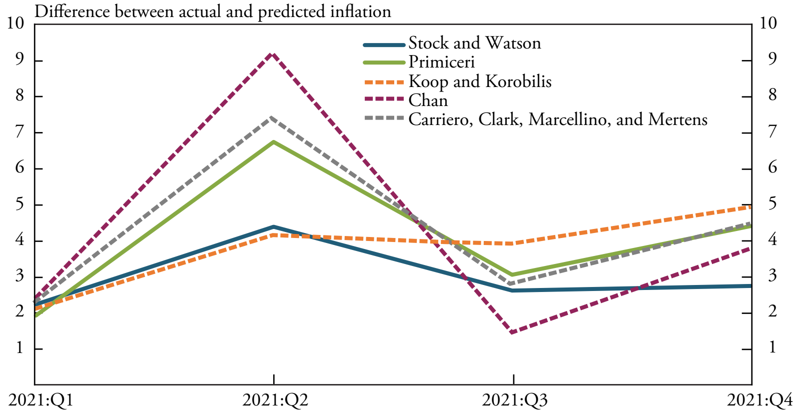
Overall, our results suggest that forecasters should not focus on only one model but rather continuously monitor multiple models. One way to do this systematically is by using model averaging, or averaging the predictions of a set of models. Importantly, this method can be combined with time-varying parameter models: dynamic model averaging allows the "importance" or influence of each model on the average prediction to change over time. Some studies have shown that model averaging or combining forecasts can outperform any one model by safeguarding against a bad forecast from a single model (Hoeting and others 1999; Faust and Wright 2013). As the results from this article intimate, model averaging might be a useful tool for forecasting during future extreme events.

Chart 4
Forecast Errors during the Pandemic

Panel A: One Quarter Ahead



Panel B: One Year Ahead



Note: Solid lines represent baseline models and dashed lines represent new models.
Sources: Stock and Watson (2007), Primiceri (2005), Korobilis and Koop (2020), Chan (2021), Carriero and others (2021), and FRED (Federal Reserve Bank of St. Louis).

Conclusion

In this article, we investigate whether forecasting innovations in time-varying parameter models led to improved inflation forecasting during the pandemic. We find that despite their promise prior to the pandemic (including during the Great Recession), these innovations did not improve the accuracy of inflation forecasts relative to a baseline model during the pandemic. Considering that forecasting inflation is more important during times of duress than normal times, researchers may need to continue developing models that can perform well during all periods or develop a different set of models specifically for times of duress.

Appendix

Model Specifications

All models use four lags, and all the samples start around 1960, with some slight variation due to data availability. For the Primiceri (2005) we use PCE inflation, the three-year Treasury yield constant maturity, and the unemployment rate as variables and obtain data from the FRED series PCEPI, DGS3, and UNRATE, respectively. We use the three-year Treasury yield to avoid issues with the zero lower bound (see Swanson and Williams 2014). For the Primiceri (2005) model, we use a Minnesota prior with code derived from Chan (2021). For the Stock and Watson (2007) model, we use the non-centered parameterization and priors from Chan (2018) and use PCE inflation data from FRED (PCEPI). For the Carriero and others (2021) model, we obtain the input data from FRED-MD, a monthly macroeconomic database. The code from Carriero and others constructs quarterly averages based on this monthly data series, and we use the "SVOt" specification to run the model. For the Chan (2021) and Korobilis and Koop (2020) models, we use the same priors and variables as in the papers and obtain the input data from FRED-QD, a quarterly macroeconomics database.

Endnotes

[1]For example, Granger (2008) shows that time-varying parameter models can even approximate nonlinearities in general (in the conditional mean).

[2]Advancements in algorithms and computing power were necessary for variable selection due to the sheer number of variables considered in this method. For example, if a researcher wanted to consider p different variables in their inflation forecasting model, then they would need to consider 2^p different model combinations with those predictions. Thus, if $p = 20$, the researcher would need to estimate and compare the performance of 1,048,576 different models. Estimating and comparing all those models would be impractical, so methods were developed to allow researchers to estimate a small number of models and decide which model to estimate next based on the forecast performance of the previously estimated models.

[3]In the Carriero and others (2021) model, only the covariance matrix is time-varying.

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Government Assistance and Moral Hazard: Evidence from the Savings and Loan Crisis

By Padma Sharma

Financial regulators aim to maintain a banking system that does not require taxpayer-financed rescues in a crisis. Interventions such as the Troubled Asset Relief Program in 2008, in which the government recapitalized banks facing extraordinary loan losses, are not only costly to taxpayers but may also lead banks to expect future assistance, potentially incentivizing them to take excessive risks. To discourage banks from risky behavior, regulators often try to signal that they will not assist banks in a future crisis; however, there are few historical examples of regulators following through on these promises to suspend assistance to banks.

Regulations passed during the savings and loan crisis in the 1980s provide an example of policies that did discourage risk-taking. In the 1980s, savings and loan institutions (S&Ls)—banks that serve households rather than firms by collecting deposits and financing home mortgages—underwent two waves of failures. After the first wave, the Federal Savings and Loan Insurance Corporation (FSLIC) liquidated or sold some failed S&Ls but assisted other failed S&Ls to keep them in operation. In 1989, however, the FSLIC became insolvent and closed.

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In its place, the U.S. government set up the Resolution Trust Corporation, a temporary agency with the power to liquidate failed S&Ls and sell their assets. Critically, the government prohibited the new agency from assisting failed institutions—thus signaling the suspension of future assistance.

In this article, I examine how suspending assistance to failed S&Ls in 1989 affected the balance sheets of operational S&Ls, based on the approach in Sharma and Banerjee (2019). I find that S&Ls responded to the change in policy differently depending on ownership structure: stock S&Ls, which are owned by equity holders entitled to surplus profits, increased their composition of safe assets relative to mutual S&Ls, which are owned by depositors that are paid out fixed interest. Because owners of stock S&Ls were likely to lose the value of their equity if they failed under the new regime, they responded by reducing risk-taking to a greater extent than owners of mutual S&Ls, who would be compensated with deposit insurance up to the insured limit under both regimes. If government assistance had remained feasible, our estimates suggest that stock S&Ls likely would have continued taking risks, lending an additional $2.14 billion and reducing their holdings of securities by $4.5 billion. In contrast, the owners of mutual S&Ls received fixed interest payments that did not change substantially across the two policy regimes. Mutual S&Ls did not engage in excessive risk-taking even when government assistance was feasible, so they had little incentive to further reduce risk-taking when assistance was suspended. These results show that when policymakers credibly signal that public assistance will not be granted to failed financial institutions, operational institutions become more conservative in their risk-taking and take steps to strengthen their balance sheets.

Section I summarizes the nature of the S&L crisis. Section II compares the FSLIC's responses to S&L failures with recommendations for regulatory actions from theoretical studies. Section III evaluates the effect of the policy change in 1989 on risk-taking among stock S&Ls relative to mutual S&Ls. Section IV infers lessons from this episode for current policies.

I. The Savings and Loan Crisis

Since their origin in the 19th century, S&Ls (also referred to as thrifts) have been associated with the broad goal of fostering home ownership. The first S&Ls were formed by groups of individuals who pooled resources and lent funds to members to use toward residential mortgages, a need banks at the time did not fulfill. To encourage homeownership, federal agencies eventually formally required S&Ls to specialize in mortgage lending and provide only fixed-rate mortgages.

This focus on mortgages served S&Ls well through the mid-20th century but was a crucial contributor to a crisis that emerged in the S&L industry in the 1980s. When interest rates rose sharply in the early 1980s, S&L institutions paid out much more in interest on their deposits than they earned on their loans and began to experience large losses. These unsustainable losses ultimately resulted in S&L institutions becoming insolvent and failing, creating the first wave of S&L failures in 1981–83.

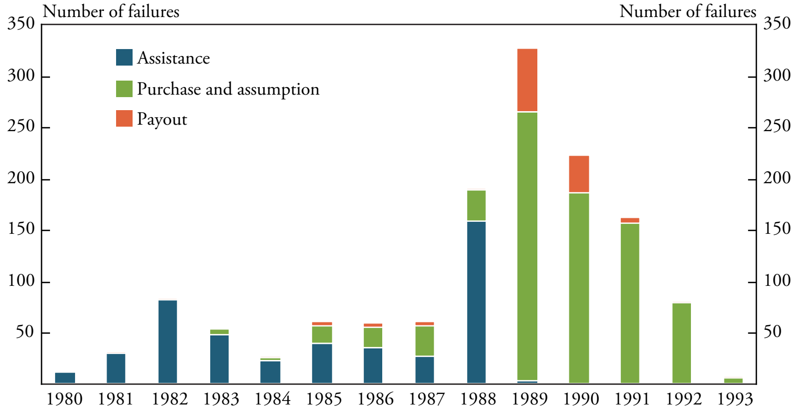
Following this first wave of failures, policymakers deregulated the S&L industry to address institutional rigidities. The new deregulatory policies not only permitted S&Ls to expand their loan offerings beyond fixed-rate residential mortgages but also lowered the safety and soundness standards under which S&Ls operated (White 1991). For example, S&Ls were permitted to issue adjustable-rate mortgages and to make business and commercial real estate loans, which were previously the domain of commercial banks. In addition, S&Ls were permitted to directly hold equity interest in real estate, which allowed them to step beyond their traditional role as lenders and operate as investors. This policy allowed S&Ls to take on additional risk, as any losses from adverse price movements on these transactions would affect S&Ls' capital more directly and swiftly than in transactions in which they were lenders. Regulators also relaxed safety standards by reducing the minimum capital thresholds that S&Ls had to maintain and by applying alternative, permissive accounting standards that determined which assets counted as capital. The new standards clouded regulators' assessments of S&Ls' financial health; institutions that would have previously been considered insolvent were considered solvent under the new rules.[1] Overall, the deregulatory policies permitted S&Ls to foray into loan categories typically serviced by commercial banks while operating under lighter regulation.

The deregulatory policies meant to alleviate the first wave of failures in 1981–83 thus enabled the risk-taking that led to a second, larger wave of S&L failures in 1985–92. In response to permissive regulations, the industry expanded rapidly over 1982–85—new institutions entered the industry and extant institutions grew larger. Growth was mainly concentrated in business lines that had become newly accessible to S&Ls, such as commercial mortgages and direct equity investment.[2] But this growth was also concentrated in specific sectors and regions, making S&Ls more vulnerable to sector-specific shocks. For example, S&Ls increasingly financed real estate projects in oil-rich states in the South and Southwest. As oil prices rose, the regions' outlook for growth brightened, and real estate projects developed rapidly. But when oil prices plummeted in 1986, real estate prices in these regions dropped steeply; S&Ls were unable to absorb the credit losses from declining real estate prices and became insolvent. Accordingly, the industry underwent a second wave of failures from 1985 to 1992.

When an S&L institution failed, the Federal Savings and Loan Insurance Corporation (FSLIC), which managed the resolution of failed institutions, could choose one of three actions: "open thrift assistance," in which they would provide financial assistance either directly to the distressed institution or to an acquirer; "purchase and assumption," in which they would sell the institution in part or whole to other healthy institutions; or "payout," in which they would liquidate the institution and pay depositors the insured component of their deposits. Open thrift assistance allowed an S&L's charter to remain open and the S&L to continue operating in its current form. The remaining two options closed the failed S&Ls' charters and discontinued their operations. Under purchase and assumption, parts of the S&L continued to exist through loans and deposits assumed by the acquiring institution. Under payout, or liquidation, all lending and deposit relationships were terminated, and the S&L fully ceased to exist.

In February 1989, open thrift assistance effectively ended when President Bush announced the FSLIC's closure and the creation of a new agency to take over its operations, the Resolution Trust Corporation (RTC).[3] The RTC did not initially have the authority to provide open thrift assistance and was only permitted to close or sell failed S&Ls (U.S. Senate 1990, p. 47).[4] Chart 1 shows the effect of this policy

Chart 1
Distribution of Failed S&Ls across Time and by Resolution Type



Source: FDIC.

change. Starting in 1989, the number of assistance transactions (in blue) approached zero, and failed S&Ls were primarily sold to other institutions under purchase and assumption transactions (in green) or liquidated (in orange).[5] Failed institutions had no recourse to continue in their current form and were forced to close. Replacing an agency that regularly provided financial assistance with another agency unauthorized to rescue institutions likely signaled to S&Ls the start of a more stringent resolution regime.

II. Predictions from Theoretical Models of Resolution

In theory, the FSLIC's assistance could have induced one of two types of responses from S&Ls. The first is moral hazard, in which assistance incentivizes S&Ls to take on excessive risk, as profits from risky loans accrue to S&L owners but losses are covered by regulators and taxpayers. The second is the franchise value effect, in which assistance programs provide incentives to shareholders to preserve the value of their institution and undertake less risk. In general, franchise value arises from the market share and the customer relationships that institutions have built over time, which enable them to generate a stream of profits into the future (Keeley 1990). When an institution is close to failure and unlikely to survive, its franchise value is diminished, and shareholders have incentives to take risks to maximize earnings in the limited time the institution has remaining. In such times, assistance programs generate franchise value effects by boosting the probability of an institution's survival and sustaining its capacity to generate profits, which shareholders will likely seek to preserve.

Which of these two effects dominate bank decision-making in the era of FSLIC assistance? From a purely theoretical perspective, the franchise value effect would dominate if institutions were assisted when losses were generated by macroeconomic shocks widely affecting the industry and liquidated when losses were driven by weak management decisions (Cordella and Yeyati 2003). However, empirical evidence shows that the FSLIC often assisted S&Ls during 1984–89 irrespective of whether they failed during macroeconomic distress or due to potentially deficient management decisions (Sharma and Banerjee 2022).[6] Because the FSLIC deviated from the decision rule that bolsters franchise value effects, I expect to find that moral hazard and excessive risk-taking were relatively more prevalent when the agency was in operation.

III. How Did Stock and Mutual S&Ls Respond to the Withdrawal of Assistance?

To evaluate the effect of the change in assistance policies on S&Ls, I examine differences in balance sheet responses across stock and mutual S&L institutions, which differ by ownership structure. Stock institutions are owned by equity holders whose returns are determined by stock prices. Shareholders at stock institutions have an incentive to engage in riskier investments that frequently result in higher dividends in excess of interest payments. But higher earnings from risky assets to shareholders arise at the cost of lower interest earnings to depositors when losses materialize from risky assets. In contrast, mutual institutions are owned by depositors for whom total returns consist of returns from stocks and interest payments on deposits. Therefore, maximizing earnings on equity at the cost of reducing interest earnings does not benefit owners of mutual S&Ls, as their total return remains unchanged. The ability to separate claims between depositors and shareholders incentivizes shareholders of stock S&Ls to lend high-risk loans that may result in higher returns, but depositor-owners of mutual S&Ls have no such incentive. Indeed, Esty (1997) shows that stock S&Ls engaged in riskier investments than mutual S&Ls over the period 1982–88. Specifically, Esty illustrates the connection between the type of institution and risk-taking by examining S&Ls that converted from mutual to stock—following reorganization, these institutions increased their risk-taking.

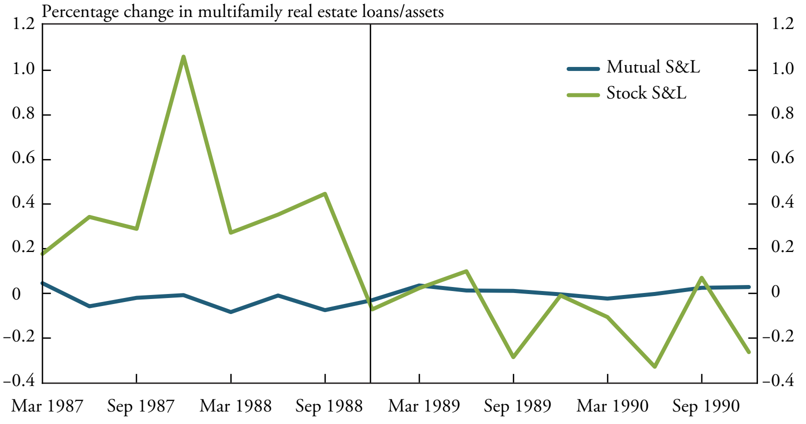
Because shareholders at stock S&Ls have incentives for risk-taking, they are more likely to have expanded risk-taking in the presence of government assistance and curtailed it when assistance was discontinued.[7] Stock S&Ls may have sought to use the funds from government assistance to lend larger shares of risky loans to generate larger returns for shareholders or to recover prior losses. Therefore, when the FSLIC closed and troubled S&Ls were more likely to be liquidated than assisted, stock S&Ls likely responded by reducing risk-taking. In contrast, depositor-owners of mutual institutions may not have responded to the change in policy, as they would have been fully compensated by deposit insurance regardless. Accordingly, stock S&Ls are considered the "treated" group and mutual S&Ls the "control" group in the ensuing analysis.

Chart 2 illustrates these differences in risk-taking across stock and mutual institutions. Stock institutions accumulated larger shares of multifamily real estate loans, a high-risk loan category, when the FSLIC was in operation, but reduced the share of such loans following its closure in 1989 (green line). Mutual institutions, however, did not shift their composition of multifamily loans before or after the regulatory change—their composition of these loans changed only marginally throughout the sample period.

In Sharma and Banerjee (2019), we quantify the differences in the estimated responses of stock and mutual S&Ls by evaluating the change in the share of each balance sheet component across the two types of institutions before and after the change in resolution policy in 1989. This measure is analogous to the "difference-in-difference" approach to evaluating the effect of policies.[8] For example, consider the effect of the change in resolution regime on the year-over-year change in the share of securities to total assets. We determine the difference in this measure before and after the change in resolution regime among stock S&Ls and repeat this calculation for mutual S&Ls. Finally, we evaluate the "treatment effect" by subtracting the pre- and post-difference for mutual S&Ls from the corresponding value for stock S&Ls. We repeat

Chart 2

Change in Balance Sheet Composition of Multifamily Real Estate Loans for Stock S&Ls Relative to Mutual S&Ls



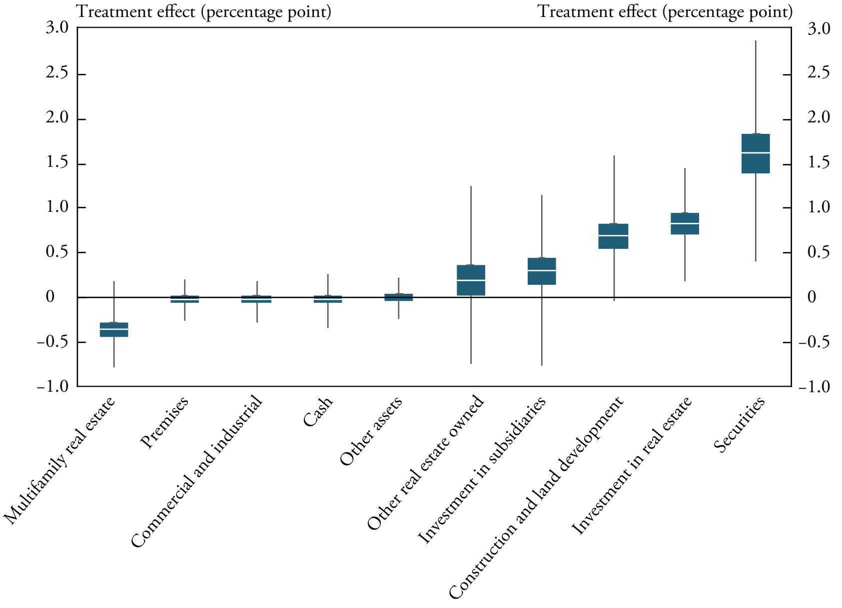
Sources: FDIC and Sharma and Banerjee (2019).

these steps for other assets on S&L balance sheets such as cash, direct equity investment, and several categories of loans. This method carries the advantage of differencing out the effects of other developments that may have affected both stock and mutual institutions, such as additional legislation introduced in 1989 to "re-regulate" the S&L industry.[9]

Chart 3, which depicts these treatment effects for a broad range of assets, shows that stock S&Ls' distribution of assets shifted away from high-risk loans and toward safer assets. The white horizontal line within each blue box depicts the median value of the treatment effect for a given asset category. The top and bottom of the box represent the 25th and 75th percentiles of the distribution of the treatment effect. Finally, the two ends of the vertical line through each box represent the maximum and minimum values of the treatment effect. This chart depicts the asset categories in increasing order of the median treatment effect from left to right. Median values above zero indicate that stock S&Ls shifted a higher share of assets into an asset category than mutual S&Ls following the regulation change. The estimates are statistically important if the full distribution of the treatment effect lies above or below zero.[10]

The shift in the composition of stock S&Ls toward securities, a low-risk asset category, suggests that the shareholders of these institutions recognized the larger losses they would incur in the event of failure

Chart 3
Change in Balance Sheet Composition of Stock S&Ls Relative to Mutual S&Ls



Sources: FDIC and Sharma and Banerjee (2019).

under the new resolution regime and strengthened their balance sheets with larger shares of safe and liquid assets. Subsequently, the share of construction and land development (CLD) loans as well as investment in real estate, which are high-risk asset categories, modestly increased on the balance sheets of stock S&Ls. This increase coincided with the rise in real estate lending across the banking and S&L industry over the course of the early 1990s (Bassett and Marsh 2017). However, the accumulation of multifamily real estate loans, a segment within commercial real estate loans and another category of high-risk loans, declined among stock S&Ls relative to mutual S&Ls. On net, stock S&Ls accumulated lower shares of high-risk loans than mutual S&Ls as increases in shares of CLD loans and investment in real estate were dominated by larger shifts into securities and declines in multifamily real estate loans. The remaining categories of loans did not change in a statistically important manner—the distribution of treatment effects for these loan categories spans both positive and negative values.[11]

In addition to ownership structure, other characteristics may influence an S&L's risk-taking. For example, larger S&Ls may take fewer risks because their shareholders have more value to lose in the event of failure. To account for these potential effects, Table 1 describes the estimated relationship between S&L-level characteristics and the change in the share of high-risk loans for stock and mutual S&Ls two years before and two years after 1989.[12] High-risk loans refer to the sum of commerical and industrial (C&I), CLD, and multifamily real estate loans, based on a definition used in the FDIC's database of Thrift Financial Reports. The table reports estimates of posterior means and 95 percent posterior intervals to quantify the uncertainty in the estimates.[13] Reported estimates are statistically important if the upper and lower bounds of the posterior intervals are both the same sign as the mean, and are not statistically important otherwise.

The relationship between S&L risk-taking and their balance sheet attributes is distinct across stock and mutual institutions. Notably, these relationships shifted either in direction or statistical importance before and after 1989 for stock S&Ls, but remained largely unchanged for mutual S&Ls. These differences suggest that the two groups of institutions were likely operating under distinct incentive structures, and provides further evidence that the reforms shifted the behavior of stock S&Ls more than mutual institutions. Bank size was negatively associated with risk-taking among stock S&Ls, but this effect became statistically important only after the regulatory reforms. Bank size is typically considered an indication of its franchise value: the higher this value, the lower the bank's incentive to engage in risk-taking (Keeley 1990). This observation reiterates the earlier finding that franchise value effects dominated over moral hazard effects for stock S&Ls after the reforms. In line with expectations, for mutual S&Ls this effect is not statistically important prior to or following the reforms.

The results for capital ratio provide new evidence on this ratio's relationship with risk-taking, on which previous studies have reached limited consensus. Stock S&Ls increased risk-taking at incrementally higher levels of the capital ratio, and this effect was statistically important after the regulatory reforms. Mutual S&Ls, on the other hand, decreased risk-taking at higher capital ratios. These differences suggest

Table 1

Determinants of Changes in the Share of High-Risk Loans for Mutual and Stock S&Ls before and after the Policy Change

	Stock S&Ls posterior estimates				Mutual S&Ls posterior estimates			
	Pre-1989		Post-1989		Pre-1989		Post-1989	
Variable	Mean	Interval	Mean	Interval	Mean	Interval	Mean	Interval
Constant	−0.03	[−0.4,0.3]	0.06	[−0.2,0.3]	0.10	[0,0.2]	−0.10	[−0.2,0]
log(size)	−0.15	[−0.4,0.1]	−0.15	[−0.3,0]	0.02	[−0.1,0.2]	0.01	[−0.1,0.1]
Capital ratio	0.14	[−0.1,0.4]	0.19	[0,0.4]	−0.22	[−0.4,0]	−0.14	[−0.2,0]
Age	0.44	[−0.2,1.1]	0.18	[−0.2,0.5]	0.13	[0,0.3]	0.10	[0,0.2]
Operating leverage	−0.12	[−0.3,0.1]	−0.01	[−0.2,0.2]	0.12	[0,0.2]	0.11	[0,0.2]
C&I ratio	0	[−0.2,0.2]	0.01	[−0.1,0.1]	−0.10	[−0.2,0]	−0.18	[−0.3,−0.1]
Interest receivable	−0.01	[−0.2,0.2]	−0.12	[−0.3,0.1]	−0.01	[−0.1,0.1]	0.00	[−0.1,0]
Earnings ratio	−0.10	[−0.4,0.2]	0.06	[−0.1,0.3]	0.02	[−0.1,0.1]	0.03	[0,0.1]
Additional control variables	S&L fixed effects, state-level and county-level controls							

that the organizational form and regulatory regime are likely salient in determining the relationship between the capital ratio and risk-taking.

The relationship between bank age and high-risk loans is somewhat surprising for both S&L types. Typically, S&L institutions that are older and more established are expected to take fewer risks than younger banks to protect their higher value against excessive credit losses. While the age of stock S&Ls was not statistically important in determining risk-taking, the relationship is positive for mutual S&Ls across both periods. These findings suggest that older mutual S&Ls likely engaged in risk-taking by relying on their longer experience in the industry.

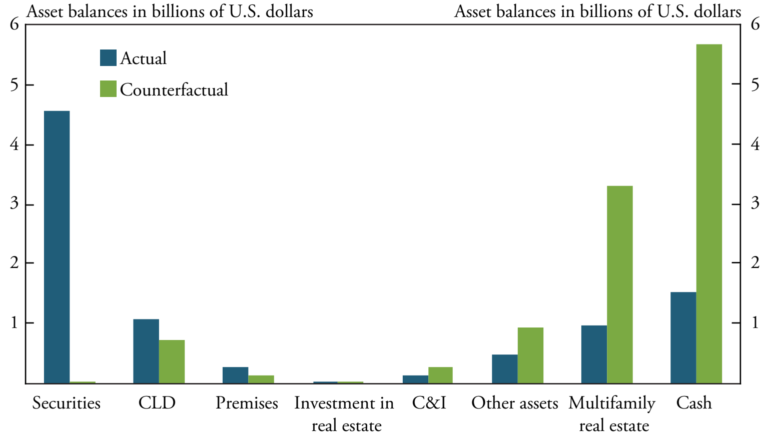
S&L institutions with high operating leverage are considered to be riskier and more likely to engage in further risk-taking. Operating leverage refers to the ratio of fixed costs to assets, and institutions with larger values of this ratio incur larger fixed costs in maintaining their operations. Mutual S&Ls with higher operating leverage accumulated larger shares of high-risk loans across both periods, but this effect is not present among stock S&Ls.

The final three variables in Table 1—the C&I ratio, interest receivable, and the earnings ratio—show no statistically important associations with high-risk loan growth at stock S&Ls. These findings suggest that the existing stock of high-risk loans, the interest due from nonperforming accounts, and the ratio of income to assets did not inform risk-taking decisions at stock institions. These findings also apply to mutual instituions, with the exception that they reduced risk-taking in response to previously accumulated C&I loans.

Overall, the estimated relationships between risk-taking and S&L characteristics describe the differential responses of mutual and stock S&Ls to the policy change. These estimates provide a basis to quantify how risk-taking among the "treated" stock S&Ls would have been different if they had responded to the policy change like the "control" group of mutual S&Ls.

A counterfactual exercise shows that without the change in policy that suspended assistance to failed S&Ls, stock S&Ls would have engaged in greater risk-taking. We can predict how the "treated" stock institutions would have behaved if they had a relatively muted response to the policy change using the estimated relationships between financial characteristics and shifts in the share of assets for the "control" group, mutual S&Ls, which underlie the results in Chart 3. The counterfactual changes in asset shares are obtained by plugging the financial characteristics of stock S&Ls into the estimated relationships for mutual S&Ls. Subsequently, the asset shares are converted into balances by multiplying with asset levels for stock S&Ls over the post-treatment period. Chart 4 presents the observed asset balances for stock S&Ls and the counterfactual levels of these balances. The main finding is that stock S&Ls would have accumulated fewer securities and engaged in more risky lending if the policy change had not shifted their incentives away from risk-taking. In particular, the green bars show that continuing the FSLIC's resolution policies would have resulted in \$3.6 billion in lending across C&I and multifamily real estate loans (green bars), both high-risk categories, compared with the \$1.1 billion they actually lent under the two categories combined (blue bars). Although stock S&Ls held securities of about \$4.5 billion after the policy change, they would have held a statistically negligible amount of this safe and liquid asset category in the absence

Chart 4
Counterfactual and Observed Asset Balances for Stock S&Ls



Sources: FDIC, Sharma and Banerjee (2019), and author's calculations.

of the change. Under the counterfactual scenario, stock S&Ls would also have held their liquid assets in the form of cash rather than securities, which would have enabled them to deploy this liquidity on short notice to issue new loans.

IV. Lessons for Regulatory Policies

When the U.S. government closed the FSLIC and replaced it with an agency that was restricted from rescuing failed S&Ls, moral hazard incentives were reversed and risk-taking declined among institutions prone to undertake risky investments.

For policymakers, the main lesson from this event is that credible signals about the unavailability of government rescues can be effective in reducing moral hazard incentives. The perception of potential government rescue can result in financial institutions extending high-risk loans. More recently, risk-taking among large institutions contributed to the 2007–09 global financial crisis, and ensuing government assistance was criticized for propagating an entrenched "too-big-to-fail" doctrine. Post-crisis reforms on capital standards were designed to signal the termination of such assistance for large institutions, including living wills that required large institutions to outline how they could be closed without generating systemic repercussions that could necessitate government assistance. However, the S&L crisis serves as a reminder that moral hazard had afflicted a large number of small institutions when such assistance was available to them, and elicited the subsequent removal of assistance and tightening of regulations. Accordingly, policies that require small institutions to preserve their capacity to withstand losses and prevent such crises remain salient.

One consequence of adopting stricter norms around assistance to troubled institutions is that lending volumes decline along with risk-taking; however, less lending of certain types of loans may in fact have protected S&Ls against additional losses. Stock S&Ls may have lent more commercial real estate and business loans and held fewer securities if assistance policies had continued to be available. But in view of S&Ls' limited experience in underwriting these categories of loans, a shift away from these assets and into holdings of securities likely strengthened the institutions. Overall, stringent regulation may lead to lower lending volumes, but promotes safety and soundness by encouraging lower risk-taking.

The broader lesson from S&Ls' risk-taking response to policy during the S&L crisis may be that lending and investment activities of financial institutions must be carefully considered when they are insured by federal agencies. As financial innovation progresses and banks take on new asset categories on their balance sheets, their unfamiliarity with the attendant risks may result in losses that ultimately cost taxpayers. Accordingly, to prevent the use of taxpayer funds in future crises, financial regulation will need to keep pace with innovations in financial products and services.

Endnotes

[1]The prevailing accounting standards were known as Generally Accepted Accounting Principles (GAAP). The new, permissive standards introduced as part of the deregulation of the S&L industry were Regulatory Accounting Principles (RAP).

[2]S&L assets under nontraditional categories such as commercial mortgages and direct lending nearly doubled from 11 percent of S&L assets in 1982 to 20 percent in 1985 (White 1991).

[3]The announcement on February 6, 1989, also stated that the FDIC would take over the insurance of S&Ls from the FSLIC.

[4]The unavailability of open thrift assistance was discussed during the Senate Oversight Hearing on the RTC. John E. Robson, the acting chair of the RTC's Oversight Board, noted that while Congress had not mandated that the RTC provide open thrift assistance, the FDIC had the discretion to provide open thrift assistance through the Savings Association Insurance Fund (SAIF) under certain limited circumstances. At the time of the hearing, however, funds were unavailable for this type of assistance. He also noted that the Oversight Board of the RTC had strong reservations about using their authority to divert funds to the FDIC toward open thrift assistance transactions and intended to evaluate the success of the FDIC in the use of assistance prior to committing resources for this purpose.

[5]The number of assistance transactions declined from 158 in 1988 to three in 1989, and none in subsequent years.

[6]Using a Bayesian statistical method, Sharma and Banerjee (2022) show that the FSLIC's decisions cannot be separated into two different decision rules based on the presence of high and low levels of economic distress accompanying S&L failure. In addition, the FSLIC provided assistance to nearly 70 percent of all failed S&Ls, suggesting that this measure was broadly used rather than being limited to S&Ls that failed during macroeconomic shocks.

[7]Although an open thrift assistance transaction dilutes the value of shares held by equity holders, it is the only resolution method that leaves equity holders with a positive share in the S&L and generates larger moral hazard incentives relative to purchase and assumption and payout (White and Yorulmazer 2014).

[8]The method introduced in Sharma and Banerjee (2019) is a novel extension of the standard "difference-in-difference" method and requires fewer assumptions. For instance, this method does not require the parallel trends assumption, which would have required changes in the share of each balance sheet component to move in the same direction across stock and mutual S&Ls prior to 1989.

[9]The Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA) was passed on August 9, 1989. The legislation created the Savings Association Insurance Fund (SAIF) to insure deposits in savings associations under the FDIC's administration. FIRREA also established the Office of Thrift Supervision to replace the Federal Home Loan Bank Board in examining and supervising

thrifts and their holding companies. This legislation also imposed stricter capital requirements on S&Ls.

[10]The median changes across the asset categories do not add up to zero because they represent a subset of asset categories. In Sharma and Banerjee (2019), we focus our analysis on high-risk and low-risk asset categories and exclude asset types such as residential real estate that were typically held by all S&Ls.

[11]The remaining asset classes consist of both safe categories, such as cash, and risky categories, such as commercial and industrial loans, other real estate owned, and investment in subsidiaries. "Other real estate owned" refers to the real estate that S&Ls acquired through foreclosure proceedings. As distress in the real estate sector deepened, S&Ls accumulated larger shares of these properties. Investment in subsidiaries also represents risk-taking; S&Ls invested directly in real estate using subsidiaries as it was the only method permitted for federally chartered thrifts to engage in these activities (McKenzie, Cole, and Brown 1992).

[12]The statistical method introduced in Sharma and Banerjee (2019) specifies a different set of estimates for treated and control groups in the pre- and post-treatment periods. This specification allows the relaxation of assumptions of parallel trends that are typically made in classical difference-in-difference estimations. Therefore, the method generates four columns of estimates in Table 1 instead of a single set of estimates that would have been obtained from a difference-in-difference setting.

[13]Posterior intervals refer to the estimation intervals obtained from Bayesian estimation methods. These methods consist of estimating posterior distributions of parameters—that is, distributions that are derived a posteriori from the data (represented in a likelihood function), and prior information (formally represented by a prior distribution). Analogous to confidence intervals, they are useful in performing inference and determining the statistical importance of an estimate. In contrast to confidence intervals, posterior intervals are compatible with a probability-based interpretation. For instance, the posterior interval for log(size) under stock S&Ls in the pre-1989 period (see Table 1), denotes that the coefficient for this variable lies between –0.4 and 0.1 with a probability of 95 percent.

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