Inflation as a Fiscal Limit

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1. Introduction

Inflation is back. After two decades of low inflation, policy makers all over the world are newly confronted with a high bout of fast-growing prices. Much is yet to be learned about this inflation episode. An aspect of particular relevance for policy makers is the persistence of the ongoing inflationary pressures. Will inflation fall as rapidly as it rose, following a similar pattern observed after the Second World War and the Korean War in the U.S.? Or will inflation drift up as observed in the late 1960s and 1970s in many advanced economies? In this paper, we argue that the answer to these important questions hinges predominantly on the fiscal authority's credibility in stabilizing a large fiscal imbalance. The central bank's anti-inflation reputation, albeit important, is not decisive.

Trend inflation is fully controlled by the monetary authority only when public debt can be successfully stabilized by credible future fiscal plans. When the fiscal authority is not perceived as fully responsible for covering the existing fiscal imbalances, the private sector expects that inflation will rise to ensure sustainability of national debt. As a result, a large fiscal imbalance combined with a weakening fiscal credibility may lead trend inflation to drift away from the long-run target chosen by the monetary authority.

This reasoning configures a natural and interesting limit on fiscal policy. This limit takes the form of incompatibility between lax fiscal policy and a monetary framework aimed at achieving a low and stable inflation environment. When fiscal imbalances are large and fiscal credibility wanes, it may become increasingly hard for the monetary authority to stabilize inflation around its desired target. If the monetary authority increases rates in response to high inflation, the economy enters a recession, which increases the debt-to-gross domestic product (GDP) ratio. If the monetary tightening is not supported by the expectation of appropriate fiscal adjustments, the deterioration of fiscal imbalances leads to even higher inflationary pressure. As a result, a vicious cycle of rising nominal interest rates, rising inflation, economic stagnation, and increasing debt would arise.

In this pathological situation, monetary tightening would actually spur higher inflation and would spark a pernicious fiscal stagflation, with the inflation rate drifting away from the monetary authority's target and with GDP growth slowing down considerably. While in the short run, monetary tightening might succeed in partially reducing the business cycle component of inflation, the trend component of inflation would move in the opposite direction as a result of the higher fiscal burden. Fiscal stagflation does not stem from a perceived or actual loss of anti-inflation reputation by the central bank. Rather, it is caused by the progressive deterioration of the fiscal authority's credibility to stabilize its large debt and the realization that the reputation of the monetary authority is incompatible with the expected behavior of the fiscal authority.

To substantiate these arguments, we build and estimate a model that allows for changes in the monetary/fiscal policy mix. In doing so, we build on previous work such as Bianchi and Ilut (2017) and Bianchi and Melosi (2017), with an important difference. We allow for the possibility that the recent fiscal interventions implemented in response to the COVID pandemic might have weakened agents' beliefs that the large fiscal imbalances will be stabilized by taking the necessary fiscal adjustments. Technically, this feature is modeled as a change in the probability of moving to a fiscally-led policy mix in which the fiscal authority is not fully committed to stabilizing debt and the central bank accommodates the resulting movements in inflation.

When we bring the model to the data, we find that movements in trend inflation can be accounted for by fiscal shocks and by changes in the policy mix. The steady increase in trend inflation observed in the 1960s and 1970s can be explained by the fast-growing government spending, which was needed to support long-lasting welfare programs associated with President Lyndon Johnson's Great Society initiatives, as well as the long and expensive war in Vietnam. These shocks, combined with a fiscally-led policy mix in which the central bank is not credibly committed to stabilize inflation, generate persistent movements in trend inflation. On the contrary, cost-push shocks only account for the spikes in inflation around the oils shocks of those years. In this respect, our model conforms to the notion that persistent high inflation is always and everywhere a fiscal phenomenon (Sargent, 2013).

Trend inflation declined in the early 1980s when policy makers adopted a monetary-led policy mix, in which the fiscal authority is credibly committed to stabilize debt and the central bank responds strongly to deviations of inflation from its desired target. This switch in the monetary and fiscal policy mix followed President Jimmy Carter's appointment of Paul Volcker as Chairman of the Federal Reserve (Fed) in August 1979 and coincided with the election of President Ronald Reagan in 1981. This interpretation of the Volcker disinflation is consistent with Samuelson (2008), who argues that the Reagan administration provided the much needed political backing to Fed Chairman Volcker's anti-inflation policies.

Fed officials were arguably aware of the change in the fiscal authority's attitude. At the July 1981 meeting of the Federal Open Market Committee (FOMC), the then-President of the Federal Reserve of Kansas City, Roger Guffey, argued: "Historically, the Federal Reserve has always come up to the hitching post and then backed off simply because the administration and the Congress have thrown bricks at us or have not been supportive of a policy of restraint. Through the course of recent history at least, we've backed off and we've made a mistake each time. I think we have an opportunity this time to carry forward what we should have done before because for the first time ever we do have, for whatever length of time, the support of the administration at least. So, we ought to take advantage of that opportunity." (FOMC meeting Transcripts, July 1981, cf. Weise (2012).)

Fiscal inflation has not completely vanished after the 1980s disinflation, as agents take into account that a return to the fiscally-led policy mix is still possible and fiscal spending remains elevated. However, the amount of fiscal inflation has remained modest for a long time because of the prevailing monetary-led policy mix. This moderate level of fiscal inflation has counteracted exogenous deflationary pressure and it has helped the central bank to avoid deflation. In fact, absent fiscal inflation, the U.S. economy would have experienced a larger deflationary bias and larger output losses during the years spent at the zero lower bound. Thus, historical circumstances might have provided a false sense of irrelevance of fiscal sustainability considerations.

The COVID pandemic, with a second spell of zero lower bound after only a few years of slightly positive interest rates, has arguably changed this perception. In the model, we allow for the possibility of changes in beliefs about the future policy mix while at the zero lower bound. We show that following the ARPA fiscal stimulus, the probability assigned to moving to the fiscally-led policy mix experienced a large increase. This change in beliefs has resulted in a large jump in fiscal inflation, accounting for approximately half (3.5 percent) of the recent increase in inflation, with cost-push shocks contributing by a similar amount. However, as mentioned above, cost-push shocks and fiscal imbalances affect inflation in very different ways. Cost-push shocks have only transitory effects on inflation, independently from the policy mix in place. Instead, shocks to long-term spending propagate very differently across monetary and fiscal policy regimes and remain a potential threat to inflation stability for a long time, given that they affect the fiscal burden for many years.

The fact that approximately half of the recent increase in inflation has fiscal roots poses some specific challenges for policy makers today. Not only does fiscal inflation tend to be highly persistent but it also requires a different policy response. When inflation has a fiscal nature, monetary policy alone may not provide an effective response. To show this, we ask whether tightening monetary policy earlier could have prevented the post-pandemic increase in U.S. inflation. To answer this question, we build a counterfactual simulation in which we keep agents' beliefs about the future policy mix unchanged, but we allow the central bank to increase interest rates in response to inflation. The increase in rates would have resulted in only a modest reduction in inflation, at the cost of a large reduction in output. This large sacrifice ratio arises because when inflation has a fiscal nature, the central bank is not uniquely responsible for its reduction.

To go back to the initial question: Will the ongoing inflationary pressures persist as in the 1960s and and 1970s? Our study underscores the risk that a similar persistent pattern of inflation might characterize the years to come. Nevertheless, we emphasize that the factors behind the heightened inflation risk today are quite different from those that caused the Great Inflation. As described in several narrative accounts (Meltzer, 2009; Taylor, 2011), the heightened inflation rate of the 1960s and 1970s was the result of the lack of the Fed's independence from the fiscal authority. This lack of independence critically tarnished the credibility of the monetary framework, paving the way for the surge of trend inflation in the 1960s and 1970s. In contrast, the risk of persistent high inflation the U.S. economy is experiencing today seems to be explained more by the worrying combination of the large public debt and the weakening credibility of the fiscal framework.

Thus, the recipe used to defeat the Great Inflation in the early 1980s might not be effective today. In the early 1980s, the resolute anti-inflation stance taken by the Fed and backed by the new administration was the winning move. An important factor behind this success was the historically low government debt that provided strong credibility to the fiscal backing. Today the problem of controlling inflation is compounded by the highly uncertain fiscal situation, with the Congressional Budget Office (CBO) projecting federal debt to keep rising after the year 2023 to reach its highest level ever recorded in 2032 (Congressional Budget Office, 2022).[1] Therefore, even though monetary policy independence is a much more widely respected and better understood value today, high inflation can still be a threat if the fiscal situation is left unresolved. In fact, we show that if the private sector loses confidence in the fiscal authority's willingness to fix this quickly deteriorating fiscal backdrop, hawkish monetary policies can mire the U.S. economy in a prolonged period of stagflation.

All told, our results suggest that conquering the post-pandemic inflation necessitates an overhaul of the fiscal framework aimed at financing the large stock of government debt as well as the increase in public expenditure needed to cover rising costs associated with population aging and climate change.

Our analysis is subject to a number of caveats. First, getting robust predictions from models at the end of the sample period is known to be a challenging task. Lacking information about the development of the macroeconomic outlook over the next years might affect the accuracy of some of our results. Specifically, our model's prediction regarding how much the ARPA fiscal stimulus has altered the perceived credibility of the fiscal framework may vary as more observations become available. Second, the evolution of the private sector's perception about the strength of the central bank's anti-inflation commitment and about the credibility of the fiscal framework cannot be observed directly. Rather, we infer them indirectly from observing the joint dynamics of the debt-to-GDP ratio, the real interest rate, and inflation. To mitigate this last caveat, we back the evolution of these beliefs with the available narrative evidence regarding the monetary and fiscal interactions.

The findings of this paper are consistent with Bianchi, Faccini, and Melosi (2022), where we develop a *A Fiscal Theory of Persistent Inflation* and find that fiscal trend inflation has increased during the pandemic. In that paper, instead of modeling regime changes in the policy mix, we build a model in which a monetary-led policy mix and a fiscally-led policy mix coexist at the same time. The model features unfunded fiscal shocks. These are shocks to transfers that are not backed by future fiscal adjustments. With respect to these shocks, policy makers follow a fiscally-led policy mix in which the central bank accommodates the increase in inflation necessary to stabilize the unfunded share of debt. As a result, these shocks trigger persistent movements in inflation and real interest rates, leading to a fiscal theory of trend inflation. However, policy makers follow a monetary-led policy mix with respect to all other shocks. Consequently, the propagation of familiar business-cycle shocks, such as TFP and monetary policy shocks, is consistent with standard general-equilibrium models and with decades of empirical work based on VAR models.

Our work is connected to the vast theoretical literature on monetary-fiscal policy interaction (Sargent and Wallace, 1981; Leeper, 1991; Sims, 1994; Woodford, 1994, 1995, 2001; Cochrane, 1998, 2001; Schmitt-Grohe and Uribe, 2000; Benhabib, Schmitt-Grohe, and Uribe, 2002; Bassetto, 2002; Reis, 2016; Bassetto and Cui, 2018; Bassetto and Sargent, 2020). Barro (1974) shows that an alternative way to generate non-Ricardian effects is if agents erroneously regard bonds as net wealth. Aiyagari and Gertler (1985) study the implications of fiscal backing of government bonds for the propagation of shocks. They find that for debt to be irrelevant, the model needs to feature a considerable degree of accommodation with respect to the monetary authority. Leeper and Zhou (2021) find that inflation plays an important role in the optimal marginal financing of fiscal needs.

In recent years, a series of papers have provided empirical evidence for the importance of the ideas put forward in the theoretical literature on monetary/fiscal policy interaction. Davig and Leeper (2006) study the implications of regime changes in the policy mix in a calibrated New Keynesian model. Bianchi and Ilut (2017) estimate a model with regime changes in the monetary/fiscal policy mix and link the high inflation of the 1960s-1970s to shocks to long-term spending combined with a fiscally-led regime. Bianchi and Melosi (2017) argue that the possibility of a return to such a regime can explain the lack of deflation in the aftermath of the Great Recession. Leeper, Traum, and Walker (2017) find that the size of fiscal multipliers depends on the policy mix in place. Eusepi and Preston (2012) show that imperfect knowledge breaks Ricardian equivalence, making the scale and composition of the public debt relevant for inflation dynamics. Hall and Sargent (2011)argue that, historically, most of U.S. debt stabilization has been achieved through a combination of growth, revaluation effects, and low real interest rates, as opposed to fiscal adjustments. Kliem, Kriwoluzky, and Sarferaz (2016) study inflation dynamics for Italy, Germany, and the United States and show that switches in the monetary/fiscal policy mix can account for observed differences in the evolution of the low-frequency relationship between the fiscal stance and inflation. In a recent opinion piece, Barro (2022) reaches a similar conclusion to the one proposed in this paper: The post-pandemic inflation can be understood as a realignment in prices necessary to stabilize the large pandemic increase in the fiscal burden. Bianchi, Fisher, and Melosi (2021), a brief paper written right after the implementation of the ARPA, showed that it was hard for standard Phillips curve models to predict any significant increase in inflation unless private sector's beliefs were to adjust owing to the need to stabilize the growing fiscal imbalance.

Bianchi and Melosi (2019) discuss the risks of the lack of coordination between the monetary and fiscal authority, focusing on fiscal stagflation. In earlier work, Sims (2011) discusses a similar stepping on a rake mechanism in the context of a fiscally-led policy mix to explain why a monetary policy shock might be able to initially lower inflation but then generate even higher inflation. Finally, Woodford (2001) and Loyo (1999) use a perfect foresight endowment economy to show that if the central bank follows the Taylor principle while the fiscal authority does not stabilize debt, an explosive path for the price level arises.

Our analysis also connects with the policy interventions that Chris Sims advocated at the 2016 Jackson Hole Symposium to replace ineffective monetary policy at the zero lower bound (Sims, 2016). Sims called for central banks "to explain that fiscal, as well as monetary, policy should be aimed at meeting inflation targets. This means, specifically, stating that inflation will intentionally be at least part of the means for financing current debt and deficits." We find that the bold fiscal interventions implemented in response to the COVID recession succeeded in increasing inflation and sustaining the recovery, lifting the economy from the zero lower bound. In this respect, the pandemic interventions might have made the zero lower bound fiscally unsustainable as in Woodford (2003) and Benhabib, Schmitt-Grohe, and Uribe (2002). However, going forward, setting clear limits on fiscal policy could be necessary to prevent inflation from remaining persistently above the desired inflation target. We discuss these kinds of limits on fiscal policy in Bianchi and Melosi (2019) and provide evidence for their empirical relevance in Bianchi, Faccini, and Melosi (2022). In Bianchi, Fisher, and Melosi (2021), we show that the macroeconomic effects of the ARPA fiscal stimulus are critically affected by agents' expectations about the post-zero lower bound (ZLB) policy mix. In this paper, we formally estimate this post-ARPA change in beliefs.

Our explanation of the Great Inflation is consistent with Clarida, Galí, and Gertler (2000) and Lubik and Schorfheide (2004), who also find that monetary policy was not responding strongly enough to inflation in the 1970s. We differ with respect to the mechanism that accounts for the rise of inflation. In their work, fiscal policy is assumed to remain committed to stabilizing government debt. As a result, the U.S. economy was subject to indeterminacy in the 1970s and the Great Inflation occurred because of a higher inflation target and the possibility of shocks to expectations (sunspot shocks). In our model, agents expected inflation to rise in order to finance the large and persistent increase in government spending which started in the 1960s with the launch of the Great Society initiatives and the Vietnam war.

2. A Model of Monetary/Fiscal Policy Interaction

In this section, we introduce the model that we will fit to U.S. data. The model is based on Bianchi and Melosi (2017) and it is obtained by augmenting a prototypical New Keynesian model with a fiscal block and a discrete shock that can push the economy to the ZLB. With respect to the original specification in Bianchi and Melosi (2017), we make an important extension: We allow for the possibility of a change in agents' beliefs about the exit strategy from the ZLB. This idea is modeled by allowing for two ZLB regimes that are characterized by the same policy behavior, but differ in terms of the probability of moving to a fiscally-led policy mix.

2.1 A New Keynesian Model

Households. The representative household maximizes expected utility:

$$\mathbb{E}_0\left[\sum_{s=0}^{\infty}\beta^t exp\left(\zeta_t^d\right)\left[\log\left(C_t - \Phi\, C_{t-1}^A - h_t\right]\right]\tag{1}$$

subject to the budget constraint:

$$P_tC_t + P_t^m B_t^m + P_t^s B_t^s = P_tW_th_t + B_{t-1}^s + \left(1 + \rho P_t^m\right)B_{t-1}^m + P_tD_t - T_t + TR_t$$

where D_t stands for real dividends paid by the firms, C_t is the level of consumption obtained aggregating a series of differentiated goods with a Dixit-Stiglitz aggregator, h_t is hours, W_t is the real wage, T_t is taxes, TR_t stands for transfers, C_t^A corresponds to the average level of consumption in the economy, and the parameter Φ captures the degree of external habit. As in Woodford (2001), we allow for a simplified maturity structure of government debt. Specifically, there are two types of government bonds: one-period government debt, B_t^s, in zero net supply with price, P_t^s and a more general portfolio of government debt, B_t^m in non-zero net supply with price. The former debt instrument satisfies $P_t^s = R_t^{-1}$. The latter debt instrument has payment structure $\rho^{T-(t+1)}$ for $T > t$ and $0 < \rho < 1$. This second asset can be interpreted as a portfolio of infinitely many bonds with average maturity controlled by the parameter ρ. The value of such an instrument issued in period t in any future period $t + j$ is $P_{t+J}^{m-J} = \rho^J P_{t+J}^m$.

The preference shock ζ_t^d is the sum of a continuous and discrete component: $\zeta_t^d = d_t + \bar{d}_{\xi_t^d}$ The continuous component d_t follows an AR(1) process: $d_t = \rho_d d_{t-1} + \sigma_d \varepsilon_{d,t}$. The discrete component $\bar{d}_{\xi_t^d}$ can assume two values: high or low $\left(\bar{d}_h \text{ or } \bar{d}_l\right)$. The variable ζ_t^d controls which of these two values is in place and evolves according a Markov-switching process with transition matrix H^d:

$$H^d = \begin{pmatrix} p_{hh} & 1-p_{ll} \\ 1-P_{hh} & p_{ll} \end{pmatrix},$$

where $P_{ji} = P\left(\xi_{t+1}^d = j\xi_t^d = i\right)$. The values of H^d, $\bar{d}_h$, and $\bar{d}_l$ are such that the unconditional mean of the discrete shock $\bar{d}_{\xi_t^d}$. is zero. This specification allows us to model recurrent shocks that are large enough to trigger the ZLB. Agents take into account that these episodes can lead to unusual responses by policy makers, as discussed below.

Firms. The economy is populated by a continuum of firms producing differentiated goods that enter the household consumption basket. The representative firm *j* faces a downward-sloping demand curve, $Y_t(j) = (P_t(j)/P_t)^{-1/\upsilon_t} Y_t$,where the parameter $1/\upsilon_t$ is the elasticity of substitution between two differentiated goods. Firms take as given the general price level, P_t, and the level of real activity, Y_t. Whenever a firm changes its price, it faces a quadratic adjustment cost:

$$AC_t(j) = .5\varphi\ (P_t(j)/P_{t-1}(j) - \Pi)^2\ Y_t(j)P_t(j)/P_t \qquad (2)$$

where $\Pi_t = P_t/P_{t-1}$ is gross inflation at time t and Π is the corresponding deterministic steady state. Shocks to the elasticity of substitution imply shocks to the markup $\aleph_t = 1/(1-\upsilon t)$. We assume that the rescaled markup $\mu_t = \kappa \log(\aleph_t/\aleph)$ follows an autoregressive process, $\mu_t = \rho_\mu \mu_{t-1} + \sigma_\mu \epsilon_{\mu,t}$, where $\kappa \equiv \dfrac{1-\upsilon}{\upsilon\varphi\Pi^2}$ is the slope of the Phillips curve. The firm chooses the price $P_t(j)$ to maximize the present value of future profits:

$$\mathbb{E}_t\left[\sum_{s=0}^{\infty} Q_s([P_s(j)/P_s]\, Y_s(j) - W_s h_s(j) - AC_s(j))\right]$$

where Q_s is the marginal value of a unit of consumption good. Labor is the only input in the firm production function, $Y_t(j) = A_t h_t^{1-a}(j)$, where total factor productivity A_t evolves according to an exogenous process: $\ln(A_t/A_{t-1}) = \gamma + \alpha_t, \alpha_t = \rho_a \alpha_{t-1} + \sigma_a \varepsilon_{a,t}, \epsilon_{a,t} \sim N(0, 1)$.

Government. Imposing the restriction that one-period debt is in zero net supply, the flow budget constraint of the federal government is given by:

$$P_t^m B_t^m = B_{t-1}^m \left(1+\rho P_t^m\right) - T_t + E_t + TP_t$$

where $P_t^m B_t^m$ captures to the market value of debt and T_t and E_t correspond to federal tax revenues and federal expenditures, respectively. Government expenditure is the sum of federal transfers and goods purchases: $E_t = P_t G_t + TR_t$. The term TP_t is a shock that captures a series of features that are not explicitly modeled here, such as changes in the maturity structure and the term premium. This shock is necessary because we treat all the components of the government budget constraint as observables. We rewrite the federal government budget constraint in terms of debt-to-GDP ratio $b_t^m = \left(P_t^m B_t^m\right) / \left(P_t Y_t\right)$:

$$b_t^m = \left(b_{t-1}^m R_{t-1,t}^m\right) / \left(\Pi_t Y_t / Y_{t-1}\right) - \tau_t + e_t + tp_t$$

where $R_{t-1,t}^m = \left(1+\rho P_t^m\right) / P_{t-1}^m$ is the realized return of the maturity bond, all the variables are expressed as a fraction of GDP, and we assume $tp_t = \rho_{tp} tp_{t-1} + \sigma_{tp} \varepsilon_{tp,t}$, $\epsilon_{tp,t} \sim N(0, 1)$.

The linearized transfers as a fraction of GDP, behave according to the following process:

$$\left(\tilde{tr}_t - \tilde{tr}_t^*\right) = \rho tr\left(\tilde{tr}_{t-1} - \tilde{tr}_t^*\right) + \left(1-\rho_{tr}\right) \Phi y\left(\widehat{yt} - \widehat{y}_t^*\right) + \sigma_{tr} \in_{tr,t}$$

$$\tilde{tr}_t^* = \rho tr^* \tilde{tr}_{t-1}^* + \sigma_{tr^*,t}, \in_{tr^*,t} \sim N(o,1), \in_{tr,t} \sim N(0,1)$$

where $\tilde{tr}_t^*$ corresponds to long-term transfers. This component captures persistent changes in spending that arise as the result of large programs.[2] The total amount of transfers moves around this trend component as a result of exogenous shocks and the response to business cycle fluctuations captured by the log-linearized output gap $\left(\widehat{yt} - \widehat{y}_t^*\right)$, where $\widehat{y}_t^*$ is potential output. The government also buys a fraction G_t/Y_t of total output. We define $g_t = 1/(1-G_t/Y_t)$ and we assume that $\tilde{g}t = \ln\left(g_t / g\right)$follows an autoregressive process: $\tilde{g}t = \rho_g \tilde{g}_{t-1} + \sigma_g \in_{g,t,} \in_{g,t} \sim N\left(0,1\right)$

Policy Rules. When the high value for the preference shock is realized $\left(\xi_t^d = h\right)$, the economy is out of the ZLB and monetary and fiscal policies are not constrained. In this case, the central bank follows a standard Taylor rule and the evolution of the policy mix can be described by a two-regime Markov switching process ξ_t^p, whose properties will be described in the next section. When the low value for the preference shock is realized $\xi_t^d = l$, the central bank lowers the interest rate until the ZLB is reached and the fiscal authority focuses on stabilizing the economy as opposed to trying to stabilize the stock of debt.

Specifically, the monetary policy rule reads as follows:

$$R_t / R = \left(1 - Z_{\xi_t^d}\right)\left(R_{t-1} / R\right)^{\rho_{R,\xi_t^p}} \left[\left(\Pi_t / \Pi\right)^{\psi_{y,\xi_t^p}}\right]^{\left(1-\rho_{R,\xi_t^p}\right)} e^{\sigma R \in R,t} + Z_{\xi_t^d}\left(R_{t-1} / R\right)^{\rho R,Z}\left(1 / R\right)^{(1-\rho R,Z)\psi Z} e^{\sigma Z \in R,t} \tag{3}$$

where $\epsilon_{R,t} \sim N(0,\ 1)$, R is the steady-state gross nominal interest rate Y_t^*, is the output t target, and Π is the deterministic steady-state level for gross inflation. The parameters $\psi_{\pi\ \xi_t^p}$ capture the central bank's response to inflation and the output gap, which depends on the policy mix ξ_t^p in place at time *t*. The dummy variable $Z_{\xi_t^d}$ is zero when the value of the preference shock is high ($\xi_t^d = h$) and one when it is low ($\xi_t^d = l$). To match the behavior of the interest rate in the data during the zero-lower-bound period, we allow for small disturbances and a gradual decline toward a value close, but not exactly equal, to zero. The size of the monetary policy shocks at the ZLB, σ_Z, is assumed to be a tenth of the standard deviation of the monetary policy shocks when out of the ZLB: $\sigma_Z = \sigma_R/10$. The persistence of changes in the interest rate at the ZLB is controlled by $\rho_{R,Z}$ and fixed to 0.2. Finally, the parameter $0 < \psi_Z \leq 1$ controls the average level of the interest rate when at the ZLB. It can be thought of as the fraction of the steady-state net interest rate. If we set $\sigma_Z = 0$, $\rho_{R,Z} = 0$, and $\psi_Z = 1$, we would obtain *Rt* = 1 at the ZLB and the net nominal interest rate would be exactly zero.[3]

The fiscal authority moves taxes in response to debt, spending, and the state of the economy:

$$\tilde{\tau}_t = \left(1 - Z_{\xi_t^d}\right)\left[\rho_{\tau,\xi_t^p}\tilde{\tau}_{t-1} + \left(1-\rho_{\tau,\xi_t^p}\right)\left[\delta_{b,\xi_t^p}\tilde{b}_{t-1}^m + \delta_{e^*}\tilde{e}_t^* + \delta_y\left(\widehat{y}_t - \widehat{y}_t^*\right)\right]\right] \\ + Z_{\xi_t^d}\left[\rho_{\tau,}Z\tilde{\tau}_{t-1} + \left(1-\rho_{\tau,Z}\right)\left[\delta_{e^*}\tilde{e}_t^* + \delta_y\left(\widehat{y}_t - \widehat{y}_t^*\right)\right]\right] + \sigma_\tau \in_{\tau,t} \tag{4}$$

where $\tilde{e}_t^* \equiv \widetilde{tr}_t^* + g^{-1}\tilde{g}_{t,} \in_{\tau,t} \sim N(0,1)$, and $\tilde{\tau}_t$ is the level of tax revenues with respect to GDP in deviations from the steady state. When the economy is in the high state of demand ($Z_{\xi_t^d} = 0$), tax revenues respond to the state of the economy, captured by the output gap, to the sum of the long-run level of transfers and government purchases, and to the level of debt. The parameter δ_{b,ξ_t^p} captures the strength with which the fiscal authority engages in debt stabilization. This, in turn, depends on the type of policy mix ξ_t^p in place at time *t*. When the large negative preference shock hits $Z_{\xi_t^d} = 1$, the fiscal authority temporarily disregards the level of debt to focus on stabilizing the economy. However, we still allow for the fiscal authority to respond to the level of spending.

2.2 Policy Changes and Beliefs

To characterize changes in policy makers' behavior out of the ZLB, we build on the partition of the parameter space introduced by Leeper (1991). For the sake of exposition, we will assume that the Taylor rule reacts only to inflation, whereas the fiscal rule reacts only to debt. In this simplified version of the model, we can distinguish four regions based on the t properties of the model under fixed coefficients (i.e., without regime changes). When the values of model parameters are fixed, the two policy rules are key in determining the existence and uniqueness of a solution. There are two determinacy regions with very distinct characteristics. In the first region, Active Monetary/Passive Fiscal (AM/PF), the Taylor principle is satisfied and the fiscal authority moves taxes to keep debt on a stable path:

$\psi_\pi^{AM} > 1$ and $\delta_b^{PF} > \beta^{-1} - 1$ Fiscal policy is dubbed passive because it passively accommodates the behavior of the monetary authority by implementing the necessary fiscal adjustments. We refer to this policy combination as the monetary-led policy mix. Under the monetary-led policy mix, absent regime changes and distortionary taxation, the macroeconomy is insulated with respect to fiscal imbalances.

The second determinacy region, Passive Monetary/Active Fiscal (PM/AF), corresponds to the case in which the fiscal authority is not committed to stabilizing the process for debt: $\delta_b^{AF} < \beta^{-1} - 1$ Now it is the monetary authority that passively accommodates the behavior of the fiscal authority, disregarding the Taylor principle and allowing inflation to move in order to stabilize the process for debt: $\psi_\pi^{PM} <$ 1. Under this regime, even in the absence of distortionary taxation, shocks to net taxes can have an impact on the macroeconomy as agents understand that they will not be followed by future offsetting changes in the fiscal variables. Therefore, the macroeconomcy is not insulated with respect to fiscal imbalances. We label this policy combination the fiscally-led regime.

In the third region, both authorities follow passive rules. Absent regime changes, this area of the parameter space leads to multiple solutions. Finally, when both authorities are active, no stationary equilibrium exists if the policy mix is in place forever. This is because this policy mix leads to explosive dynamics for debt and inflation. However, when introducing regime changes, a solution might still exist as long as the lack of coordination between the two authorities does not persist for too long. We will use this policy combination to understand whether the Federal Reserve could have prevented the recent increase in inflation by simply increasing rates.

In the benchmark model, when the preference shock is high ($\xi_t^d = h$)the economy is out of the ZLB ($Z_{\xi_t^d} = 0$)and the evolution of policy makers' behavior is captured by a two-regime Markov chain that evolves according to the transition matrix H^p:

$$H^p = \begin{bmatrix} pMM & 1 - pFF \\ 1 - pMM & pFF \end{bmatrix},$$

where $p_{ji} = p\left(\xi^p_{t+1} = j \mid \xi^p_t = i\right)$. This transition matrix is supposed to capture the stochastic outcome of a game between the monetary and fiscal authorities that is not explicitly modeled in this paper. Regime M is the *monetary-led regime*: $\psi_{\pi,M} = \psi_\pi^{AM} > 1$ and $\delta_{b,M} = \delta_b^{PF} > \beta^{-1}-1$. Regime F is the *fiscally-led regime*: $\psi_{\pi,F} = \psi_\pi^{PM} < 1$ and $\delta_{b,F} = \delta_b^{AM} < \beta^{-1} - 1$.

When the low value for the preference shock occurs ($\xi^d_t = l$), the ZLB becomes binding ($Z_{\xi^d_t} = 1$), and policy makers' behavior is now constrained. In this third regime, the central bank lowers the interest rate until it hits the ZLB and the fiscal authority temporarily disregards the level of debt in order to focus on stabilizing the economy. Notice that the ZLB policy mix can be considered as an extreme version of the fiscally-led policy mix. However, while out of the ZLB, switches to the fiscally-led regime capture the deliberate choices of policy makers, the ZLB regime is triggered by an exogenous negative preference shock that prompts the fiscal authority to forgo fiscal adjustments to counter the effects of a deep recession. Once the preference shock is back to its high value, policy makers' behavior is not constrained anymore.

Thus, the occurrence of a large contractionary shock imposes a constraint on policy makers' behavior. However, agents' beliefs are not constrained. Therefore, beliefs about the future policy behavior after the ZLB are key to understanding the behavior of the macroeconomy at the ZLB. To model agents' beliefs at the ZLB, we introduce a set of parameters controlling the expected exit strategy from the ZLB. The parameter pZ_iM represents the probability that once the discrete preference shock is reabsorbed, the economy will move to the the monetary-led regime, under beliefs *i*. We allow for two possible beliefs, resulting into two distinct parameters, pZ_1M and pZ_2M. Thus, we allow for two possible ZLB regimes that only differ with respect to the probability assigned to moving to the monetary-led policy mix once out of the ZLB.

We are going to estimate these two parameters. To facilitate the exposition, and without loss of generality, we are going to label them $pZ_F M$ and $pZ_M M$, (instead of pZ_1M and pZ_2M). Our estimates will show that $pZ_MM > pZ_FM$, implying that under regime Z_M, a return to the monetary-led policy mix is perceived as more likely than under regime Z_F . Note that this is a result and not an assumption, because we are going to have the same priors on the two ZLB regimes.

To summarize, the joint evolution of policy makers' behavior and the discrete preference shock is controlled by the combined chain $\xi_t \equiv \left[\xi_t^p, \xi_t^d\right] = \left\{[M,h],[F,h],[Z_M,l],[Z_F,l]\right\}$. The corresponding transition matrix H is obtained by combining the transition matrices H^d and H^p with the parameters pZ_MM and pZ_FM :

$$H = \begin{bmatrix} p_{hh}H^p & (1-pu)\begin{bmatrix} pZ_MM & pZ_FM \\ 1-pZ_MM & 1-pZ_FM \end{bmatrix} \\ (1-p_{hh})\begin{bmatrix} .5 & .5 \\ .5 & .5 \end{bmatrix} & p_{ll}\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \end{bmatrix}.$$

2.3 Solving the MS-DSGE Model

The model presents trend growth. The model variables are then rescaled with respect to the unit root technology process A_t and the model equations are linearized around the deterministic steady state. The model can be solved with any of the solution methods developed for Markov-switching DSGE models. We use the solution method of Farmer, Waggoner, and Zha (2009). This solution algorithm takes into account that agents form expectations while aware of the possibility of entering the ZLB and of changes in policy makers' behavior. Furthermore, agents understand that entering the ZLB is an event induced by an exogenous shock that can modify policy makers' behavior even once the constraint stops being binding. Thus, our framework allows us to model *recurrent* ZLB episodes and to capture the impact of different beliefs about policy makers' exit strategy from the ZLB.

The solution assumes the form of a MS-VAR with cross equation restrictions in the DSGE state vector S_t:

$$S_t = C\left(\xi_t^p, \theta, H\right) + T\left(\xi_t^p, \theta, H\right)S_{t-1} + R\left(\xi_t^p, \theta, H\right)Q\left(\xi_t^v, \theta^v\right)\varepsilon_t \quad (5)$$

where θ, θ^v, and S_t are vectors that contain the structural parameters, the stochastic volatilities, and all the variables of the model, respectively. We allow for a break in the volatility of all innovations to accommodate the large shocks observed during the pandemic. Appendix A provides more details about the linearization and the solution algorithm.

In the solution above, the law of motion of the model depends on the structural parameters (θ), the policy regime in place (ξ_t^p), and the probability of moving across regimes (H). This notation highlights that the properties of one regime depend not only on the structural parameters describing that particular regime, but also on what agents expect is going to happen under alternative regimes and on how likely it is that a regime change will occur in the future. In other words, the law of motion governing the evolution of the economy depends on agents' beliefs about future regime changes.

3. Fiscal Inflation

The model solution is combined with a system of observation equations. We estimate the model with Bayesian methods. We include seven observables spanning the sample period 1954Q4-2022Q1: real GDP growth, annualized GDP deflator inflation, annualized federal funds rate (FFR), annualized debt-to-GDP ratio, federal tax revenues to GDP ratio, federal expenditure to GDP ratio, and a transformation of the government purchases to GDP ratio. All variables are expressed in percentage points when reporting the results.

We fix the regime sequence for the out-of-the-zero-lower-bound regimes based on the VAR evidence presented in Bianchi and Melosi (2017). Specifically, we assume that the fiscally-led regime was in place from 1957Q2 to 1981Q3, while the monetary-led regime was in place during the remaining part of the sample except for the ZLB periods. Based on the behavior of the FFR, we assume that the economy was at the ZLB a first time from 2008Q4 to 2015Q4 and then a second time in correspondence of the COVID Pandemic from 2020Q2 to the end of the sample. In our baseline estimation, we allow for a change in beliefs about the future policy mix in correspondence of the ARPA fiscal shock in 2021Q1. This implies that, formally, a regime change occurred at that date, but this regime change

Table 1
Regime Sequence
The table reports the regime sequences for the policy mix and stochastic volatilities.

Subsample	Policy regime	Volatility regime
1955:Q4-1957:Q1	Monetary-led (*M*)	Pre-pandemic volatility
1957:Q2-1981:Q3	Fiscally-led (*F*)	Pre-pandemic volatility
1981:Q4-2008:Q3	Monetary-led (*M*)	Pre-pandemic volatility
2008:Q4-2015:Q4	ZLB low prob of F (*ZM*)	Pre-pandemic volatility
2016:Q1-2020:Q1	Monetary-led (*M*)	Pre-pandemic volatility
2020:Q2-2020:Q4	ZLB low prob of F (*ZM*)	Pandemic volatility
2021:Q1-2022:Q1	ZLB high prob of F (*ZF*)	Pandemic volatility

did not alter current policy rules; the only change was in the expected future behavior of policy makers.[4] Our discussion will then focus on the change in the probability of moving to the fiscally-led policy mix. Finally, we allow for a break in the volatility of all innovations starting from 2020Q1 to accommodate the large shocks observed during the pandemic. The sequences for the policy regimes and the stochastic volatility regimes are summarized in Table 1.

Before moving to present the results, it is useful to mention the importance of estimating the model over the whole sample, as opposed to focusing exclusively on the two ZLB episodes. The properties of the fiscally-led regime are mostly identified by the study of the effects of fiscal imbalances during the 1960s and 1970s.[5] Similarly, the properties of the monetary-led regime are mostly pinned down by the behavior of the economy between the post-Volcker disinflation period and the first occurrence of the ZLB. For given properties of the monetary-led and fiscally-led regimes, the parameters $pZ_M M$ and $pZ_F M$ are informed by the effects of fiscal imbalances on the macroeconomy at the ZLB. Thus, these key parameters are identified by the joint dynamics of fiscal variables, inflation, and real activity during the ZLB period, taking into account how the economy would respond if agents were to expect one or the other regime to occur after the ZLB.

3.1 Parameter Estimates

We report priors and posteriors for the parameters in Table 2 and Table 3. The priors for the parameters that do not move across

Table 2
Prior and Posterior Moments of Policy Parameters

	Mode	Mean	Median	5 percent	95 percent	Type	Mean	SD
ψ_π,M	2.1441	2.1996	2.2003	1.6966	2.6862	N	2.5000	0.3000
ψ_y,M	0.5539	0.5631	0.5465	0.3471	0.8454	G	0.4000	0.2000
ρ_R,M	0.8826	0.8829	0.8847	0.8396	0.9195	B	0.5000	0.2000
ρ_τ,M	0.9780	0.9766	0.9782	0.9573	0.9900	B	0.5000	0.2000
ψ_π,F	0.7009	0.7727	0.7559	0.5906	1.0151	G	0.8000	0.3000
ψ_y,F	0.2806	0.3074	0.3047	0.2340	0.3893	G	0.1500	0.1000
$\rho R,F$	0.6474	0.6688	0.6694	0.5906	0.7431	B	0.5000	0.2000
ρ_τ,F	0.6070	0.6392	0.6427	0.5090	0.7581	B	0.5000	0.2000
$\delta_{b,M}$	0.0493	0.0489	0.0471	0.0261	0.0781	G	0.0700	0.0200
$\delta_{b,F}$	0.0000	-	-	-	-	F	0.0000	-
$\overline{d}_l$	-0.1756	-0.1733	-0.1762	-0.2206	-0.1141	N	-0.3000	0.1000
ψ_Z	0.9720	0.9715	0.9717	0.9648	0.9778	B	0.9500	0.0200
p_{hh}	0.9955	0.9932	0.9953	0.9822	0.9978	D	0.9615	0.0264
p_{ll}	0.8640	0.8072	0.8255	0.6343	0.9173	D	0.8333	0.1034
PMM	0.9992	0.9918	0.9973	0.9660	0.9995	D	0.9615	0.0264
$pPFF$	0.9978	0.9907	0.9962	0.9619	0.9991	D	0.9615	0.0264
PZ_MM	0.9834	0.8599	0.9439	0.3889	0.9904	D	0.5000	0.2236
PZ_FM	0.7107	0.5363	0.5589	0.1660	0.8469	D	0.5000	0.2236

The table reports the prior specification and the mode, mean, median and 5 and 95 percentiles of the posterior distribution of the model parameters. Subscripts M and F denote B the parameter under the Monetary-led regime and the Fiscally-led regime, respectively. B stands for Beta distribution; G stands for Gamma distribution; N stands for Normal distribution; IG stands for Inverse gamma; D stands for Dirichlet distribution; and F denotes a parameter that is fixed before estimation at the value shown in the column Mean.

Table 3
Prior and Posterior Moments of the Other Parameters

	Mode	Mean	Median	5 percent	95 percent	Type	Param 1	Param 2
κ	0.0064	0.0060	0.0059	0.0033	0.0086	G	0.3000	0.1500
ρtr	0.2171	0.2193	0.2178	0.1474	0.2990	B	0.2000	0.0500
δ_y	0.3560	0.3946	0.3896	0.3067	0.5020	N	0.4000	0.2000
Φ	0.8531	0.8596	0.8599	0.8295	0.8880	B	0.5000	0.2000
δ_e^*	0.3492	0.4319	0.4196	0.2561	0.6504	B	0.5000	0.2000
ρ_g	0.9799	0.9854	0.9840	0.9766	0.9960	B	0.5000	0.2000
ρ_a	0.5251	0.4377	0.4454	0.1936	0.6484	B	0.5000	0.2000
ρ_d	0.4275	0.4056	0.4067	0.2938	0.5111	B	0.5000	0.2000
ρ_{tp}	0.3488	0.3432	0.3428	0.2491	0.4401	B	0.5000	0.2000
ρ_μ	0.6208	0.6751	0.6784	0.6044	0.7332	B	0.5000	0.2000
π_*	0.5396	0.5309	0.5302	0.4542	0.6093	G	0.5000	0.0500
γ	0.3986	0.3948	0.3946	0.3337	0.4593	G	0.4000	0.0500
b^*	1.0580	1.0493	1.0507	0.9095	1.1843	N	1	0.1000
g^*	1.0872	1.0868	1.0871	1.0717	1.1010	N	1.0600	0.0400
τ^*	0.1705	0.1707	0.1707	0.1654	0.1765	N	0.1800	0.0100
ϕ_y	-0.2149	-0.2194	-0.2189	-0.2780	-0.1610	N	-0.4000	0.2000
$\sigma_{R,l}$	0.1779	0.1794	0.1792	0.1657	0.1945	IG	2.9454e-05	2.5891

Table 3 continued

$\sigma_{g,l}$	0.2752	0.2743	0.2739	0.2547	0.2956	IG	1.1782e-04	2.5891
$\sigma_{a,l}$	0.6196	0.7571	0.7337	0.4810	1.1161	IG	1.1782e-04	2.5891
$\sigma_{\tau,l}$	0.4038	0.4073	0.4065	0.3778	0.4396	IG	4.7126e-04	2.5891
$\sigma_{d,l}$	7.0012	7.3907	7.3067	6.2160	8.8046	IG	0.1320	14.6969
$\sigma_{tr,l}$	0.4229	0.4243	0.4239	0.3855	0.4645	IG	4.7126e-04	2.5891
$\sigma_{tp,l}$	3.0335	3.0372	3.0291	2.8203	3.2778	IG	1.1782e-04	2.5891
$\sigma_{\mu,l}$	0.1152	0.1042	0.1033	0.0862	0.1252	IG	2.9454e-05	2.5891
$\sigma_{tr*,l}$	0.2548	0.2642	0.2626	0.2227	0.3107	IG	2.7189e-06	4.1751
$\sigma_{R,h}$	0.2717	0.3073	0.2943	0.2108	0.4505	IG	2.9454e-05	2.5891
$\sigma_{g,h}$	0.6591	0.7543	0.7222	0.5231	1.0960	IG	1.1782e-04	2.5891
$\sigma_{a,h}$	0.5663	0.9544	0.7331	0.4022	1.9290	IG	1.1782e-04	2.5891
$\sigma_{\tau,h}$	0.8961	1.0566	0.9989	0.6962	1.6071	IG	4.7126e-04	2.5891
$\sigma_{d,h}$	25.9036	28.6652	28.0400	21.4327	38.1862	IG	0.5282	14.6969
$\sigma_{tr,h}$	8.2725	9.1263	8.8623	6.6632	12.3372	IG	0.0019	2.5891
$\sigma_{tp,h}$	8.7961	10.2272	9.8000	6.8195	15.0638	IG	1.1782e-04	2.5891
$\sigma_{\mu,h}$	0.1819	0.2122	0.2029	0.1434	0.3135	IG	2.9454e-05	2.5891
$\sigma_{tr^*,h}$	0.0725	0.1010	0.0881	0.0537	0.1904	IG	2.7189e-06	4.1751

The table reports the prior specification and the mode, mean, median and 5 and 95 percentiles of the posterior distribution of the model parameters. The subscript l and h denote the pre-pandemic and pandemic volatility regimes, respectively. B stands for Beta distribution; G stands for Gamma distribution; N stands for Normal distribution; IG stands for Inverse gamma; and D stands for Dirichlet distribution. For the Inverse gamma prior distribution Param 1 and Param 2 denote the shape and the scale parameters, respectively. For all the other prior distributions, Param 1 and Param 2 denote the mean and the standard deviation, respectively.

regimes are diffuse and in line with previous contributions in the literature. As for the parameters of the Taylor rule, the prior for the autoregressive component is symmetric across regimes, whereas the priors for the responses to inflation and the output gap differ across regimes to be consistent with the properties of the parameter space discussed above: Under the monetary-led regime (M) monetary policy is active, whereas under the fiscally-led regime (F), monetary policy is passive. In a similar way, the priors for the response of taxes to government debt are asymmetric across the two regimes: Under the fiscally-led regime and the ZLB regime, this parameter is restricted to zero ($\delta_{b,F} = 0$) and not reported in the table, whereas under the monetary-led regime ($\delta_{b,M} = \delta_b$) it is expected to be large enough to guarantee stability of debt. We restrict the persistence of the long-term component of transfers ($\rho_e L = .99$) and choose a relatively tight prior on the standard deviation of its innovations. We fix the discount factor β to .9985, a value broadly consistent with an annualized 2 percent real interest rate, and the average maturity to 5 years (this is controlled by the parameter ρ). The capital share, α is equal to 0.33. Furthermore, we assume that the persistence of the fiscal rule at the ZLB coincides with its value in the fiscally-led regime: $\rho_\tau,Z = \rho_\tau,F$.

Since we fixed the regime sequence, the estimates of the transition matrix are determined by the model dynamics across the different regimes and not by the frequency of regime changes. We choose priors for the persistence of the monetary-led and fiscally-led regimes that reflect the prolonged periods spent under these two regimes. We use a loose and symmetric prior for the parameters $pZ_M M$ and $pZ_F M$, which capture the two possible beliefs about the policy mix that will be carried out after the liftoff of the interest rate from the ZLB. The fact that the priors for both parameters are centered on .5 implies that we maintain an agnostic view with respect to which exit strategy agents regard as most likely during the first and second ZLB episodes.

Regarding the parameters of the Taylor rule, under the monetary-led regime the interest rate reacts strongly to both inflation and the output gap. The opposite occurs under the fiscally-led regime. Under the fiscally-led and ZLB regimes the response of taxes to debt is restricted to zero, while under the monetary-led regime it turns out to be significantly larger than the threshold value described in Subsection 2.2 ($\beta^{-1}-1= .0015$).

Both the monetary-led regime and the fiscally-led regime are quite persistent, implying that when one of the two regimes is in place, agents expect to spend a significant amount of time under that regime. The persistence of the high state for the discrete preference shock is also high. This implies that when out of the ZLB, agents attach a small weight to the possibility of a large contraction in real activity deriving from the negative preference shock. This result is consistent with the fact that before the 2008 financial crisis, the U.S. economy had always been able to avoid the ZLB.

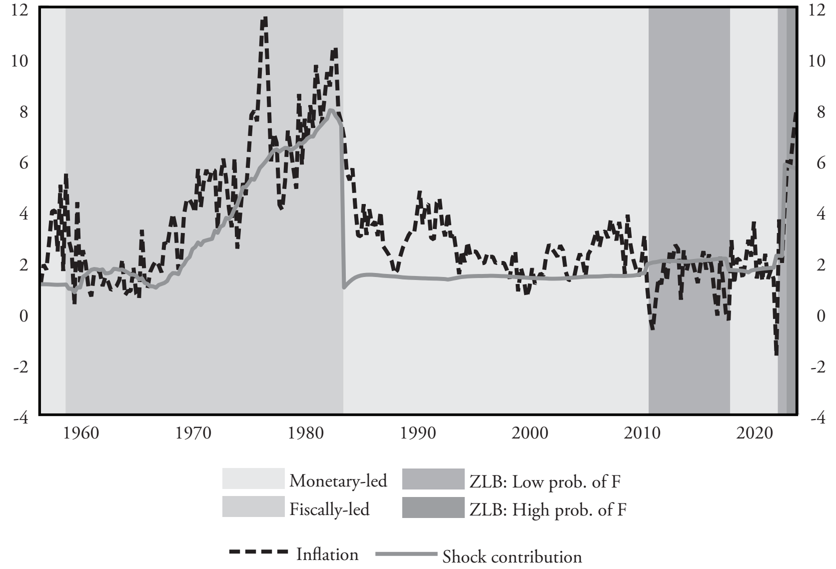
When at the ZLB, under the first set of beliefs, agents regard it as quite likely that once the negative preference shock is reabsorbed, policy makers will move to the monetary-led regime (pZ_MM = 98 percent at the posterior mode). However, this probability is smaller than the estimated persistence of the monetary-led regime (p_{MM} is around 99 percent). Furthermore, the persistence of the low state of demand is also lower than the persistence of the high state of demand (86 percent vs 99 percent). Therefore, when the economy entered the first ZLB episode, the probability attached to switching to the fiscally-led regime experienced a sizable increase. However, the probability of moving back to a monetary-led regime declined significantly following the ARPA shock (pZ_FM = 71 percent at the posterior mode). As we shall see, this large change in beliefs had important consequences for inflation and real activity during the recovery from the COVID pandemic.

3.2 Fiscal Policy and Historical Inflation Dynamics

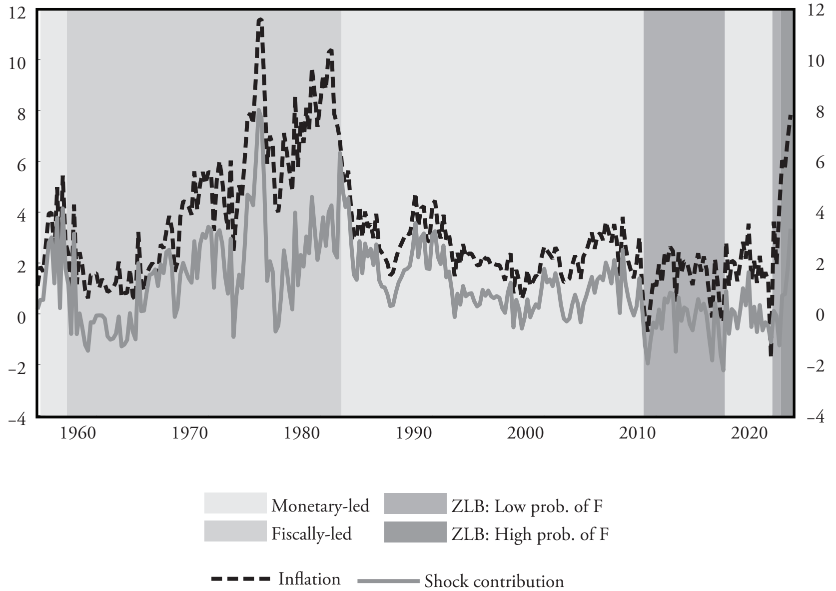
As a first step, we want to understand the relative importance of fiscal shocks in accounting for the historical evolution of inflation. Chart 1 presents the contribution of shocks to long-term transfers and cost-push shocks to inflation dynamics. In the chart, the dashed line corresponds to inflation, while the solid line corresponds to what inflation would have been if only the shock of interest had occurred, keeping the policy and beliefs regime sequences as given. To facilitate the interpretation of the results, the gray areas denote the different

Chart 1
Fiscal Inflation and Cost-Push Shocks

Long-Term Transfers



Cost-Push Shocks



The chart reports the contribution of shocks to the long-term component of transfers and cost-push shocks to inflation dynamics over the sample 1954:Q4-2022:Q1. The gray dashed line corresponds to inflation, while the blue solid line corresponds to what inflation would have been if only the shock of interest had occurred, keeping the policy and beliefs regime sequences as given. The gray areas denote the different policy regimes in place.

policy regimes in place. Note that toward of the end of the sample, during the second ZLB occurrence, we distinguish between the ZLB regime with low probability of moving to a fiscally-led regime (Z_M) and the ZLB regime with high probability of moving to a fiscally-led regime (Z_F). These two regimes only differ with respect to the probabilities assigned to the two exit strategies.

A first important result is that cost-push shocks account for the high-frequency movements of inflation, while long-term transfer shocks account for the low-frequency movements of inflation. The low-frequency component of inflation started increasing in the mid-1960s when the Great Society initiatives, a series of large, long-term welfare programs, were introduced. These shocks to the long-term component of spending, combined with a fiscally-led policy mix, led to an increase in trend inflation. The change in the policy mix in the early 1980s corresponded with a quick decline in inflation. As we shall see below, this decline is the result of changes in both monetary and fiscal policy, not just monetary policy. After this quick decline in inflation, the fiscal component of inflation remains fairly stable until the ZLB period because of the prevailing policy mix.

Cost-push shocks account for the spikes in inflation in the late 1960s, 1974, and at the end of the 1970s, but not for the break in trend inflation. In fact, the high frequency component of inflation has not changed dramatically between the pre- and post-Volcker period, while trend inflation has a clear break (Stock and Watson, 2007). As we will explain in more detail below, this is due to the different propagation of fiscal shocks under a fiscally-led and monetary-led policy mix.

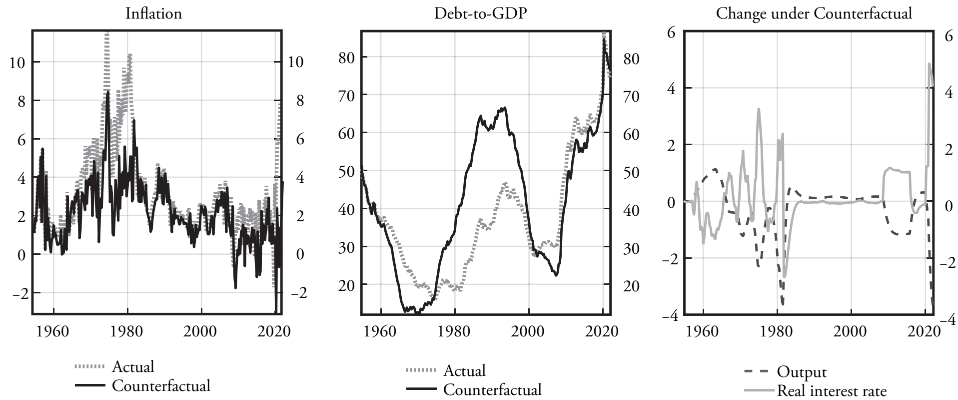
When moving to the post-2008 period, we see that cost-push shocks tend to lower inflation until the onset of the COVID pandemic, when we observe a sharp increase in the level of inflation attributed to these shocks. Over the same years, the increase in the probability of moving to the fiscally-led regime estimated for the ZLB periods contributes positively to inflation. During the first ZLB period, this effect is relatively modest and arguably helps the central bank to remain closer to the desired 2 percent target, counteracting the deflationary pressure of the cost-push shocks. However, following the ARPA shock, the jump in the probability of moving to a fiscally-led policy mix determines a large increase in the component of inflation due to long-term transfers. Note that what drives inflation up is not so much the fiscal shock itself, but the change in beliefs about the future policy mix. In light of the unprecedented fiscal interventions implemented in response to the pandemic, it is conceivable that agents revised their beliefs about the future monetary/fiscal policy mix.

To further illustrate the role of the monetary/fiscal policy mix and agents' beliefs in accounting for macroeconomic dynamics, we consider a counterfactual simulation in which policy makers always follow the monetary-led policy mix, except when encountering the ZLB. Specifically, we modify the baseline model to have the same probability of high and low discrete demand shocks, but we assume that when in the high state of demand, policy makers always follow the monetary-led policy mix and agents form expectations accordingly. When the low-demand discrete shock hits, the economy moves to the ZLB, but agents know that once the economy moves back to the high state of demand, policy makers will return to the monetary-led policy mix. This counterfactual is designed to capture a situation in which there is no doubt about the resolve of the fiscal authority to stabilize debt.

We then simulate both the actual model and the counterfactual model using the estimated sequence of shocks and we compare the simulated series of inflation and debt-to-GDP implied by the two models in Chart 2.[6] The first two panels of Chart 2 report the evolution of inflation and debt in the data (Actual) and in the counterfactual scenario. The last panel of the figure reports the change in output and real interest rates under the counterfactual scenario. This change is computed as the difference between the counterfactual and actual variables. We define the real interest rate as the difference between the FFR and inflation, so this rate is precisely pinned by the observables used in estimation.

In line with the shock decomposition presented above, if policy makers had always followed the monetary-led policy mix, inflation would have been remarkably lower in the 1960s and 1970s. We still

Chart 2
Counterfactual Simulation: Always Monetary-Led Policy Mix



This chart compares the realized (Actual) historical behavior of the economy with a counterfactual scenario in which policy makers always follow the monetary-led policy mix, except when at the zero lower bound. Agents' beliefs are adjusted accordingly: Agents believe that when out of the ZLB, only the monetary-led policy mix is possible. In the first two panels, the gray dotted line and black solid line correspond to the Actual and Counterfactual scenarios, respectively. The third panel of the figure reports the change in output and real interest rates under the counterfactual scenario. This is computed as the difference between the counterfactual and actual variables. The sample is 1954:Q4-2022:Q1. The scale is percentage points.

observe the spikes in inflation in correspondence of the oil shocks, but trend inflation remains low. Consistent with this finding, real interest rates would have been higher, while output would have been lower. Higher real interest rates and lower output would have made the debt-to-GDP ratio *higher* during the middle part of the sample, despite the fact that under the counterfactual scenario the fiscal authority is increasing taxes to lower debt.

This last result highlights that the low debt and the high inflation of the 1970s are the two sides of the same coin. A large increase in fiscal spending generated inflationary pressure that was accommodated by the central bank, causing low real interest rates and higher output, contributing to keeping the debt-to-GDP ratio low. Debt started increasing in the 1980s, when the change in the policy mix determined an increase in real interest rates and a drop in inflation and output. In the aftermath of the Volcker disinflation, we see that the counterfactual scenario presents slightly lower inflation and higher output. This is because in the counterfactual scenario, agents exclude the possibility of a change to the fiscally-led regime, while in the baseline model they do not. Thus, in the baseline model, the possibility of a return to the fiscally-led policy mix generates some modest inflationary pressure, that the central bank counteracts. This generates a small output loss under the baseline scenario.

Moving to the more recent period, the discrepancy between the actual and counterfactual scenarios becomes large again. First, inflation would have been visibly lower during the two ZLB episodes. The difference in the inflation paths is primarily due to the increase in the probability of moving away from the monetary-led policy mix and the large accumulation of debt during the last two recessions. This small level of fiscal inflation partially offsets the deflationary bias of the 2010s, when average inflation failed to hone in on the central bank's two-percent target (Amano, Carter, and Leduc, 2019; Hills, Nakata, and Schmidt, 2019; Bianchi, Melosi, and Rottner, 2021)

This difference widens significantly once agents' beliefs react to the large change in spend.ing following the ARPA shock. During this period, inflation would have been approximately 4 percent lower under the counterfactual scenario. However, the output loss would also have been large: 3.7 percent at the end of the sample. Thus, the model attributes a large part of the post-pandemic recovery and increase in inflation to the change in the perceived probability of moving away from the monetary-led policy mix. Fiscal inflation contributes to the rebound in the real economy. A similar pattern was already at work during the first ZLB episode, but the scale was different, because the probability attributed to moving to a fiscally-led policy mix was lower.

Summarizing, the results presented in this section suggest that in a country such as the U.S. that issues debt in its own currency, fiscal policy has a natural limit. A stable and low level of inflation can be achieved only under an appropriate fiscal arrangement. When the monetary authority's objective of price stability is not backed by the fiscal authority, large increases in government spending lead to large and persistent increases in inflation. In the 1960s and the 1970s, a sequence of shocks to the long-term component of spending, combined with a waning fiscal backing, explains the Great Inflation. The Great Inflation ended when the whole monetary/fiscal policy mix changed. Under the new monetary and fiscal framework, the fiscal authority was credibly committed to stabilize the federal debt and the monetary authority gained its independence in pursuing price stability. Fiscal inflation provided a useful buffer to avert deflation after the Great Recession and fueled the post-pandemic recovery, but this came at the cost of a large increase in inflation in the post-pandemic period.

It is worth emphasizing that the findings presented in this historical analysis of U.S. inflation do not depend on the particular New Keynesian framework used in the empirical analysis or on the way that we model changes in the monetary/fiscal policy interaction. In Bianchi, Faccini, and Melosi (2022), we take a different modeling approach by allowing for unfunded fiscal shocks in an otherwise standard medium-size New Keynesian model to provide a fiscal theory of trend inflation. Unlike funded fiscal shocks, unfunded shocks are not expected to be stabilized with future fiscal adjustments and produce movements in trend inflation. We also consider distortionary taxation and hand-to-mouth consumers to break Ricardian equivalence even when the fiscal authority is fully committed to stabilize debt. This richer fiscal structure allows us to take into account that a fiscal stimulus can temporarily push output above its potential level, generating inflationary pressure, even when agents are certain to remain in a monetary-led policy mix.

Despite the different modeling strategy, we reach similar conclusions with respect to the role of fiscal shocks in accounting for persistent movements in inflation. We find that movements in trend inflation are driven by the amount of unfunded debt, as opposed to funded fiscal shocks, even in presence of hand-to-mouth consumers. In this respect, our results echo but differ from the arguments of Summers (2021) and Blanchard (2021) that stimulative fiscal policy may end up overheating the economy. In line with what suggested by these scholars, our analysis attributes a pivotal role to the ARPA fiscal stimulus in explaining the high inflation readings of the past months. Nevertheless, we focus on a very different mechanism that rests on the increase in trend inflation needed to stabilize a large and growing fiscal imbalance.

In the next section, we provide a brief excursus on the historical evolution of the U.S. monetary and fiscal policy mix to substantiate the evolution of regimes estimated in the literature and used in our analysis.

3.3 A Brief Narrative Account

Bianchi and Ilut (2017) and Bianchi, Faccini, and Melosi (2020, 2022) provide detailed narrative evidence to interpret the historical evolution of the U.S. monetary and fiscal policy mix. To keep this paper self-contained, we briefly summarize the key steps of these historical accounts. This exercise is useful to understand how to interpret the econometric results in light of political and economic events.

The increase in spending which triggers the Great Inflation in the model started in the mid-1960s with the Great Society initiatives (cf. the left panel of Chart 1). These programs–launched by President Lyndon Johnson on May 7, 1964–boosted current and long-term government spending in education, medical care, welfare, social housing, environment, and transportation. The Great Society platform kept expanding throughout the 1970s under Republican administrations.

At the same time, Fed Chairman Arthur Burns was pressured repeatedly by the Johnson and Nixon administrations to keep interest rates low. During a conversation that occurred on Oct. 23, 1969, just after Burns's nomination to the Fed had been announced, President Richard Nixon invited Burns "to see [him] privately anytime and suggested communicating through an intermediary in order to preserve the myth of the autonomous Fed." (Abrams, 2006). Levin and Taylor (2013) argue that this political interference by the fiscal authority played a critical role in causing inflation to drift up in the 1960s and 1970s. These scholars also document that Burns (1979) himself openly acknowledged these political pressures: "...the central bank's practical capacity for curbing an inflation that is driven by political forces is very limited." These accounts are consistent with the predominance of the fiscally-led policy mix regime in those years.

President Jimmy Carter appointed Paul Volcker as Fed Chairman in August 1979. Chairman Volcker immediately tried to quash inflation by tightening monetary policy, but this aggressive action did not succeed initially. In fact, Goodfriend and King (2005) argue that "the start of a deliberate disinflation dates to late 1980" and that this initial increase in the federal funds rate did not represent a significant discontinuity from how the Fed had tried to reduce inflation in the 1970s. This first attempt by Chairman Volcker was doomed by the decision to accommodate the Carter Administration's request to introduce credit controls on March 14, 1980. This choice proved to be detrimental for two reasons. First, it forced the Fed to lower the fed funds rate before seeing considerable pullback in price dynamics. Second, it was yet another blow to the independence of the monetary authority. As a result, the Fed had to start the effort all over again.

In the meantime, President Carter lost the presidential race against Ronald Reagan, who ran on a strong anti-inflation platform. President Reagan provided the necessary support for fighting inflation. The credit controls were removed in July 1980, and this time Volcker kept interest rates high for a prolonged period of time with no interference by the Reagan administration.

Later on, Volcker said that "[u]nlike some of his predecessors, [President Reagan] had a strong visceral aversion to inflation." Despite the fact that the change in monetary policy caused a large contraction in real activity, President Reagan refused to criticize the Fed chairman publicly (Samuelson, 2008). Thanks to this support, Volcker was able to keep interest rates high until inflation finally fell. This fiscal backing did not have to result in an immediate increase in primary surpluses. This is mostly for two reasons. First, thanks to the low rates of the 1960s and 1970s, the debt-to-GDP ratio was at an historical minimum. Second, the recession induced by the change in the monetary/fiscal policy mix naturally implied a drop in tax revenues and an increase in spending. What is required to reduce fiscal inflation is that agents expect that primary surpluses will increase over time.

As debt started increasing due to the rise in real interest rates and the large spending programs, the necessary fiscal adjustments were put into place. While the tax cut contained in the Economic Recovery Tax Act of August 1981 led to an immediate fiscal deficit, it was quickly followed by partially compensating deficit-reducing measures. These were aimed at increasing tax revenues, either through higher tax rates or through expanding the tax base. These changes included the Tax Equity and Fiscal Responsibility Act of 1982, the Social Security Amendments of 1983, and the Deficit Reduction Act of 1984.

Romer and Romer (2009) also note that President Reagan was a strong advocate of spending reductions and that he viewed tax cuts as the most effective way to reduce the size of the government, following the "starve-the-beast" hypothesis. Thus, the reforms also signaled the intention of moving toward a small government, focused on some key functions, such as national defense. Thus, President Reagan was strongly in favor of a reduction in the size of the government, and, more importantly, not willing to allow inflation to be used as a tool for fiscal adjustment.

All these accounts support the prediction of our model that the end of the Great Inflation was the result of a change in both monetary and fiscal policy.

As shown above, fiscal inflation has not disappeared after the Volcker disinflation and its presence is not always an issue. During the first ZLB episode, fiscal inflation counteracted deflationary forces and prevented a more severe output loss. However, the recent fiscal interventions might have caused a significant change in the perceived future policy mix. In the next subsection, we will focus on this last event in more detail.

4. Conquering the Post-Pandemic Inflation

In the previous section, we have shown that trend inflation is in large part a fiscal phenomenon that can be understood in light of changes in the monetary/fiscal policy mix. While other shocks can affect inflation in the short run, in the long run a low and stable inflation requires a credible fiscal framework. In view of these considerations, it is interesting to ask under which conditions policy makers can regain control of inflation in the post-pandemic era.

4.1 Could Monetary Policy Alone Have Averted the Post-Pandemic Inflation?

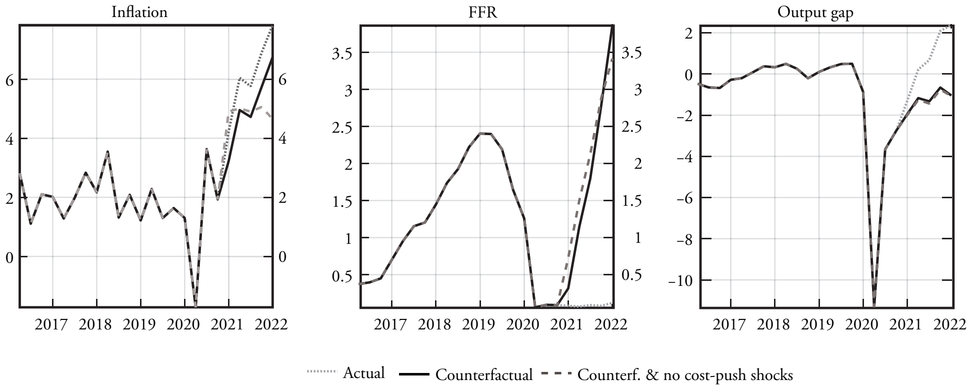
In the previous subsection, we have shown a decomposition of inflation between cost-push shocks and long-term spending shocks. Both shocks played a role in the post-pandemic surge in inflation. However, the counterfactual simulation presented above has highlighted that while the cost-push shock component of inflation appears to behave similarly even when changing the perceived future policy mix, the effects of shocks to long-term fiscal spending are heavily affected by this perception. Given that half of the recent surge in inflation has a fiscal origin, a natural question to ask is whether monetary policy could have neutralized it by stepping on the interest-rate brake more quickly and aggressively and, if so, at what cost.

In order to answer this question, we consider a counterfactual simulation in which we modify the behavior of the monetary authority, while keeping agents' beliefs about the future policy mix unchanged.[7] Specifically, we assume that right after the realization of the ARPA stimulus shock and the associated change in beliefs about the future policy mix, the central bank leaves the ZLB and increases the policy rate as it would do under the monetary-led policy mix. We assume that this behavior comes as a surprise for agents in the economy. This allows us to have the same starting point in 2021Q1 for the baseline model and for this counterfactual model.

Chart 3 reports the results. The dotted line corresponds to the data (Actual scenario), while the solid line is the counterfactual scenario in which the monetary authority increases the interest rate as it would do under the monetary-led policy mix, but without the necessary fiscal backing and without a change in agents' beliefs about the probability of moving to the fiscally-led policy mix. We also report how the economy would have behaved under the counterfactual policy behavior if no cost-push shocks had occurred starting from 2021Q1 (dashed line).

From this exercise, it is clear that even if the monetary authority had anticipated the liftoff and tightened the interest rate aggressively, it would not have been able to suppress the large increase in inflation. This is because half of the increase in inflation observed in 2021 has a fiscal nature (left plot of Chart 2) and it is driven by a shift in beliefs about how the large stock of debt and the ARPA stimulus will be financed. The more hawkish monetary policy would have lowered inflation by only 1 percentage point at the cost of reducing output

Chart 3
Counterfactual Simulation: Active Monetary Policy Following the ARPA Shock, but no Change in Beliefs



The chart reports a counterfactual simulation in which, in response to the ARPA shock in 2021:Q1, the central bank adopts the reaction function of the monetary-led policy mix, but agents' beliefs about the future policy mix are unchanged. This policy change comes as a surprise for agents in the economy. The dark gray dashed line corresponds to the actual data, the black solid line corresponds to the counterfactual simulation, and the dashed light gray line corresponds to the counterfactual simulation without cost-push shocks starting from 2021:Q1. Until 2021:Q1 the actual and counterfactual series coincide. The sample is 2018:Q1-2022:Q1.

by around 3.4 percentage points. This is a quite large sacrifice ratio. This result is not driven by the presence of cost-push shocks. When we completely remove cost-push shocks (dashed yellow line), output barely changes while inflation remains elevated at around 4.6 percent.

This result is driven by agents' beliefs. In this counterfactual scenario, we keep the fiscal shocks and agents' beliefs unchanged. The central bank is increasing the policy rate, but agents still expect that the ARPA stimulus has increased the probability of moving to the fiscally-led policy mix. By increasing interest rates, the Fed is able to cool down the economy because of nominal rigidities. However, the assumed monetary tightening alone is not enough to significantly cut inflation because price dynamics are mostly driven by a perceived lack of fiscal sustainability.

To sum up, we showed that anticipating the liftoff and swiftly raising the policy rate *in isolation* would not have averted the post-pandemic surge in prices. In the next section, we will show that the reasons behind this dismal outcome have to be found in the fiscal nature of the recent rise in inflation.

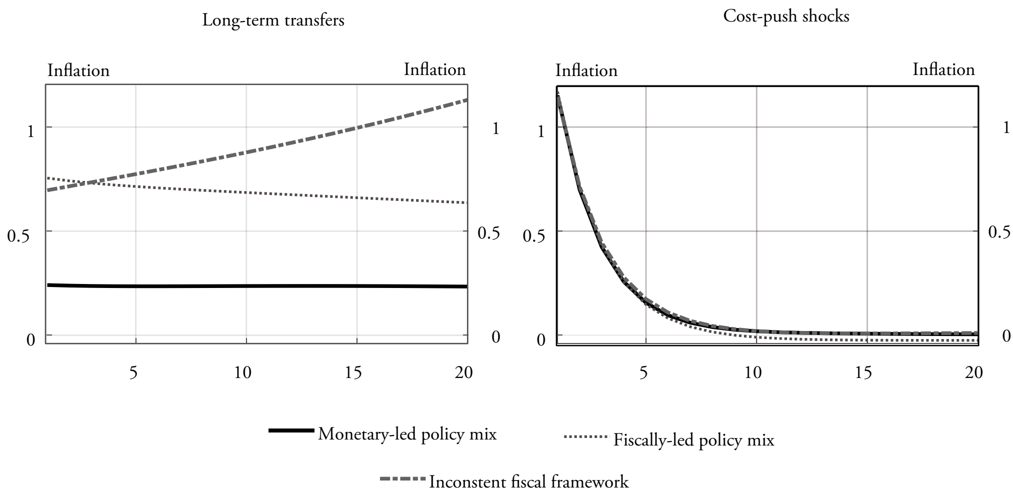
4.2 Fiscal Stagflation

We showed that keeping inflation low and stable may be quite challenging for a central bank if the fiscal framework is not perceived to be consistent with debt stabilization. When this is the case, fiscal shocks have a large and persistent effect on inflation. On the other hand, cost-push shocks have relatively short-lasting effects on inflation. Our counterfactual simulations suggest that these effects do not vary significantly in response to the current or expected monetary and fiscal policy mix.

To formalize this point, we study a simplified version of the model in which the fiscal framework may be perceived to be inconsistent with debt stabilization. We achieve this by introducing an additional regime, which we call the inconsistent fiscal framework regime. To simplify the model, we assume that (*i*) the fiscally-led regime is an absorbing state, (*ii*) discrete demand shocks are shut down $\left(\bar{d}_{\xi_t^d}\right)$, and (*iii*) the ZLB constraint never binds. In t the baseline case, the regime with the Inconsistent fiscal framework is assumed to be followed by the fiscally-led policy mix. The new regime is introduced to isolate the consequences of adopting a resolute anti-inflation monetary policy stance without the necessary fiscal backing. Hence, in that regime, we assume that the monetary authority responds to inflation as in the monetary-led regime (see Table 2) but does not respond to output and the last period's interest rate. The fiscal authority does not adjust taxes in response to changes in the debt-to-GDP ratio in the inconsistent fiscal framework regime. The monetary and fiscal policy rules under the monetary-led and fiscally-led policy regimes are identical to the posterior mode–shown in Table 2. Analogously, the model parameters that are not affected by changes in the monetary and fiscal policy mix are also calibrated to the posterior mode. A more thorough description of how the simplified model with the Inconsistent fiscal framework regime is calibrated is in Appendix C.

Chart 4 shows the impulse responses to a shock to long-term transfers (left panel) and to a cost-push shock (right panel) under three policy regimes: monetary-led, fiscally-led, and inconsistent fiscal framework. The first result that emerges is that a long-term transfers shock causes a large and persistent increase in inflation under the fis-

Chart 4
Inflation Persistence Due to Fiscal and Cost-Push Shocks



The charts report the impulse response function of inflation to a one-standard deviation long-term transfers shock (left panel) and to a one-standard-deviation cost-push shock (right panel) under the monetary-led policy mix, the fiscally-led policy mix, and the absence of a consistent fiscal framework to achieve price stability (inconsistent fiscal framework). Agents know the true transition probabilities of these three policy regimes and form their beliefs accordingly.

cally-led policy mix. Agents understand that the fiscal authority will not implement the necessary fiscal adjustments. This creates inflationary pressures that are accommodated by the central bank. Under the monetary-led regime the same shock generates a much smaller increase in inflation. The increase is not zero, because agents consider the possibility of a future regime change. Shocks to long-term transfers do not dissipate quickly. Thus, even if policy makers are currently committed to fiscal adjustments, agents know that the fiscal burden might result in high inflation at some point in the future.

Under the third scenario–when the monetary authority responds to inflation as in the monetary-led regime but without fiscal backing–not only does inflation increase persistently, but it takes an explosive path. The shock to spending determines an increase in the fiscal burden, causing inflationary pressures. The central bank reacts by increasing rates, causing a recession. The recession and a higher cost of financing debt further increase the fiscal burden that in turn generates additional inflationary pressure. In this case, not only is the central bank unable to lower inflation, but by increasing rates it is causing even more inflation and economic stagnation. We call this outcome *fiscal stagflation*.

In the data, the scenario is still not so grim. Agents still regard a change to a monetary-led policy mix as more likely. However, the large increase in the probability assigned to a fiscally-led policy mix explains why, in the counterfactual above, the increase in rates had only a modest effect on inflation.

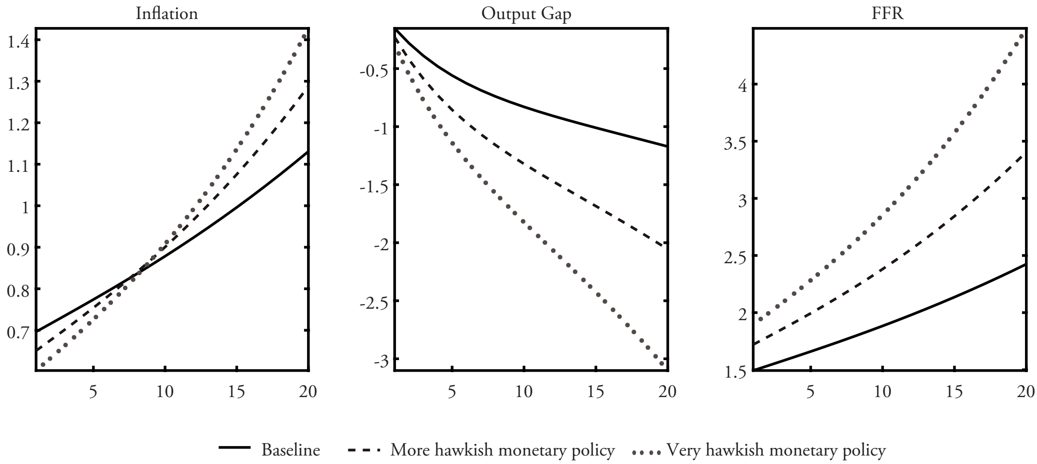
Finally, it is interesting to contrast these results with the impulse responses to a cost-push shock. In this case, the policy mix in place is almost irrelevant. This is because, in the data, cost-push shocks only imply transitory movements in inflation. Thus, it is entirely possible that we will see a partial reduction in inflation in the months ahead as the effects of cost-push shocks fade away. However, based on our analysis, the fiscal component of inflation is likely to persist, unless the necessary fiscal backing is reinstated. In the next section, we study how policy makers can deal with this fiscal component of inflation.

4.3 Reining in Fiscal Inflation and Avoiding Fiscal Stagflation

We now tackle the issue of what policy makers can do to combat a rise in fiscal inflation in our model. We first show that a more hawkish monetary policy unsupported by a credible fiscal arrangement cannot resolve the problem of fiscal inflation and, in fact, only accelerates inflationary dynamics and slows down economic activity even further. We then show that a change in agents' beliefs about the future policy mix is quite effective in quashing fiscal inflation.

Chart 5 shows the response of inflation, the output gap, and the interest rate to a shock to long-term transfers as the central bank becomes progressively more hawkish. However, we assume that agents remain convinced that eventually the economy will move to a fiscally-led policy mix to stabilize the increase in debt resulting from the larger spending. The different lines correspond to different values for the parameter controlling the response of the monetary authority to inflation, ψ_π. The black solid line corresponds to the posterior mode estimate for this parameter under the monetary-led policy mix ($\psi_{\pi,M}$). Under the gray short dashed line the value of this parameter increases by 25 percent, while under the gray short dashed line it increases by 50 percent.

Chart 5
Fiscal Stagflation as the Monetary Authority Becomes More Hawkish



Impulse responses of inflation, the output gap, and the federal funds rate (FFR) to a shock to long-term transfers as the central bank becomes progressively more hawkish. Agents expect that eventually the economy will move to a fiscally-led policy mix and the fiscal authority is not currently implementing fiscal adjustments. The different lines correspond to different values for the parameter controlling the response of the monetary authority to inflation, ψ_π. The black solid line corresponds to the posterior mode estimate for ψ_π, M in Table 2, the dashed line increases the value of this parameter by 25 percent, while the gray dotted line increases the value of this parameter by 50 percent.

As explained above, the increase in spending determines inflationary pressure because agents expect that eventually the additional fiscal burden will be stabilized with inflation. As the central bank increases the response to inflation, the initial jump in inflation becomes smaller at the cost of generating a larger contraction in real activity. In addition, the success on inflation is ephemeral. Eventually the paths of inflation cross and the more hawkish response leads to higher inflation and larger output losses. The reason is as follows: The more hawkish the monetary policy response, the larger the increase in the fiscal burden, the larger the acceleration in inflation. Across all scenarios, fiscal stagflation persists as agents expect that the increase in the fiscal burden will also contribute to generating future inflation.

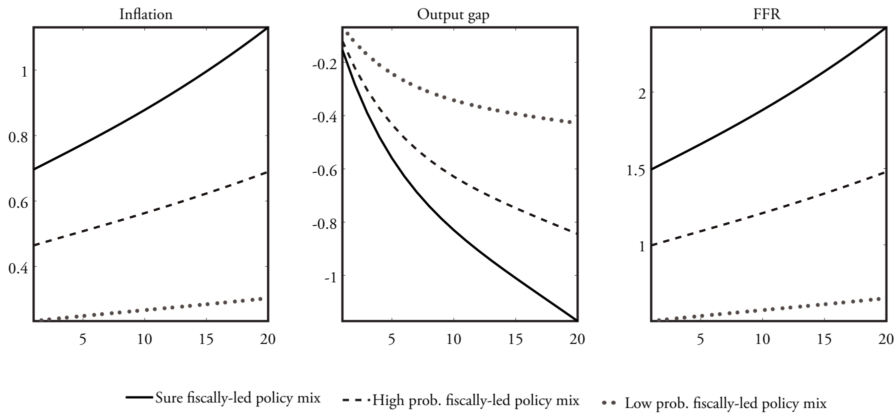
This result is driven by the fact that while the response of the monetary authority to fiscal inflation becomes progressively more hawkish, agents' beliefs about future policy remain unchanged. The reason behind this apparently puzzling result is that by tightening monetary policy, the monetary authority increases the service of the debt and depresses output. As a result, the debt-to-GDP ratio increases. Agents expect that the debt will not be stabilized by future fiscal adjustments, which leads to an increase in fiscal inflation. The monetary authority raises the interest rate even more to respond to the rising fiscal inflation, exacerbating the fiscal imbalance and further accelerating the price dynamics.

As the three lines show, this vicious spiral has progressively more pernicious effects on price stability and the economy as the monetary authority intensifies its response to rising inflation. This exercise serves as an important warning for policy makers: If fiscal policy is perceived to be inconsistent with price stability, the monetary authority may fail in its attempt to rein in inflation, paving the way to fiscal stagflation. Bianchi and Ilut (2017) argue that this mechanism is behind the failed disinflation of the 1970s, and is the reason why Volcker did not immediately succeed in bringing inflation down when appointed in August 1979. Monetary policy changed earlier than fiscal policy. The appropriate fiscal backing came only in the early 1980s.

What can be done when policy makers are confronted with fiscal inflation? Our model suggests that it is critical to reassure the private sector that the large stock of debt will be repaid by raising taxes or cutting government expenditure. One way to do so is to announce a credible plan indicating how the fiscal authority intends to stabilize the existing fiscal imbalance. Reaffirming that the central bank has the backing of the fiscal authority in its quest to reduce inflation also helps, but it is not sufficient if fiscal interventions are not perceived as consistent with this goal.

In presence of fiscal inflation, tightening monetary policy can be successful only to the extent that the resulting increase in the cost of servicing debt prompts the fiscal authority to make the necessary fiscal adjustment, reinstating the credibility of the fiscal framework. In other words, for monetary policy to be successful, agents need adjust their beliefs about the future policy mix in response to the increase in interest rates. To illustrate the underlying mechanism, we revisit the effects of long-term spending shocks when varying agents' beliefs about the future policy mix. We keep the response of the central

Chart 6
Fiscal Stagflation as Agents' Beliefs About the Future Policy Mix Vary



Impulse responses of inflation, the output gap, and the federal funds rate (FFR) to a shock to long-term transfers as beliefs about the future policy mix change. The central bank responds to inflation as implied by the monetary-led policy mix while the fiscal authority does not adjust taxes. The different lines correspond to different probabilities that the next policy mix will be fiscally led; the black line: fiscally-led policy mix is expected to follow with certainty; gray dashed line: fiscally-led policy mix is expected to follow with probability 0.67; gray dotted line: fiscally-led policy mix is expected to follow with probability 0.33.

bank to inflation fixed at its value under the monetary-led policy mix, but we progressively reduce the probability of a change to the fiscally-led policy mix. In this case, the monetary authority can considerably mitigate and possibly escape the fiscal stagflation scenario.

Chart 6 presents the results. The solid black line coincides with the black solid line of Chart 5, given that we maintain the assumption that agents are certain that the fiscal authority will not take the necessary fiscal adjustments to stabilize the public debt, and eventually the monetary authority will revert to a passive policy. As we progressively reduce the probability of a change to the fiscally-led policy mix, two important effects arise. First, the inflationary pressure goes down. Second, fiscal stagflation is mitigated. In the limit, if a change to the fiscally-led policy mix is completely ruled out, the inflationary pressure and fiscal stagflation would almost completely disappear (not shown).[8]

Summarizing, the massive fiscal interventions implemented during the pandemic succeeded in raising inflation–after a period of persistently shallow price dynamics and low interest rates–and in providing quick support to the economy. However, going forward, a clearer demarcation of the boundaries of fiscal policy might be needed to ensure low and stable inflation.

5. Conclusions

Historically, movements in fiscal inflation account for changes in trend inflation, while cost-push shocks determine more transitory movements. Thus, an implicit fiscal limit arises to the extent that a low and stable inflation target requires fiscal policies that are consistent with this goal. Absent this fiscal backing, the central bank cannot maintain inflation at the desired target. We have argued that the rise in trend inflation in the 1960s and 1970s was a fiscal phenomenon that ended when the monetary/fiscal policy mix changed in the early 1980s. Since then, fiscal inflation has remained modest because of the prevailing policy mix. In the decade before the pandemic, fiscal inflation has been counteracting deflationary forces and, in fact, helped in preventing the U.S. economy from slipping into deflation.

Following the COVID pandemic, the U.S., like many other countries, has implemented robust fiscal interventions. We have shown that these policy interventions facilitated the quick rebound observed after the pandemic recession. At the same time, they also contributed to the surge in fiscal inflation. Increasing rates, by itself, would not have prevented the recent surge in inflation, given that large part of the increase was due to a change in the perceived policy mix. In fact, increasing rates without the appropriate fiscal backing could result in fiscal stagflation. Instead, conquering the post-pandemic inflation requires mutually consistent monetary and fiscal policies providing a clear path for both the desired inflation rate and debt sustainability.

Appendix

A. Benchmark Model

In what follows, we provide the details for the solution and estimation of the model.

A.1 System of Equations

1. Linearized Euler equation:

$$
\begin{aligned}
\left(1+\Phi M_{\alpha}^{-1}\right)\hat{y}_t = & -\left(1-\Phi M_{\alpha}^{-1}\right)\left[\hat{R}_t - E_t\tilde{\pi}_{t+1} - (1-\rho d)d_t - \bar{d}_{\xi_t^d} + E_{\xi_t^d}\bar{d}_{\xi_{t+1}^d}\right] \\
& -\left(\Phi M_{\alpha}^{-1} - \rho_\alpha\right)\alpha_t + E_t\hat{y}_{t+1} + \left(1-\rho_g + M_{\alpha}^{-1}\Phi\right)\tilde{g}_t \\
& + M_{\alpha}^{-1}\Phi\left(\hat{y}_{t-1} - \tilde{g}_{t-1}\right)
\end{aligned}
$$

where $M_a = \exp(\boldsymbol{\gamma})$ and $\bar{d}_{\xi_t^d}$ follows a Markov-switching process governed by the transition matrix H^d. Refer to the next subsection for details about how to handle the discrete shock.

2. New Keynesian Phillips curve:

$$
\begin{aligned}
\tilde{\pi}_t = \kappa & \left(\begin{array}{c} \left[\dfrac{1}{1-\Phi M_A^{-1}} + \dfrac{\alpha}{1-\alpha}\right]\hat{y}_t - \dfrac{1}{1-\Phi M_A^{-1}}\tilde{g}_t \\ -\dfrac{\Phi M_A^{-1}}{1-\Phi M_A^{-1}}\left(\hat{y}_{t-1} - \tilde{g}_{t-1} - \alpha_t\right) \end{array} \right) \\
& + \beta E_t\left[\tilde{\pi}_{t+1}\right] + \tilde{\mu}_t
\end{aligned}
$$

where we have used the rescaled markup $\tilde{\mu}_t = \kappa\left(\dfrac{\upsilon}{1-\upsilon}\right)\tilde{\upsilon}_t$

3. No arbitrage condition

$$
\tilde{R}_t = E_t\left[\tilde{R}^m_{t,t+1}\right]
$$

4. Return long term bond

$$
\tilde{R}^m_{t-1,t} = R^{-1}\rho\tilde{P}^m_t - \tilde{P}^m_{t-1}
$$

5. Government budget constraint

$$\tilde{b}_t^m = \beta^{-1}\tilde{b}_{t-1}^m + b^m\beta^{-1}\left(\hat{R}_{t-1,t}^m - \hat{y}_t + \hat{y}_{t-1} - \alpha_t - \tilde{\pi}_t\right)$$
$$-\tilde{T}_t + \widetilde{tr}_t + g^{-1}\widetilde{g_t} + \widetilde{tp_t}$$

6. Monetary policy rule

$$\tilde{R}_t = \left[1 - Z_{\xi_t^d}\right]\left[\rho_{R,\xi_t^p}\tilde{R}_{t-1} + \left(1 - \rho_{R,\xi_t^p}\right)\left(\psi_{\pi,\xi_t^p}\tilde{\pi}_t + \psi_{y,\xi_t^p}\left[\hat{y}_t - \hat{y}_t^*\right]\right) + \sigma_{R^{\in}R,t}\right]$$
$$+Z_{\xi_t^d}\left[\rho_{R,Z}\tilde{R}_{t-1} - \left(1 - \rho_{R,Z}\right)\psi_Z \log(R) + \sigma_{Z^{\in}R,t}\right]$$

7. Fiscal rule

$$\tilde{T}_t = \rho_{T,\xi_t^p}\tilde{T}_{t-1} + \left(1 - \rho_{T,\xi_t^p}\right)\left[\delta_{b,\xi_t^b}\tilde{b}_{t-1}^m + \delta_{e^*}\left(\widetilde{tr}_t^* + g^{-1}\tilde{g}_t\right) + \delta_y\left(\widehat{y_t} - \widehat{y}_t^*\right)\right] + \sigma_T \in_{T,t}$$

8. Transfers

$$\left(\widetilde{tr}_t - \widetilde{tr}_t^*\right) = \rho_{tr}\left(\widetilde{tr}_{t-1} - \widetilde{tr}_t^*\right) + \left(1 - \rho_{tr}\right)\Phi\mathrm{y}\left(\widehat{y_t} - \widehat{y}_t^*\right) + \sigma_{tr} \in_{tr,t,} \in_{tr,t} \sim N(0,1)$$

9. Long-term component of transfers

$$\widetilde{tr}_t^* = \rho_{tr^*}\widetilde{tr}_{t-1}^* + \sigma_{tr^*,t,} \in_{tr^*,t} \sim N(0,1)$$

10. Government purchases

$$\left(\tilde{g}_t = \ln\left(g_t / g\right)\right):$$

$$\tilde{g}_t = \rho_g\tilde{g}_{t-1} + \sigma_g \in_{g,t}, \quad \in_{g,t} \sim N(0,1).$$

11. TFP growth

$$a_t = \rho_a a_{t-1} + \sigma_a \varepsilon_{a,t}$$

12. Term premium

$$t_{pt} = \rho_{tp} tp_{t-1} + \sigma_{tp}\varepsilon_{tp,t}$$

13. The rescaled markup $\mu_t = \kappa \log(\aleph_t/\aleph)$, where $\aleph_t = 1/(1-\upsilon t)$, follows an autoregressive process,

$$\mu_t = \rho_\mu \mu_{t-1} + \sigma_\mu \epsilon_{\mu,t}$$

14. Output target

$$\left[\frac{1}{1-\Phi M_\alpha^{-1}} + \frac{\alpha}{1-\alpha}\right]\hat{y}_t^* = \frac{1}{1-\Phi M_\alpha^{-1}}\tilde{g}_t + \frac{\Phi M_\alpha^{-1}}{1-\Phi M_\alpha^{-1}}\left(\hat{y}_{t-1}^* - \tilde{g}_{t-1} - \alpha_t\right)$$

A.2 Model Solution

As explained in the main text, the Markov-switching process for the discrete preference shock $\bar{d}_{\xi_t^d}$ is defined in a way that its steady state is equal to zero. In order to solve the model we implement the following steps:

1. Introduce a variable $e_{\xi_t^d}$, always equal to 1, controlling the regime that is in place for the discrete preference shock. Augment the DSGE state vector with this variable, loading the value of the discrete shock in place at each point in time.

2. Use the aforementioned dummy variable to rewrite all the equations linked to the discrete preference shock. These are the linearized Euler equation and the linearized Taylor rule.

3. Solve the model using Farmer, Waggoner, and Zha (2009). This returns a MS-VAR:

$$\tilde{S}_t = \tilde{T}\left(\xi_t^P, \theta, H\right)\tilde{S}_{t-1} + \tilde{R}\left(\xi_t^P, \theta, H\right)Q\left(\xi_t^v, \theta^v\right)\varepsilon_t$$

in the augmented state vector $\tilde{S}_t$.

4. Extract the column corresponding to the dummy variable $e_{\xi_t^d}$ from the matrix $\tilde{T}$ and redefine the matrices and the DSGE state vector accordingly. This will return a MSVAR with a MS constant:

$$S_t = C\left(\xi_t^P, \theta, H\right) + T\left(\xi_t^P, \theta, H\right)S_{t-1} + R\left(\xi_t^P, \theta, H\right)Q\left(\xi_t^v, \theta^v\right)\varepsilon_t$$

where Q is a diagonal matrix that contains the standard deviations of the structural shocks and S_t is a vector with all variables of the model.

Our model allows for non-orthogonality between policy makers' behavior and a discrete shock. This allows us to solve a model in which agents take into account that a large preference shock leads to an immediate change in policy, the zero lower bound, and, potentially, to further changes. This proposed method is general and can be applied to other cases in which a shock induces a change in the structural parameters.

A.3 Matrices Used in the Counterfactual Simulations

We here describe the matrices used in the simulations reported in the paper.

A.3.1 Always Monetary Led

In the first counterfactual simulation, policy makers always follow the monetary-led regime when out of the zero lower bound. Furthermore, there is only one zero-lower-bound regime from which agents expect to return to the monetary-led regime. Therefore, the transition matrix used to solve this counterfactual economy is given by:

$$H^p = 1, H^d = \begin{bmatrix} p_{hh} & 1 - p_{ll} \\ 1 - p_{hh} & p_{ll} \end{bmatrix}, H^c = H^d.$$

where p_{hh} and p_{ll} are the estimated parameter values.

A.3.2 Active Monetary Policy Following the ARPA Shock

In this counterfactual economy, once agents' beliefs change following the ARPA shock, the central bank lifts from the ZLB and moves to active monetary policy. However, beliefs are assumed to be unchanged, meaning that agents still expect that a change to a Fiscally-led policy mix is now more likely. We further assume that the response of the central bank to the increase in inflation comes as a surprise. This assumption allows us to simulate the economy with the same starting point observed in the data as 2021:Q1. If agents could anticipate this counterfactual behavior of the central bank, the pre-shock period would also be affected.

These assumptions boil down to the following transition matrix:

$$H^{cc} = \begin{bmatrix} p_{bb}H^{p} & (1-p_{ll})\begin{bmatrix} PZ_M M & PZ_F M & PZ_C M \\ 1-PZ_M M & 1-PZ_F M & 1-PZ_C M \end{bmatrix} \\ (1-p_{bb})\begin{bmatrix} .5 & .5 & .0 \\ .5 & .5 & 0 \\ 0 & 0 & 0 \end{bmatrix} & p_{ll}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \end{bmatrix}.$$

where Z_C denotes the counterfactual regime in which monetary policy coincides with the monetary-led Taylor rule, but fiscal policy does not change with respect to the ZLB regimes.Furthermore, $pZ_CM = pZ_FM$, implying that agents still regard the possibility of a movement to a fiscally-led policy mix quite likely.

B. Estimation of the DSGE Model

This appendix describes the dataset and provides details for the benchmark model.

B.1 Dataset

Real GDP, the GDP deflator, and the series for fiscal variables are obtained from the Bureau of Economic Analysis. The fiscal series are built using NIPA Table 3.2. (Federal Government Current Receipts and Expenditures). Government purchases (G) are computed as the sum of consumption expenditure (L24), gross government investment (L44), net purchases of nonproduced assets (L46), minus consumption of fixed capital (L47). Transfers are given by the sum of net current transfer payments (L25-L18), subsidies (L35), and net capital transfers (L45-L41). Tax revenues are given by the difference between current receipts (L40) and current transfer receipts (L18). All variables are then expressed as a fraction of GDP. Government purchases are transformed in a way to obtain the variable g_t defined in the model. The series for the federal funds rate is obtained averaging monthly figures downloaded from the St. Louis Fed website.

B.2 MCMC Algorithm and Convergence

Draws from the posterior are obtained using a standard Metropolis-Hastings algorithm initialized around the posterior mode. When working with models whose posterior distribution is very complicated in shape it is very important to find the posterior mode. In a MS-DSGE model, this search can turn out to be an extremely time-consuming task, but it is a necessary step to reduce the risk of the algorithm getting stuck in a local peak. Here are the key steps of the Metropolis-Hastings algorithm:

- Step 1: Draw a new set of parameters from the proposal distribution: $\vartheta \sim \mathrm{N}\left(\theta_{n-1,}c\overline{\Sigma}\right)$.

- Step 2: Compute $\alpha\ (\theta^{m}; \vartheta) = \min\{p\ (\vartheta)/p(\theta^{m-1)),1}\}$ where $p\ (\theta)$ is the posterior evaluated at θ.

- Step 3: Accept the new parameter and set $\theta^{m} = \vartheta$ if $u < \alpha\ (\theta^{m}; \vartheta)$ where $u \sim U\ ([0, 1])$, otherwise set $\theta^{m} = \theta^{m-1}$.

- Step 4: If $m \leq n^{sim,}$ stop. Otherwise, go back to Step 1.

The diagonal matrix $\overline{\Sigma}$ is obtained rescaling the posterior mode parameter values with the parameter c set to obtain an acceptance rate of around 35 percent. We verify convergence with the Brooks-Gelman-Rubin potential reduction scale factor using within and between variances based on three multiple chains used in the paper. The three chains consist of 2,100,000 draws each (1 in every 3,000 draws is saved).

B.3 Determining the Time of the Change in Beliefs at the ZLB

For tractability, we fix the sequence of Markov-switching regimes to estimate the model. The chosen regime sequence is largely based on results obtained in previous work (Bianchi and Melosi, 2017). For the most recent period, we allow for a regime change while the economy is still at the ZLB. This regime change involves agents' beliefs as opposed to a change in the policy mix. This change in beliefs coincide with the first quarter of 2021, in the aftermath of the

Table 4

Change in beliefs at the ZLB	Likelihood	Posterior
2020:Q2	7,328.6	7,386.5
2021:Q1	7,330.5	7,388.5

The table shows the value of the posterior and the likelihood at the posterior mode under two alternative assumptions about when agents' beliefs about the future policy mix changed. The results associated with the highest posterior mode are in bold.

ARPA shock. We verified that the model returns a worse fit when the change in beliefs is assumed to coincide with the beginning of the second ZLB episode.

C. The Model with the Inconsistent Fiscal Framework Regime

We study a simplified version of the estimated model in which the fiscal framework may be perceived to be inconsistent with debt stabilization. We achieve this by introducing an additional regime, which we call the Inconsistent fiscal framework regime. To simplify the model, we assume that (*i*) the fiscally-led regime is an absorbing state, (*ii*) discrete demand shocks are shut down ($\overline{d}_{\xi_t^d}$), and (*iii*) the ZLB constraint never binds. In the baseline case, the regime with inconsistent fiscal framework is assumed to be followed by the fiscally-led policy mix. The new regime is introduced to isolate the consequences of adopting a resolute anti-inflation monetary policy stance without the necessary fiscal backing. Hence, in that regime, we assume that the monetary authority responds to inflation as in the monetary-led regime (see Table 2) but does not respond to output and the last period's interest rate. The quarterly probability that agents start seeing the fiscal framework as inconsistent is 1 percent. The Inconsistent fiscal framework regime is assumed to have an expected duration of twenty months. The probability of moving from the monetary-led policy mix to the fiscally-led policy mix is the same as the estimated one (0.0008). The fiscal authority is committed to respond to the debt-to-output ratio only in the monetary-led regime. The monetary and fiscal policy rules under the monetary-led and fiscally-led policy regimes are identical to the posterior mode–shown in Table 2. The model parameters that are not affected by changes in the monetary and fiscal policy mix are also calibrated to the posterior mode.

Assuming that regimes are ordered as follows (1) monetary-led, (2) fiscally-led, and (3) inconsistent fiscal framework, the transition matrix H reads as follows:

$$H = \begin{bmatrix} pMC^{\tilde{H}^{p}} & (1-pcc)\begin{bmatrix} 1-p_{CF} \\ p_{CF} \end{bmatrix} \\ (1-p_{mc}) & P_{CC} \end{bmatrix} = \begin{bmatrix} 0.9892 & 0 & 0 \\ 0.0008 & 1.0000 & 0.1500 \\ 0.0100 & 0 & 0.8500 \end{bmatrix},$$

where P_{MC} denotes the quarterly probability that the fiscal framework remains consistent (0.99), P_{CC} stands for the probability that the Incompatible fiscal framework regime will stay in place in the next quarter (0.85), and p_{CF} denotes the quarterly probability that the Incompatible fiscal framework regime will be followed by the Fiscally-led regime, which is one in the baseline case. In constructing Chart 6 in the paper, we progressively lower this parameter to show that fiscal stagflation dissipates as the probability that the Incompatible fiscal framework regime will be followed by the fiscally-led regime is reduced. $\tilde{H}^{p}$ is the transition matrix governing the evolution of the monetary-led and fiscally-led policy mixes. That matrix is calibrated using the estimated transition of the matrix H^{p} (Table 2) defined in the main text after imposing the restriction that the fiscally-led regime is an absorbing state; that is,

$$\tilde{H}^{P} = \begin{bmatrix} PMM & 0 \\ 1-pMM & 1 \end{bmatrix} = \begin{bmatrix} 0.9992 & 0 \\ 0.0008 & 1 \end{bmatrix}.$$

Endnotes

[1]The CBO bases its projections on the assumption that in 2023 inflationary pressures will subside. Furthermore,the CBO warns that, if lawmakers amended current laws to maintain certain policies now in place, even larger increases in debt would ensue.

[2]In what follows, $\hat{x}_t$ denotes the percentage deviation of a detrended variable from its own steady state. For all the variables normalized with respect to GDP (debt, expenditure, and taxes) $\tilde{x}_t$ denotes a linear deviation, while for all the other variables $\tilde{x}_t$ denotes a percentage deviation.

[3]Our approach to modeling the ZLB differs from the conventional one, which implies $R_t = \max(0, R_t^*)$,where R_t^* is the interest rate implied by the Taylor rule. Our approach is computationally more tractable and allows us to focus on the consequences of changes in the policy mix and in beliefs about the *future* policy mix.

[4]We also considered a version of the model in which this change in beliefs at the ZLB occurs as soon as the economy encounters the ZLB for the second time, i.e. on 2020:Q1. However, this second version of the model returns a worse fit.

[5]The discussion here is simplified to the extent that the properties of one regime depend on the properties of the other regimes because agents take into account the possibility of regime changes. Furthermore, the model features feedback effects from the macroeconomy to the fiscal variables.

[6]The simulated series from the actual model are identical to the data used to estimate the model.

[7]In Section 4.3, we will consider the case in which tightening monetary policy works as a signaling device coordinating the beliefs of the private sector away from the Fiscally-led policy mix. In this exercise we abstract from this signaling channel, to focus on the effects of a monetary tightening unbacked by a strong fiscal commitment to stabilize government debt.

[8]They would not completely disappear because there is still a probability–albeit a modest one–to move to the fiscally-led policy mix from the monetary-led policy mix in every quarter. See the transition probabilities in Appendix C.

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