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The Dire Effects of the Lack of Monetary and Fiscal Coordination

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Abstract

What happens if the government's willingness to stabilize a large stock of debt is waning, while the central bank is adamant about preventing a rise in inflation? The large fiscal imbalance brings about inflationary pressures, triggering a monetary tightening, further debt accumulation, and additional inflationary pressure. Thus, the economy will go through a spiral of higher inflation, output contraction, and further debt accumulation. A coordinated commitment to inflate away the portion of debt resulting from a large recession leads to better macroeconomic outcomes by separating the issue of long-run fiscal sustainability from the need for short-run fiscal stabilization. This strategy can also be used to rule out episodes in which the central bank becomes constrained by the zero lower bound.

JEL Codes: E31, E52, E62, E63, D83

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"This is the United States government. First of all, you never have to default because you print the money, I hate to tell you, OK?"

(Donald Trump, May 10, 2016, on CNN)

"Moreover, uncertainty regarding fiscal and other economic policies has increased. [...] Participants noted that, in the circumstances of heightened uncertainty, it was especially important that the Committee continue to underscore in its communications that monetary policy would continue to be set to promote attainment of the Committee's statutory objectives of maximum employment and price stability."

(Minutes of the Federal Open Market Committee's meeting of December 13-14, 2016)

1 Introduction

One of the main legacies of the Great Recession is the severe fiscal imbalance that is characterizing many advanced economies. Some scholars have argued that fiscal imbalances can affect both inflation and real activity, even in the absence of plain default on government debt (Leeper 1991; Sims 1994; Woodford 1994.) Whether these effects materialize or not largely depends on expectations about future monetary and fiscal policies. One possibility is that the government is expected to be able to take the adequate corrective fiscal measures to stabilize the dynamics of debt, while the central bank is credibly committed to keeping inflation stable.[1] In this case, the macroeconomic implications of fiscal imbalances have been shown to be quite tenuous. Alternatively, the private sector may find it implausible that the large debt can be stabilized by just future economic growth and fiscal adjustments. When this type of belief starts materializing, inflation expectations tend to rise because the private sector expects that inflation will ultimately stabilize the fiscal imbalance. If the central bank is expected to accommodate this upsurge in inflation expectations, the real interest rate falls, causing a temporary economic boom and a reduction in the fiscal burden.[2] As the first quotation illustrates, this interdependence between monetary and fiscal policies is well understood by policymakers, even if it is not always so bluntly spelled out.

In both cases that we have outlined, the private sector believes that the two authorities are working together to implement policies that are coordinated to attain an appropriate inflation rate. Nevertheless, a third scenario in which the private sector expects that policymakers will follow non-coordinated policies could also arise. Specifically, the fiscal authority keeps postponing indefinitely the necessary fiscal adjustments, while the monetary authority insists

[1] This policy mix is also called active monetary/passive fiscal policy mix.

[2] This policy mix is also called passive monetary/active fiscal policy mix.

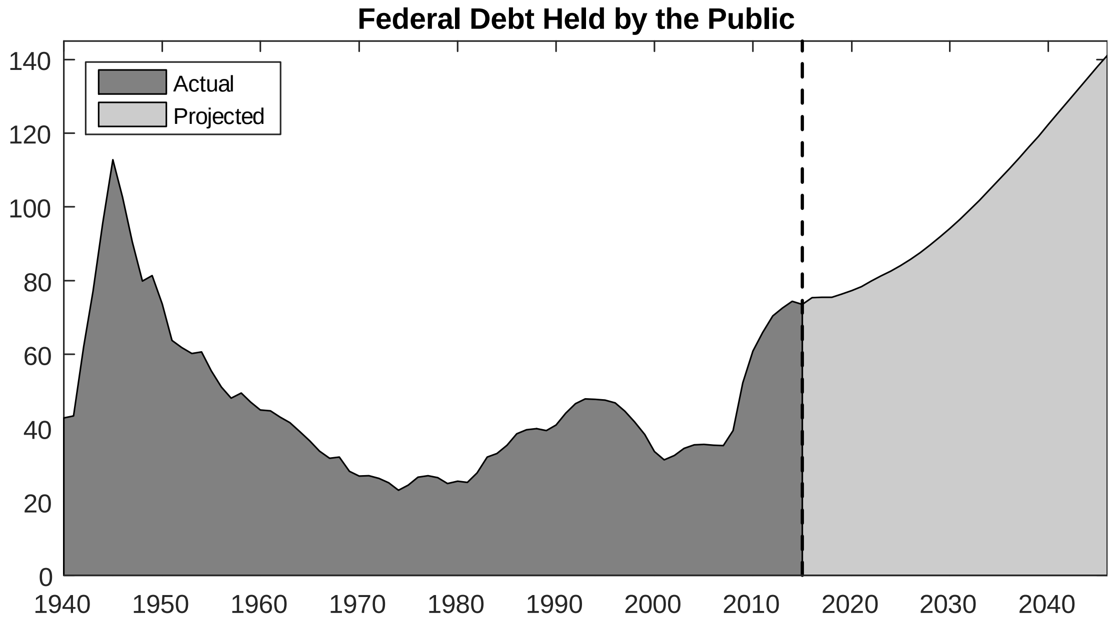

Figure 1: Debt is reported in percentage of GDP. Data from 2016 on are projected (light gray). Vertical dashed line marks fiscal year 2016. Source: Congressional Budget Office (2016).

that inflation stability will be preserved, remaining credibly committed to raise interest rates to combat inflation.[3] This policy mix is not coordinated, reflecting a disagreement between the two authorities on whether inflation should or should not be used to stabilize debt. This third scenario is still not fully understood. In this paper, we investigate the macroeconomic consequences of the lack of coordination between the monetary and fiscal authorities when there are large fiscal imbalances.

There are several reasons that make the lack of monetary and fiscal policy coordination particularly relevant. Currently, the U.S. public debt is on an unstable path. Figure 1 shows the projected dynamics of the federal debt as a percentage share of gross domestic product (GDP) under current law by the Congressional Budget Office (CBO) as of August 2016.[4] This picture strongly suggests that fiscal sustainability is far from being accomplished. Population aging and lower expected potential growth contribute to this gloomy outlook. Furthermore, U.S. debt is at its highest level since the beginning of the Korean War in 1950, suggesting that economic growth alone is unlikely to be enough to guarantee its sustainability without fiscal adjustments. As of now, no plan has been announced to reduce this severe fiscal imbalance. Given the explosive dynamics of U.S. debt, delaying fiscal consolidation will call for more

[3]This situation occurs when both the monetary and fiscal authorities engage in active policies.

[4]Figure 1 is a projection based on current legislation and on assumptions about future GDP growth, future interest payments on the federal debt, and demographic factors. This graph is not a forecast in that it does not reflect any assumption about when inflation and future primary government's surpluses will rise to stabilize the explosive fiscal imbalance projected by the CBO. The purpose of this paper is to explore the consequences of a policy conflict about the role of inflation in stabilizing debt.

sizable corrective measures up to the point where the private sector could become skeptical that such massive adjustments can be realistically implemented. Similarly, uncertainty about the potential growth rate of the U.S. economy after the Great Recession compounds the problem by making it harder to precisely quantify how large the corrective measures have to be.[5] If the U.S. government overestimates the potential economic growth rate, the fiscal adjustment alone may be considered insufficient by the public, calling for an increase in inflation accommodated by the Federal Reserve. That said, as the second quotation at the beginning suggests, the Federal Reserve seems committed not to give up on inflation stabilization, especially in situations of high uncertainty about what the fiscal authority is expected to do.

We first introduce a simple frictionless Fisherian model to review the role of monetary and fiscal policy coordination in determining inflation and inflation expectations. When this coordination entails that the fiscal authority disregards the level of government debt and the monetary authority de-emphasizes inflation stabilization, inflation expectations adjust to ensure that public debt is on a stable path. This simple model allows us to derive a closed-form analytical relationship between government debt and inflation expectations. Furthermore, this simple model proves to be useful in highlighting the key mechanisms at play when policymakers temporarily fail to coordinate. We show that if the fiscal authority withdraws its backing from the monetary authority by disregarding the level of public debt, every attempt at fighting inflation by the central bank ends up generating even larger fiscal imbalances, which, in turn, heighten the path of inflation. This result suggests that the monetary authority cannot control inflation if the fiscal authority is not credibly committed to making the necessary fiscal adjustments. Indeed, without a credible commitment to provide fiscal backing, any attempt by the central bank to control inflation is not only ineffective, but also counterproductive, leading to even higher inflation and an economic slowdown.

We then build a more elaborate model with nominal rigidities by extending the basic new-Keynesian framework to include a fiscal rule, policy uncertainty, and the possibility of discrete negative demand shocks that occasionally trigger large recessions and debt accumulation. We use this model to show that the lack of policy coordination can be highly detrimental. For instance, if agents expect that the fiscal authority will disregard the level of debt but the monetary authority will insist that inflation will not be allowed to rise, the economy can go through a spiral of lower output, higher inflation, and higher debt. When such an institutional conflict emerges, agents expect that inflation will eventually increase because of the rising fiscal imbalances. The central bank raises the interest rate to keep inflation at bay. However, this action causes the fiscal burden to become larger, inducing agents to expect even higher inflation.

[5] A recent article in the *New York Times* argues that President Donald Trump and the Federal Reserve have different view about the potential growth rate for the U.S. economy. See Appelbaum (2017). The Federal Reserve has continuously revised down its expectations for future growth since the end of the Great Recession (Leubsdorf 2016), highlighting the high uncertainty about the long-run growth of the U.S. economy.

In this case, hawkish monetary policy not only is unable to keep inflation low, but also has the perverse effect of significantly depressing economic activity. When this scenario materializes, changes in agents' beliefs about the resolution of the conflict represent an additional source of volatility.

These results should also make apparent why the lack of policy coordination has not been extensively studied in the context of general equilibrium models such as the one presented in this paper. As we have explained, a lack of coordination may lead to explosive dynamics for inflation, output, and debt. While explosive dynamics are in principle compatible with the solution of general equilibrium models, non-stationary solutions are generally ruled out when studying models approximated around a steady state. Specifically, the policy combination that we are interested in would lead to non-existence of stationary solutions if we were to consider a model without policy changes, in which the explosive dynamics would persist indefinitely (see Leeper 1991.) In this paper we make progress on this issue by introducing the possibility of changes in the policy mix and leveraging the recent advancements in the literature on solution methods for rational expectation models with parameter instability. These new solution methods allow for the possibility of *temporarily* explosive dynamics as long as the system as a whole remains stationary. This requires checking the frequency with which such explosive regimes manifest themselves. We elaborate more on this point later in the paper.

We then devote the last part of the paper to showing that the adverse consequences of the institutional conflict can be avoided if policymakers accept to inflate away just the portion of debt accumulated during the large contraction. In this scenario, policymakers concede that the post-recession debt is likely to be too large to be stabilized by fiscal adjustments alone and they are prepared to accept just enough inflation to stabilize the portion of debt resulting from the large recession itself. Such policy has the important feature of separating the problem of long-run fiscal sustainability from the need for stabilization policies in the aftermath of a large contraction. We find that this strategy raises short-term inflation expectations and, hence, mitigates the recession by lowering the real interest rate. Since the recession is attenuated, public debt rises only moderately and so does inflation given that only a small fiscal imbalance needs to be stabilized. Given that the policy clearly separates long-run fiscal sustainability from short-run fiscal interventions, the pre-existing fiscal burden does not contribute to create long-run inflationary pressures and macroeconomic instability. Finally, once the initial contractionary shock is fully reabsorbed, the economy naturally reverts to the pre-crisis policies and macroeconomic outcomes. As a methodological contribution, we show how to model this type of coordinated strategy based on endogenous targets in dynamic general equilibrium models.

If followed systematically, this strategy is shown to be particularly useful when large deflationary shocks cause the nominal interest rate to hit its lower bound. By promising to inflate away the debt resulting from exceptionally large recessions, the proposed strategy works like an automatic stabilizer that raises inflation expectations exactly when monetary policy would otherwise become constrained by the zero lower bound. In this respect, our work is related to Woodford (2003) and Benhabib, Schmitt-Grohe and Uribe (2002) who show that liquidity traps can be made fiscally unsustainable. Furthermore, the coordinated strategy that we propose shares some features with the policy interventions that Chris Sims has advocated at the 2016 Jackson Hole meeting to replace ineffective monetary policy at the zero lower bound (Sims 2016). Sims calls 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." In fact, our coordinated strategy can be implemented by explicitly announcing that a projected portion of the debt-to-GDP ratio will be repaid through fiscal adjustments. No fiscal plans are instead provided to stabilize the amount of the debt-to-GDP ratio that exceeds that projection.

This paper belongs to a research agenda that aims to understand the role of fiscal policy in explaining changes in the reduced form properties of the macroeconomy. Bianchi and Ilut (2017) show that the Great Inflation of the 1970s can be explained in light of a fiscally-led regime. Bianchi and Melosi (2013) introduce the notion of *dormant shocks* that are fiscal shocks that raise inflation many years after they occurred. Bianchi and Melosi (2017) show that policy uncertainty about the way debt will be stabilized empirically accounts for the lack of deflation in the United States during the Great Recession. This paper differs from the aforementioned contributions in several ways. We focus on the perils related to a lack of coordination between the monetary and fiscal authorities when there is a large fiscal imbalance. We emphasize that the *possibility* of this type of institutional conflicts now or in the future can challenge the central bank's ability to keep inflation stable and represents a serious drag on economy activity. Furthermore, we show how policymakers can spark an increase in inflation expectations and stimulate economic activity by using a coordinated policy strategy. Finally, we explain how to build shock-specific rules, as a technical contribution. This method is general and it is of independent interest.

Our work is related to the vast literature that studies the interaction between monetary and fiscal policies in determining inflation dynamics (Sargent and Wallace 1981; Leeper 1991; Sims 1994; Woodford 1994, 1995, 2001; Cochrane 1998, 2001; Schmitt-Grohe and Uribe 2000; Bassetto 2002; Eggertsson, 2008; Reis 2016; among many others). Most of this literature is focused on the US economy, but Jarociński and Maćkowiak (2017) study the implications of different monetary and fiscal policy coordination schemes for achieving determinacy of a unique rational expectations equilibrium in the model that captures the salient features of the Euro Area. Our focus is on the US economy, but we believe that some of our results are also relevant for other countries. Del Negro and Sims (2015) argue that when the central bank's balance sheet is large and composed of long-duration nominal assets, fiscal support to the balance sheet would be appropriate to allow the monetary authority to control inflation. This sort of support is different from what we call fiscal backing in this paper, which is required for keeping inflation stable regardless of the level of the central bank's balance sheet. Davig, Leeper, and Walker (2010) study how to resolve the "unfounded liabilities problem," which stems from the unsustainable exponential growth in the Social Security, Medicare, and Medicaid spending with no plan to finance it. They provide a coordinated resolution of this long-term fiscal imbalance, which requires specifying a probability distribution for monetary and fiscal behavior over a long time span. The emphasis in our paper is instead on the lack of coordination between the monetary and fiscal authorities and on how to reconcile the benefits of short-run stabilization policies with the need for long-run fiscal sustainability. While Fernandez-Villaverde et al. (2015) study the macroeconomic effects of changes in the magnitude of fiscal *shocks*, we focus on the effects of uncertainty about the future monetary and fiscal policy mix.

The paper is organized as follows. In Section 2, we introduce a simple Fisherian model to study the implications of monetary and fiscal policy coordination for price dynamics. The simplicity of this model and the absence of policy uncertainty allow us to derive all results analytically. The New Keynesian model with policy uncertainty is introduced in Section 3. In Section 4, we calibrate the New Keynesian model and simulate the effects of expecting a lack of coordination between the monetary and fiscal authority. The coordinated strategy and its implications are studied in Section 5. In Section 6, we present our conclusions.

2 A Simple Model of Inflation Determination

We construct a simple model to lay the groundwork for how monetary and fiscal policies jointly determine equilibrium dynamics for inflation. This model draws from previous studies by Leeper (1991); Leeper and Walker (2013); Sims (1994); Woodford (2001).

2.1 Deterministic economy

Let us first consider a deterministic economy populated by infinitely many households and a government. An infinitely lived representative household has concave and twice continuously differentiable preferences over non-storable consumption goods. The household is endowed with a constant quantity of non-storable goods Y and derives utility $U(\cdot)$ from consuming these goods C_t. The government issues one-period debt (liabilities) to households that can trade them for one unit of the goods at price P_t. Government liabilities have purchase price $Q_t < 1$. The government raises real net surpluses τ_t (net to the returns paid on the debt outstanding) to repay its maturing liabilities. In symbols, the government budget constraint reads as follows:

$$P_t \tau_t + Q_t B_t = B_{t-1}. \tag{1}$$

Market clearing requires $C_t = Y$ in every period and the households' Euler equation implies the Fisher equation: $Q_t^{-1} = \beta^{-1} P_{t+1}/P_t$, where $\beta < 1$ is the households' discount factor.

The two-period case. Let us assume that the households live only two periods, implying that the government cannot sell new debt in the final period, $B_2 = 0$. For a given time sequence of net real surpluses $\{\tau_1, \tau_2\}$ and nominal debts (B_0, B_1), the government's budget constraint pins down the price level:[6]

$$P_1 = \frac{-Q_1 B_1 + B_0}{\tau_1}, \tag{2}$$

$$P_2 = \frac{B_1}{\tau_2}. \tag{3}$$

Thus, for a given sequence of primary surpluses/deficits, the larger the stock of debt at the end of the previous period, the higher the price level in a period. The final period's budget constraint is particularly illustrative. This equation illustrates that for a given primary surplus that the government is able to raise in the final period, the larger the stock of debt outstanding at the beginning of the period, the higher the price of consumption goods (relative to government liabilities/bonds) in that period, P_2. The government is issuing too much debt with respect to its ability to raise real resources to repay it. Thus, the relative price of the less abundant consumption goods to the abundant government debt has to go up to clear the market.

The infinite-period case. We can use the Fisher equation to get rid of bond price Q_t in the government budget constraint. We obtain

$$P_t = \frac{\beta P_{t-1} B_{t-1}}{B_{t-2} - P_{t-1} \tau_{t-1}}. \tag{4}$$

For a given a sequence of debts and real primary surpluses $\{B_t, \tau_t\}$, the flow government budget constraint equation (4) determines the equilibrium dynamics of the price level conditional on the initial price level P_1. If one knew this initial price level P_1, one could use these equations to pin down the equilibrium sequence of the price levels $\{P_2, P_3, ...\}$. To determine the price level we need to take an extra step. The transversality condition for government bonds, which ensures that consumers willingly hold debt, requires the present value of debt

[6] Note that the price of government bonds Q_1 is determined by the price level in the two periods via the Fisher equation.

to equal zero.[7] Imposing this condition on government behavior results in the intertemporal budget constraint:

$$\frac{B_0}{P_1} = \sum_{s=0}^{\infty} \beta^s \tau_s. \tag{5}$$

A higher initial debt B_0 or a stream of smaller real primary surpluses $\{\tau_t\}$ raises the price level. The real value of debt (i.e., its value in terms of consumption goods) is given by the discounted stream of future primary real surpluses that the government is able to generate. A higher initial debt B_0 must be backed by future higher real surpluses. Otherwise, consumption goods are relatively less abundant than government debt and, hence, the price level P_1 has to go up to clear the market where goods and government liabilities are traded.

Notice that as long as the real return to government debt is constant (or exogenous), the link between inflation and fiscal imbalances stems from the intertemporal budget constraint. The other model equations do not interfere with this mechanism.

2.2 A stochastic environment with monetary and fiscal policy

We now move to introduce a richer setting in order to understand how monetary and fiscal policies jointly determine the price level. Let us assume that the discount factor is affected by an exogenous process ϵ_t^d that follows an independent and identically distributed (i.i.d.) zero-mean exogenous process: $\mathbb{E}\left(\epsilon_t^d\right) = 0$. The problem for the representative household reads as follows

$$\max_{C_t, B_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \exp\left(\epsilon_t^d\right) U\left(C_t\right),$$

subject to the flow budget constraint $P_t C_t + Q_t B_t + P_t \tau_t = P_t Y + B_{t-1}$ with $Q_t < 1$. Solving the household's problem yields the Fisher equation:

$$R_t = \mathbb{E}_t \left(\beta^{-1} \frac{\exp \epsilon_t^d}{\exp \epsilon_{t+1}^d} \Pi_{t+1} \right). \tag{6}$$

Furthermore, we introduce a monetary authority that controls the nominal interest rate on government bond $R_t = Q_t^{-1}$ by using the rule

$$\frac{R_t}{R_*} = \left(\frac{\Pi_t}{\Pi_*} \right)^{\psi}, \tag{7}$$

[7] The transversality condition for government bonds is

$$\lim_{t \to \infty} \beta^{t+1} \frac{B_t}{P_{t+1}} = 0.$$

We rule out hyperinflation and hyperdeflation. Such price processes would imply explosive real balance and real debt paths that violate transversality.

where the starred variables denote the value of the variables at the deterministic steady state. This equation describes monetary policy and ties the changes in the nominal rate to inflation deviations from its steady-state value. We refer to equations (6) and (7) as the monetary block of this simple economy.

The government budget constraint equation (1) can be equivalently rewritten as

$$\tau_t + R_t^{-1} b_t = \frac{b_{t-1}}{\Pi_t}, \tag{8}$$

where $b_t \equiv B_t/P_t$ denotes the real value of the government liabilities at time t.

The government's ability or willingness to raise primary real surpluses τ_t across periods is captured by the following fiscal rule (expressed in real terms):

$$\tau_t - \tau_* = \delta\left(b_{t-1} - b_*\right) + \epsilon_t^{\tau}, \tag{9}$$

where ϵ_t^{τ} follows an i.i.d. zero-mean exogenous process: $\mathbb{E}\left(\epsilon_t^{\tau}\right) = 0$. Note that according to this simple fiscal rule, the government adjusts primary surpluses to respond to the previous period's real stock of debt. We refer to equations (8) and (9) as the fiscal block of the economy.

We linearized the model equations around the steady-state equilibrium. The Fisher equation (6) and the monetary rule (7) can be expressed as follows:

$$\tilde{R}_t = \epsilon_t^d + \mathbb{E}_t \tilde{\pi}_{t+1}, \tag{10}$$

$$\tilde{R}_t = \psi \tilde{\pi}_t. \tag{11}$$

The two equations that make up the fiscal block can be written as follows:

$$\hat{\tau}_t + \hat{b}_t = \beta^{-1}\hat{b}_{t-1} + b_* \tilde{R}_t - \beta^{-1} b_* \tilde{\pi}_t, \tag{12}$$

$$\hat{\tau}_t = \delta \hat{b}_{t-1} + \epsilon_t^{\tau}, \tag{13}$$

where we use $\widetilde{x}$ to denote the log-deviation of a variable x from its steady-state value, whereas we use $\widehat{x}$ to denote its linear deviation from the steady state. Note that we linearize the primary surplus τ_t and the real value of debt b_t around the steady state as these variables can potentially be negative. In what follows, we always assume that the steady-state real value of debt is positive ($b_* > 0$).

Equation (12) highlights the *two key links* between monetary and fiscal policy. The first link is captured by the interest rate appearing on the right-hand side of equation (12): A monetary tightening brings about fiscal imbalances. The second link is captured by the inflation term appearing on the right-hand side of equation (12): A fall (rise) in inflation raises (reduces) the real burden of government debt. These two links make monetary policy and fiscal policy interdependent. Notice that both inflation $\tilde{\pi}_t$ and the nominal interest rate $\tilde{R}_t$ are multiplied by the magnitude of the steady-state real value of debt b_* in equation (12). Therefore, the larger the average value of fiscal imbalances, the stronger the degree of interdependence between monetary and fiscal policy. As argued in the introduction, policymakers are aware of this interdependence. As we shall see, these links play a central role in determining whether there exists a unique stable rational expectations equilibrium (determinacy), or infinitely many of them (indeterminacy), or none of them in our simple model.

Plugging the monetary rule (11) into the Fisher equation (10) yields the following equation:

$$\psi\tilde{\pi}_t = \epsilon_t^d + \mathbb{E}_t\tilde{\pi}_{t+1}, \tag{14}$$

which we will refer to as the *monetary-block equation.* Furthermore, combining equation (12) with the fiscal rule (13) and the monetary rule (11) yields

$$\hat{b}_t = \left[\beta^{-1} - \delta\right]\hat{b}_{t-1} + b_*\left(\psi - \beta^{-1}\right)\tilde{\pi}_t - \epsilon_t^\tau, \tag{15}$$

which we will refer to as the *fiscal-block equation.* Notice that whether higher inflation reduces or increases the real stock of debt primarily depends on how strongly the monetary authority responds to inflation (ψ). Inflation raises the real value of debt if the central bank aggressively raises the interest rate in response to inflation deviations from the target ($\psi > \beta^{-1}$). This rise in the interest rate ends up increasing the fiscal burden by making its serving cost larger via the first link that we discussed when presenting equation (12). This is an important point to which we will return.

Defining the rational expectations errors $\eta_t \equiv \tilde{\pi}_t - \mathbb{E}_{t-1}\tilde{\pi}_t$ and replacing $\tilde{\pi}_t$ with $\mathbb{E}_{t-1}\tilde{\pi}_t + \eta_t$ in both equations (14)-(15) yield the following system of linear equations:

$$\begin{aligned}\begin{bmatrix}\mathbb{E}_t\tilde{\pi}_{t+1}\\ \hat{b}_t\end{bmatrix} &= \begin{bmatrix}\psi & 0\\ b_*\left(\psi-\beta^{-1}\right) & \beta^{-1}-\delta\end{bmatrix}\begin{bmatrix}\mathbb{E}_{t-1}\tilde{\pi}_t\\ \hat{b}_{t-1}\end{bmatrix}\\ &\quad+\begin{bmatrix}-1 & 0\\ 0 & -1\end{bmatrix}\begin{bmatrix}\epsilon_t^d\\ \epsilon_t^\tau\end{bmatrix}+\begin{bmatrix}\psi\\ b_*\left(\psi-\beta^{-1}\right)\end{bmatrix}\eta_t.\end{aligned} \tag{16}$$

This system has two eigenvalues: ψ and $\beta^{-1} - \delta$. There is only one non-predetermined variable ($\mathbb{E}_t\tilde{\pi}_{t+1}$). Since the second eigenvalue lies outside the unit circle if $\delta < \beta^{-1} - 1$, our exercise confirms the partition of the parameter space introduced by Leeper (1991): The two policy parameters ψ and δ determine these eigenvalues and, hence, the existence and uniqueness of a stable rational expectations equilibrium for this Fisherian economy. Let us review the four possible cases.

Monetary-Led Policy Mix. Suppose that the monetary authority conducts an *active monetary policy* by aggressively adjusting the interest rate to stabilize inflation. This policy is captured by setting $\psi > 1$ in the monetary policy rule (7). Furthermore, let us assume that the government is committed to generate enough primary surpluses so as to stabilize the real stock of debt $\hat{b}_t$. This goal is achieved by assuming that the fiscal authority adjusts primary surpluses to debt fluctuations in a way to guarantee that debt always remains on a stable path. More precisely, if the fiscal policy parameter δ is larger than $\beta^{-1} - 1$, then the root $(\beta^{-1} - \delta)$ in the fiscal-block equation (15) is lower than one, which implies stationary dynamics for the real value of debt $\hat{b}_t$. When policymakers follow this policy mix, there exists a unique stable rational expectations equilibrium.[8]

It should be noted that this kind of monetary and fiscal policy interactions leads policymakers to coordinate their policies in a *countercyclical* manner. As an inflationary shock (e.g., $\epsilon_t^d > 0$) hits the economy, the central bank aggressively raises the interest rate. This aggressive monetary contraction leads to an increase in the debt service costs ($\hat{\imath}_t$) - equation (15) - and hence to a fiscal imbalance. The fiscal rule implies that the fiscal authority raises taxes aggressively ($\delta > \beta^{-1} - 1$) to make sure that the higher real stock of debt will be reabsorbed. The opposite happens after a deflationary shock. We call this form of interaction *monetary-led policy mix* meaning that the monetary authority is the leading authority, while the fiscal authority accommodates monetary policy decisions by adjusting primary surpluses in a way to keep debt on a stable path.

In our simple setting it is possible to characterize analytically the unique rational expectations equilibrium. In this equilibrium, the law of motion for inflation is as follows:

$$\tilde{\pi}_t = \psi^{-1} \epsilon_t^d. \tag{17}$$

Combining this result with the fiscal-block equation (15) delivers the equilibrium law of motion of debt $\hat{b}_t$.

Equation (17) reveals an important property of this equilibrium: fiscal shocks ϵ_t^τ do not affect inflation; they only affect fiscal variables (i.e., debt and primary surpluses). Since the fiscal authority is committed to systematically adjusting the stream of primary surpluses to repay its debt, inflation is completely insulated from the fiscal block and fiscal imbalances are never relevant for inflation determination. We call this feature *Monetary and Fiscal Dichotomy*. Again, the Dichotomy requires to assume that (*i*) the central bank strives to stabilize inflation, (*ii*) the government is committed to raise taxes to stabilize debt, and (*iii*) agents believe that policymakers will carry out these policies in every state of the world.

[8] Active monetary policy induces an explosive root in the monetary-block equation. Since there is only one forward-looking variable, the Blanchard-Kahn conditions for determinacy are satisfied.

Fiscally-Led Policy Mix. Now suppose that the government is not committed to raise enough primary surpluses so as to guarantee fiscal sustainability. This scenario is captured by setting the fiscal policy parameter δ in the fiscal rule (9) strictly lower than the steady-state value of the net real rate $\left(\beta^{-1}-1\right)$. Furthermore, we assume that the monetary authority conducts a passive monetary policy by weakly adjusting the interest rate to stabilize inflation. This policy is captured by setting $\psi \leq 1$ in the monetary policy rule (7). Now the root $\left(\beta^{-1}-\delta\right)$ in the fiscal-block equation (15) is larger than one, which implies that the government is not taking the necessary fiscal adjustments to stabilize the debt. Therefore, when debt deviates from its value of steady state, agents want to sell government liabilities in exchange for consumption goods. They understand that the government will not repay debt with consumption goods. Consequently, the price of consumption goods must go up to clear the market.

However, for this scenario to be consistent with a stable equilibrium, the behavior of the central bank plays a key role. By responding to inflation less than one to one, the central bank accommodates the price adjustment that is necessary to stabilize the debt dynamics.[9] As a result, the dynamics of the forward-looking variable (i.e., inflation expectations) are pinned down by the need for making the real value of debt stationary. Hence, there exists a unique stable rational expectations equilibrium. In this simple framework, the relationship between inflation expectations and the deviations of debt from its steady state can be analytically characterized:[10]

$$\mathbb{E}_t \tilde{\pi}_{t+1} = \frac{1}{b_*}\left[1 - \frac{\delta}{\beta^{-1}-\psi}\right]\hat{b}_t. \tag{18}$$

This equation quantifies by how much inflation expectations have to adjust to keep the real value of debt on a stable path and to ensure the uniqueness of the stable rational expectations equilibria. Furthermore, this equation is quite revealing about the interplay between monetary and fiscal policies. The active fiscal authority can disregard the level of debt because the passive monetary authority allows inflation to rise to stabilize fluctuations in the real value of debt. We call this policy mix *fiscally-led policy mix*. Quite clearly, equation (18) breaks down the *Monetary and Fiscal Dichotomy.* Now inflation is no longer insulated from fiscal developments.

The rational expectation equilibrium (REE) can be characterized by plugging equation (18) into the monetary-block equation (14) to get rid of inflation expectations. We obtain

$$\psi \tilde{\pi}_t = \epsilon_t^d + \xi \hat{b}_t, \tag{19}$$

with $\xi \equiv \frac{1}{b_*}\left[1-\frac{\delta}{\beta^{-1}-\psi}\right]$ capturing the response of the expected inflation needed to stabilize the real stock of debt, as illustrated by equation (18). Combining equation (19) with the fiscal-

[9] In technical jargon, the passive monetary policy makes the monetary-block equation's root stable, and hence, the Blanchard-Kahn conditions for determinacy are satisfied.

[10] A detailed derivation of this equation is provided in Appendix A.

block equation (15) yields a system of linear equations that can be solved by simply inverting a 2×2 matrix. Some tedious but straightforward algebra allows us to characterize the unique REE solution under the PM/AF policy mix:[11]

$$\begin{bmatrix} \tilde{\pi}_t \\ \hat{b}_t \end{bmatrix} = \begin{bmatrix} 0 & \xi \\ 0 & \psi \end{bmatrix} \begin{bmatrix} \tilde{\pi}_{t-1} \\ \hat{b}_{t-1} \end{bmatrix} + \begin{bmatrix} \frac{1}{\beta^{-1}-\delta} & -\frac{\xi}{\beta^{-1}-\delta} \\ -\frac{b_*\left(\beta^{-1}-\psi\right)}{\beta^{-1}-\delta} & -\frac{\psi}{\beta^{-1}-\delta} \end{bmatrix} \begin{bmatrix} \epsilon_t^d \\ \epsilon_t^\tau \end{bmatrix} \tag{20}$$

Two features of the solution (20) are worthy emphasizing. First, as already noticed, inflation is generally not insulated from fiscal shocks ϵ_t^τ under this alternative policy mix. Second, the central bank's systematic response to inflation (ψ) induces the dynamics of debt and, hence, inflation to become persistent. This is strikingly different from the monetary-led case, in which inflation follows an i.i.d. process. Notice that this simple Fisherian model features only i.i.d. shocks. The persistent dynamics of inflation under the fiscally-led policy mix entirely stem from monetary contractions in response to inflation that occur so long as $\psi > 0$. These timid monetary contractions end up slowing down the inflation-driven reduction in the real value of debt and, in doing so, raise the amount of inflation that is necessary for stabilizing debt, everything else being equal.

Passive Monetary and Fiscal Policies. So far we have considered situations in which policies are coordinated, in the sense that they are conducive to a unique equilibrium. These situations always reflect an explicit or implicit agreement between the monetary and fiscal authorities about the appropriate path of inflation and debt in every state of the world. In what follows, we are going to consider the possibility of a lack of coordination between the two authorities. By this we mean a situation in which the two authorities follow policies that are not conducive to a unique path for inflation and the real value debt.

The first possibility we consider is that both authorities engage in passive policies. This means that the monetary authority disapplies the Taylor principle ($\psi \leq 1$) and the fiscal authority adjusts the stream of future primary surpluses to stabilize debt ($\delta \geq \beta^{-1} - 1$). This policy mix is not coordinated because monetary policy fails to anchor inflation expectations while fiscal policy does not require inflation to reabsorb fiscal imbalances, which are addressed by raising primary surpluses. As a result, inflation is indeterminate; that is, there exist infinitely many stable paths for inflation that are consistent with the concept of rational expectations equilibrium.

[11] A detailed derivation is in Appendix A.

2.3 Lack of Coordination and Policy Changes

Let us now consider the case that is the focus of this paper. Suppose that the central bank applies the Taylor principle ($\psi > 1$) and that the fiscal authority disregards the level of debt ($\delta < \beta^{-1} - 1$). In this case, monetary and fiscal policies are not coordinated in the sense that monetary and fiscal policies are not geared toward the determination of the inflation rate. Rather, the two policy authorities are in a sort of conflict to control inflation: the lack of response of the fiscal authority to the level of debt would call for debt stabilization *via* inflation, whereas the central bank adjusts the interest rate aggressively to prevent inflation from deviating from its steady-state (target) level. These two policies are clearly inconsistent. If this lack of coordination were to persist indefinitely, no stable rational expectations equilibrium would exist. However, this policy mix is still consistent with a stable equilibrium if it is not perceived to be permanent. In what follows, we use the simple Fisherian model to study the macroeconomic implications of a situation in which both monetary and fiscal authorities conduct active policies in a struggle to control inflation.

We assume that the economy is at its steady-state equilibrium when at time $t = 1$, it is hit by a positive discount factor shock, $\epsilon_t^d > 0$. At this point, the fiscal authority starts disregarding the level of debt $\left(\delta = \delta_A < \beta^{-1} - 1\right)$ while the monetary authority is conducting an active policy ($\psi = \psi_A > 1$). We can interpret this policy mix with both authorities active as a situation in which there is conflict over the inflation rate. On the one hand, the central bank wants to secure full control over inflation, preventing fiscal imbalances from having any effects on inflation dynamics. On the other hand, the fiscal authority wants the central bank to let inflation adjust so as to stabilize the real value debt.

We assume that one of the two authorities will eventually have to concede the control of inflation in period $t = 2$ and revert to the passive policy. We consider two cases: one in which the monetary authority wins ($\psi = \psi_A > 1$ and $\delta = \delta_P > \beta^{-1} - 1$ in period $t = 2$) and the other in which the fiscal authority eventually prevails ($\psi = \psi_P < 1$ and $\delta = \delta_A < \beta^{-1} - 1$ in period $t = 2$). To make our analysis as simple as possible, we assume that agents know with certainty what policy mix is adopted by policymakers at time $t = 1$ and in every subsequent period. Later on we will relax this assumption.

Case 1 Conflict and Monetary-Led Resolution In this case, the monetary authority is not adjusting its behavior in response to the fiscal authority's decision to withdraw its fiscal backing. In period $t = 2$, the fiscal authority will revert to passive fiscal policy. This case is illustrative of a situation in which agents expect that after the initial period of conflict with the fiscal authority, the central bank will succeed in securing fiscal backing, a necessary condition for controlling inflation.

At time $t = 1$, agents anticipate that policymakers will eventually coordinate their policies in line with the monetary-led policy mix and hence, at time $t = 2$ inflation will depend only on future shocks (see equation (17).) Since the discount factor shock is i.i.d., it follows that $\mathbb{E}_1 \tilde{\pi}_2 = 0$. Consequently, REE inflation at time 1 is given by $\tilde{\pi}_1 = \psi_A^{-1} \epsilon_1^d > 0$. Since debt is at steady state at time $t = 0$, plugging the equilibrium inflation rate at time $t = 1$ into the fiscal-block equation (15) yields the real value of debt at time $t = 1$, which is $\hat{b}_1 = b_* \left(1 - \beta^{-1} \psi_A^{-1}\right) \epsilon_1^d$.

Notice that fiscal authority's actions have no implications whatsoever for REE outcomes in period 1. Agents understand that the fiscal authority has withdrawn its backing only in the short term and soon it will revert to passive policy. Importantly, the fiscal imbalance that arises in period 1 does not influence the dynamics of inflation at time $t = 1$ and in any subsequent period. The stronger the monetary authority responds to inflation (i.e., the higher ψ_A), the lower inflation in period 1. A proactive central bank will induce a larger fiscal imbalance, requiring the government to raise taxes more aggressively from period 2 onward. When the central bank's response to inflation is sufficiently strong,$\psi_A > \beta^{-1} \approx 1$, debt responds positively to the inflationary shock. This result is due to the fiscal effects of the contractionary monetary policy conducted in the first period.

Case 2: Conflict and Fiscally-Led Resolution In this case, policymakers compete for to gain full control over how to determine the rate of inflation in the first period, but unlike in case 1, the fiscal authority is expected to emerge victorious. This case sheds light on what happens when the central bank fights back against the fiscal authority's decision to remove its support for stabilizing inflation, but agents expect that fiscal backing will not be secured in the long run.

At time $t = 1$, agents know that policymakers will coordinate over their policies in line with the Fiscally-led policy mix, and hence, they expect that $\mathbb{E}_1 \hat{\pi}_2 = \xi \hat{b}_1$. Consequently, at time $t = 1$, the REE inflation must satisfy

$$\tilde{\pi}_1 = \psi_A^{-1} \epsilon_1^d + \psi_A^{-1} \xi \hat{b}_1, \tag{21}$$

and the stock of debt

$$\hat{b}_1 = b_* \left(\psi_A - \beta^{-1}\right) \tilde{\pi}_1. \tag{22}$$

We can solve the linear system of equations (21)-(22) and obtain

$$\tilde{\pi}_1 = \frac{1}{\xi b_* \beta^{-1} + \psi_A \left(1 - \xi b_*\right)} \epsilon_1^d, \tag{23}$$

$$\hat{b}_1 = \frac{b_* \left(\psi_A - \beta^{-1}\right)}{\xi b_* \beta^{-1} + \psi_A \left(1 - \xi b_*\right)} \epsilon_1^d, \tag{24}$$

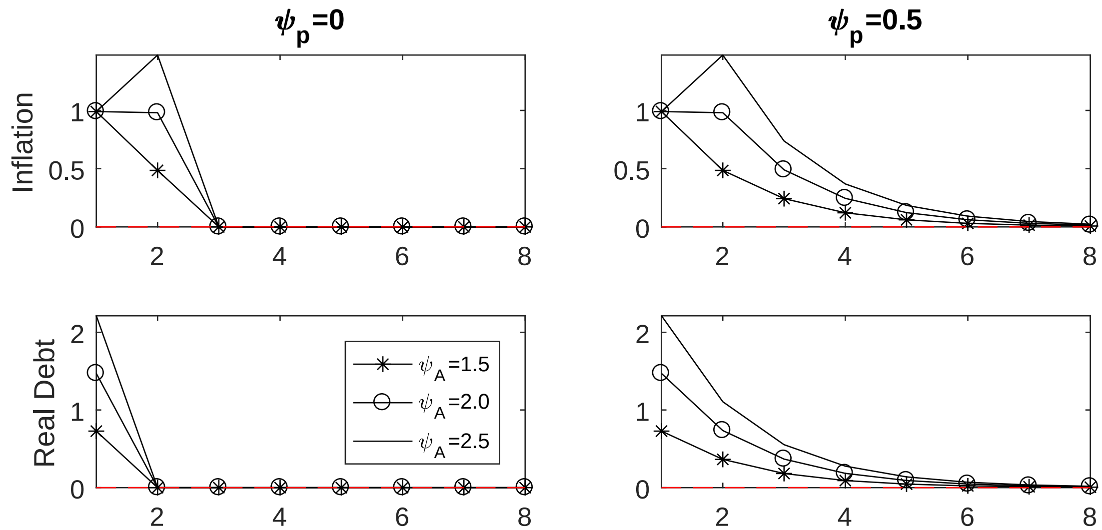

Figure 2: Conflict and Fiscally-led Resolution. Response of inflation and real debt to a discount factor shock for different central bank's responses to inflation in period 1 (different lines, see the legend) and from period 2 on (left panels $\psi_P = 0$ and right panels $\psi_P = 0.5$). Fiscal policy is active in all periods.

where $\xi \equiv \frac{1}{b_*}\left[1 - \frac{\delta_A}{\beta^{-1}-\psi_P}\right]$. As explained earlier, this term captures the response of inflation expectations that is necessary to stabilize the real stock of debt under the fiscally-led regime. This is a slightly more complex equilibrium to analyze than the previous ones because both authorities' actions play some role in shaping macroeconomic outcomes. In particular, unlike in case 1, fiscal policy can now affect inflation outcomes.

To simplify the analysis, let us assume that the government does not respond at all to debt; that is, $\delta_A = 0$. In this case, one can use the fact that $\xi b_* = 1$ to simplify the equilibrium equations (23)-(24). It then follows that inflation in period $t = 1$ is equal to $\beta\epsilon_1^d$ and is therefore totally unaffected by the monetary authority's actions. The important lesson is that independent of how strongly the central bank responds to the inflationary consequences of the discount factor shock during the conflict period ($t = 1$), inflation raises by the fixed amount $\beta\epsilon_t^d$.

Furthermore, it should be noted that debt also rises after the shock because $\psi_A > \beta^{-1}$.[12] As in case 1, this increase is due to the active monetary policy: to control inflation the monetary authority raises the interest rate, which in turn determines an increase in the service cost of debt. Even more importantly, a more aggressive monetary policy during the conflict period causes a higher fiscal imbalance, which in turn brings about a higher inflation rate in the following period. The more hawkish monetary policy is during the conflict period (i.e., the higher ψ_A), the larger the stock of debt at the end of period 1 because monetary tightening raises the interest paid on government debt.

[12] Note that if $\delta_A = 0$, then equation (24) implies that $\hat{b}_1 = \left[b_*\beta\left(\psi_A - \beta^{-1}\right)\right]\epsilon_1^d$.

If the central bank keeps responding to inflation in the post-conflict period ($\psi_P > 0$), then the hawkish policy strategy taken during the conflict period leads to a persistently higher path of inflation afterward. To see this, recall that from period $t = 2$ onward, the dynamics of inflation and debt are determined by equation (20). As explained earlier, the central bank's (timid) response to inflation ($\psi_P > 0$) during the post-conflict period induces persistent inflation dynamics.

Figure 2 illustrates these three results by showing the propagation of an inflationary shock for a set of central bank's responses to inflation in period 1, $\psi_A \in \{1.5, 2.0, 2.5\}$, and for a set of passive responses in subsequent periods, $\psi_P \in \{0, 0.5\}$ (left and right plots, respectively). We set the discount factor $\beta = 0.9901$. Furthermore, we assume that the steady-state debt-to-output ratio b_* is equal to 0.6 and the fiscal authority's active response (δ_A) is equal to 0. The key lesson that we learn from this simple model goes as follows: If agents expect that the central bank has lost fiscal backing permanently, hawkish monetary policy backfires. Hawkish monetary policy not only fails to lower inflation during the conflict period, but also ends up delivering higher inflation in the post-conflict periods because it generates an increase in the stock of debt that needs to be stabilized by inflation. As we shall see subsequently, this key lesson also applies to richer models.

3 A New-Keynesian Model

In this section we build a more elaborate model by extending the basic new-Keynesian model employed by Clarida, Galí, and Gertler (2000), Woodford (2003), Galí (2008), and Lubik and Schorfheide (2004) to include a fiscal rule, the possibility of occasionally large recession episodes that are associated with sizable debt accumulation, and uncertainty about the post-recession monetary and fiscal policy mix. The economy consists of a continuum of monopolistic firms, a representative household, and a monetary authority (or central bank). Some of the elements of the model are similar to the ones used in Bianchi and Melosi (2017). This will allow us to calibrate the model by borrowing some of the parameters estimated in that paper that featured changes in the monetary and fiscal policy mix and the possibility of large preference shocks. However, the key distinctive feature of the current model—the possibility of conflicts between policymakers—was not contemplated in that paper. The results that follow are robust to using simpler or richer versions of the New-Keynesian model. The key ingredients are the presence of nominal rigidities, to create a link between inflation and real activity, and changes in policymakers' behavior, to create the possibility of a conflict between the monetary and fiscal authorities.

3.1 The Model

Households. Households derive utility from consumption C_t and disutility from labor h_t:

$$\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t \exp\left(\zeta_d\right)\left[\log\left(C_t\right)-h_t\right]\right], \tag{25}$$

where β is the household's discount factor. The preference shock ζ_d is the sum of a continuous and discrete component: $\zeta_d = d_t + \overline{d}_{\xi_t^d}$. The continuous component d_t follows an AR(1) process: $d_t = \rho_d d_{t-1} + \sigma_d \epsilon_{d,t}$. The discrete component $\overline{d}_{\xi_t^d}$ can assume two values: high or low ($\overline{d}_h$ or $\overline{d}_l$). The variable ξ_t^d controls the regime in place and evolves according to the transition matrix H^d:

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

where $p_{ji} = P\left(\xi_{t+1}^d = j | \xi_t^d = i\right)$. Henceforth, when the the variable $\xi_t^d = h$ and, hence, $\overline{d}_{\xi_t^d} = \overline{d}_h$, we say that the economy is in the *high state of demand*. Conversely, when the the variable $\xi_t^d = l$ and, hence, $\overline{d}_{\xi_t^d} = \overline{d}_l$, we say that the economy is in the *low state of demand*.

This specification is in the spirit of Christiano et al. (2011). However, in the current setup shocks to preferences are assumed to be recurrent, and agents take into account that these episodes can lead to unusual responses from policymakers, as discussed later on. The household budget constraint is given by:

$$P_t C_t + P_t^m B_t^m + P_t^s B_t^s = P_t W_t h_t + B_{t-1}^s + \left(1+\rho P_t^m\right) B_{t-1}^m + P_t D_t - T_t + TR_t,$$

where D_t stands for real dividends paid by the firms, P_t is government of consumption good, h_t is hours, W_t is the real wage, T_t is taxes, and TR_t stands for transfers. Following Woodford (2001), we assume that 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 P_t^m. The former debt instrument satisfies $P_t^s = R_t^{-1}$. The latter debt instrument has the payment structure $\rho^{T-(t+1)}$ for $T > t$ and $0 < \rho < 1$. The asset can be interpreted as a portfolio of infinitely many bonds with an average maturity controlled by the parameter ρ. The value of such an instrument issued in period t in any future period $t+j$ is $P_{t+j}^{m-j} = \rho^j P_{t+j}^m$.

Firms. The representative firm j faces a downward-sloping demand curve with price elasticity $1/\upsilon$: $Y_t(j) = \left(P_t(j)/P_t\right)^{-1/\upsilon} Y_t$. Differentiated goods $Y_t(j)$ are aggregated into final goods Y_t through a standard CES aggregator function. Whenever a firm changes its price, it faces a quadratic adjustment cost:

$$AC_t(j) = .5\varphi\left(P_t(j)/P_{t-1}(j) - \Pi\right)^2 Y_t(j) P_t(j)/P_t, \tag{26}$$

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 $\kappa \equiv \frac{1-\upsilon}{\upsilon\varphi\Pi^2}$ is the slope of the Phillips curve. The firm chooses the price $P_t(j)$ to maximize the present value of future profits:

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

where Q_s is the stochastic discount factor for the representative household. Labor is the only input in the firm production function, $Y_t(j) = A_t h_t^{1-\alpha}(j)$, where total factor productivity A_t evolves according to an exogenous process: $\ln(A_t/A_{t-1}) = \gamma + a_t$, $a_t = \rho_a a_{t-1} + \sigma_a \epsilon_{a,t}$, $\epsilon_{a,t} \sim N(0,1)$. Firms take as given the general price level, P_t, the equilibrium real wages, W_t, and the level of real activity, Y_t.

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

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

where E_t represents government expenditure, which is the sum of government transfers and government goods purchases: $E_t = TR_t + P_t G_t$. We rewrite the federal government budget constraint in terms of the debt-to-output ratio $b_t^m \equiv (P_t^m B_t^m)/(P_t Y_t)$:

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

where $R_{t-1,t}^m = (1+\rho P_t^m)/P_{t-1}^m$ is the realized return of the maturity bond and all the fiscal variables in the above equation are expressed as a fraction of nominal output; that is, $\tau_t \equiv T_t/P_t Y_t$ and $e_t \equiv E_t/P_t Y_t$.

Let us denote the government transfers as a fraction of nominal output as tr_t. The linearized transfers as a fraction of nominal output, $\widetilde{tr}_t$, is assumed to follow

$$\begin{aligned}
\left(\widehat{tr}_t - \widehat{tr}_t^*\right) &= \rho_{tr}\left(\widehat{tr}_{t-1} - \widehat{tr}_t^*\right) + (1-\rho_{tr})\,\psi_y\,(\tilde{y}_t - \tilde{y}_t^*) + \sigma_{tr}\epsilon_{tr,t}, \\
\widehat{tr}_t^* &= \rho_{tr}^* \widehat{tr}_{t-1}^* + \sigma_{tr^*}\epsilon_{tr^*,t},\ \ \epsilon_{tr^*,t} \sim N(0,1),\ \ \epsilon_{tr,t} \sim N(0,1),
\end{aligned}$$

where $\widehat{tr}_t^*$ represents a long-term component that is meant to capture the large programs that arise as the result of a political process that is not modeled here.[13] Transfers move around this

[13]In what follows, $\tilde{x}_t$ denotes the log-deviations of a (stationary) variable from its steady-state value. For all the variables normalized with respect to nominal output (debt, expenditure, transfers, and taxes), $\hat{x}_t$ denotes linear deviations from the steady state.

trend component as a result of business cycle fluctuations captured by the log-linearized output gap $(\tilde{y}_t - \tilde{y}_t^*)$, where $\tilde{y}_t^*$ is potential output in log-deviations from it steady-state value. Potential output is defined as the output that would arise under flexible prices and no markup shocks. The government also buys a fraction G_t/Y_t of total output. We define $g_t \equiv 1/(1-G_t/Y_t)$, and we assume that $\tilde{g}_t \equiv \ln(g_t/g)$ follows an autoregressive process: $\tilde{g}_t = \rho_g \tilde{g}_{t-1} + \sigma_g \epsilon_{g,t}$, $\epsilon_{g,t} \sim N(0,1)$.

Policy Rules. The monetary policy rule reads as follows:

$$R_t/R = (R_{t-1}/R)^{\rho_{R,\xi_t^p}} \left[(\Pi_t/\Pi)^{\psi_{\pi,\xi_t^p}} (Y_t/Y_t^*)^{\psi_{y,\xi_t^p}} \right]^{\left(1-\rho_{R,\xi_t^p}\right)} e^{\sigma_R \epsilon_{R,t}}, \tag{27}$$

where R is the steady-state gross nominal interest rate and Π is the deterministic steady-state level for gross inflation. The parameters ψ_{π,ξ_t^p} and ψ_{y,ξ_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. As explained in the next section, the policy mix in place will also depend on the state of demand that, in turn, is controlled by ξ_t^d.

The fiscal authority sets taxes according to the following rule:

$$\hat{\tau}_t = \rho_{\tau,\xi_t^p} \hat{\tau}_{t-1} + \left(1 - \rho_{\tau,\xi_t^p}\right) \left[\delta_{b,\xi_t^p} \hat{b}_{t-1}^m + \delta_y (\tilde{y}_t - \tilde{y}_t^*) \right] + \sigma_\tau \epsilon_{\tau,t}, \tag{28}$$

where $\hat{\tau}_t$ is the level of tax-revenues-to-GDP ratio in linear deviations from the steady state. The parameter δ_{b,ξ_t^p} captures the fiscal authority's attitude toward debt stabilization, which depends on the type of policy mix ξ_t^p in place at time t. Even for the fiscal rule, the policy rule in place will also depend on the state of demand that, in turn, is controlled by ξ_t^d.

3.2 Policy Regimes

The Markov-switching process ξ_t^p determines the policy mix *conditional* on the state of demand ξ_t^d. This exogenous variable captures in reduced form the complex interplay between the monetary and fiscal authorities. The fact that the state of demand is discrete makes it easier to condition the type of monetary and fiscal policies adopted, which is captured by ξ_t^p, on the state of demand, which is captured by ξ_t^d. Agents are rational, and they understand that recessions and expansions affects the way in which the monetary and fiscal authorities coordinate their policies.

When the state of the demand is high ($\xi_t^d = \bar{d}_h$), three possible policy mixes can arise depending on ξ_t^p. Policymakers can conduct a *monetary-led policy mix ($\xi_t^p = M$)*, with monetary policy geared toward inflation stabilization ($\psi_\pi = \psi_{\pi,M} > 1$) and fiscal policy aimed at adjusting primary surpluses to stabilize the debt-to-output ratio ($\delta_b = \delta_{b,M} > \beta^{-1} - 1$). When demand is high, policymakers can also follow a *fiscally-led policy mix ($\xi_t^p = F$)*, with the monetary authority that de-emphasizes inflation stabilization ($\psi_\pi = \psi_{\pi,F} \leq 1$) and the fiscal authority that disregards the level of debt ($\delta_b = \delta_{b,F} \leq \beta^{-1} - 1$). Finally, a *non-coordinated* (or *conflict*) *policy mix* ($\xi_t^p = C$) can arise, with the monetary authority that is resolute in his commitment to stabilize inflation ($\psi_\pi = \psi_{\pi,C} > 1$) and the fiscal authority that disregards debt stabilization ($\delta_b = \delta_{b,C} \leq \beta^{-1} - 1$). As shown in the Fisherian model, the third policy mix leads to no stable rational expectations equilibria when considered in isolation.[14] In this case, the government would like inflation to adjust to stabilize debt, whereas the central bank does not want to let inflation go up. Thus, this regime captures the possibility that the monetary and fiscal authorities go through a conflict over the determination of the rate of inflation. We refer to this type of policy mix as non-coordinated in the sense that policymakers are not in agreement about what is the rate of inflation that they see as appropriate.

When the state of demand is low ($\xi_t^d = \bar{d}_l$), we assume that the monetary authority de-emphasizes inflation stabilization and the government carries out a fiscal stimulus by momentarily disregarding the level of debt. Therefore, when the state of demand is low, the policy mix is fiscally led ($\psi_\pi = \psi_{\pi,F} \leq 1$ and $\delta_b = \delta_{b,F} \leq \beta^{-1} - 1$). It is worth clarifying that the fact that policymakers respond with the fiscally-led policy mix to large recessions is not essential for the main results of this paper. However, we believe that this assumption is quite plausible, since policymakers arguably put less emphasis on inflation and debt stabilization during severe economic downturns.

More formally, the joint dynamics of demand and policy regimes are captured by the following transition matrix Q:

$$Q = \begin{bmatrix} p_{hh} Q^H & (1 - p_{ll}) Q^O \\ (1 - p_{hh}) Q^I & p_{ll} Q^L \end{bmatrix}.$$

The columns of this matrix sum to one. The matrix Q^H controls the dynamics of the policy regime ξ_t^p conditional on being in a high state of demand. As we discussed earlier, when the state of demand is high, the policy regime can be monetary led, fiscally led, or non-coordinated. Q^L is the transition matrix that governs the evolution of policy regimes during the large recession triggered by the discrete demand shock ξ_t^d (the low state of demand). As we noticed before, these regimes are all characterized by the fiscally-led policy mix. However, the regimes differ in terms of the policy mix that is likely to prevail once the negative preference shock is reabsorbed. These possible outcomes are captured by the transition matrix Q^O. The matrix Q^I controls the policy regime dynamics when the low state of demand materializes ($\xi_t^d = \bar{d}_l$).

This modelling framework captures rational agents' uncertainty about the response of pol-

[14]Leeper's results for the Fisherian model would apply to this New Keynesian model if the policy regimes were not allowed to change. With Markov-switching, the analysis of global stability of the system is more complicated. We will focus on parameterizations that ensure mean square stability of the model (Costa, Fragoso, and Marques 2004).

icymakers to the potentially large accumulation of debt that occurs in response to a large contractionary shock. As we shall see, agents' beliefs about what will happen after a large recession are critical for the macroeconomic dynamics during the recession. These beliefs are captured by the matrix Q^O. The remaining shocks are assumed to be small, and hence, recessions caused by these shocks are assumed not to give rise to relevant fiscal strain.

Linearization. We linearize the fiscal variables around the steady state and log-linearize all the non-fiscal variables. Details on how we solve the linearized model are in Appendix B.

3.3 Policy Conflicts and Solution

In this paper, we contemplate scenarios in which agents expect that the fiscal authority can disregard the level of debt (active fiscal policy) while the central bank remains committed to stabilizing inflation (active monetary policy). We call this mix of active monetary and fiscal policies non-coordinated because it is inconsistent with determining the unique path for inflation. In fact, if this policy mix were followed forever, Leeper (1991) shows that there is no stable rational expectations equilibria. To see why, suppose that inflation is above target and that the Federal Reserve tries to push it down by increasing the federal funds rate more than one-to-one in response to the observed deviation. This action prompts an increase in the real interest rate, a contraction in output, and, consequently, an acceleration in the rise of the debt-to-output ratio. This acceleration in the dynamic of the debt-to-output ratio would require an increase in taxation, but agents know that this is not going to happen because the fiscal authority is active. Therefore, the adjustment has to come through an increase in inflation that triggers an even larger increase in the interest rate and so on. Clearly, the economy is on an explosive path, and if this situation were to persist, no *stationary* solution would exist. This explains while this scenario has been largely neglected in the study of monetary/fiscal policy interactions.

However, if the conflict (active monetary policy/active fiscal policy) regime is expected to eventually end, the model can still admit a stable and unique rational expectations equilibrium. The model could present temporary explosive dynamics, but as long as these are not expected to last for too long, a stationary solution would still exist. This is the key insight that allows us to solve the model allowing for periods of conflict by leveraging the recent advancements in the literature on solution methods for Markov-switching general equilibrium models. We use the solution algorithm proposed by Farmer, Waggoner, and Zha (2009). This solution method requires the solution to satisfy mean square stability: First and second moments need to be stationary when taking into account the possibility of regime changes. However, quite importantly, the solution method does *not* impose that all regimes taken in isolation are stationary, allowing for temporary explosive dynamics. Given that agents form expectations by taking into

Parameter	Value	Parameter	Value
$\psi_{\pi,M}$	1.7890	p_{hh}	0.9999
$\psi_{y,M}$	0.4413	p_{ll}	0.9465
$\rho_{R,M}$	0.8697	p_{MM}	0.9902
$\delta_{b,M}$	0.0778	p_{FF}	0.9932
$\rho_{\tau,M}$	0.9666	p_{CC}	0.9000
$\psi_{\pi,F}$	0.6903	δ_y	0.2814
$\psi_{y,F}$	0.2655	ϕ_y	-2.0000
$\rho_{R,F}$	0.6576	ρ_{tr}	0.4620
$\delta_{b,F}$	0.0000	$\overline{d}_h$	0.0429
$\rho_{\tau,F}$	0.6501	$\overline{d}_l$	-0.1300
$\psi_{\pi,C}$	2.0000	κ	0.0072
$\psi_{y,C}$	0.0000	$b_*/4$	0.2795
$\delta_{b,C}$	0.0000	$100\ln\gamma$	0.4120
$\rho_{R,C}$	0.0000	$100\ln\Pi$	0.5000
$\rho_{\tau,C}$	0.6501	$100\ln R$	1.0628

Table 1: Parameter values and transition matrix elements calibrated based on Bianchi and Melosi (2017). Only the parameters that matter for the simulations in the main text of the paper are reported in the table. The complete table is shown in Appendix C.

account the possibility of regime changes, their expectations are still finite at every horizon, even when the economy is temporarily on an explosive path because of the conflict between the two authorities. As we shall see, the properties of the solution are determined by which authority agents expect to eventually give up by moving to a passive policy.

4 The Effects of Lack of Policy Coordination

Table 1 shows the parameter values used in this paper. We denote the probability of staying in the monetary-led, fiscally-led, and conflict policy mix as p_{MM}, p_{FF}, and p_{CC}, respectively. Most of the parameter values and transition probabilities are based on a previous estimation by Bianchi and Melosi (2017). Nonetheless, the model estimated by Bianchi and Melosi (2017) does not feature non-coordinated regimes. We calibrate the probability $p_{CC} = 0.90$, implying that agents expect the conflict regime to last 10 quarters. Moderate changes to this parameter values in this parameter would not affect the key mechanisms that will be discussed later. We assume that during the conflict the central bank responds even more strongly to inflation than in the monetary-led case ($\psi_{\pi,C} = 2.0 > \psi_{\pi,M}$). Furthermore, the central bank is totally focused on controlling inflation and completely disregards the level of real activity $\psi_{y,C} = 0$. This parameter choice serves the important purpose of clearly showing the leading mechanisms at play when policymakers do not coordinate their policies or when they are expected not to coordinate their policies after a large recession. To induce large debt accumulation during the low state of demand, we assume that transfers adjust more strongly to business cycle conditions (δ_y) than during regular business cycle fluctuations. These parameter choices allow us to see the effects of a lack of monetary and fiscal policy coordination more clearly in the graphs that follow but these choices do not affect the main results of the paper.

The magnitude of the negative demand shock ($\bar{d}_l$) is three times smaller than the shock that caused the Great Recession based on the estimates of Bianchi and Melosi (2017). We set the value of the negative demand shock to be smaller in order to avoid the issue of the zero lower bound constraint for the nominal interest rate. Increasing the magnitude of the negative discrete demand shock would strengthen the results of the paper but at the costs of making the exposition of the key mechanisms unnecessarily more complicated. The parameter $b_*/4$ denotes the steady-state debt-to-output ratio on an annualized basis whose value is estimated by Bianchi and Melosi (2017). The other parameters do not play a key role in determining the results that follow. The table with all the parameter values is shown in Appendix C.

Following Bianchi and Melosi (2017), the probability that a large recession hits in every high-demand period is very tiny, since the probability p_{hh} is very close to one. While this parameterization is certainly extreme, it simplifies the analysis substantially by implying that once the economy exits the recession, the high-demand regime is de-facto an absorbing state. This choice has the advantage of clearly isolating the key mechanisms at play when we introduce the possibility of non-coordination between the monetary and fiscal authorities. The value for the parameter ρ captures the average duration of U.S. debt which is roughly five years. The parameter controlling the elasticity of substitution between differentiated goods, ν, and the parameter controlling the degree of nominal rigidities φ are not separably identifiable once the model is log-linearized and, hence, as in Bianchi and Melosi (2017), we directly calibrate the slope of the New Keynesian Phillips curve, κ, that links inflation $\tilde{\pi}_t$ to real activity $\hat{y}_t$. The value of β is pinned down by $\gamma\Pi/R$, whose values are provided in Table 1.

In this section, we use the calibrated model to run a series of simulations to study situations in which agents lose their trust in the government's commitment to make the necessary fiscal adjustments to stabilize debt. Apart from the initial debt-to-output ratio, which is calibrated to match the U.S. debt at the end of 2016 according to the CBO (77%), in all simulations we assume that all variables are at the steady state when the economy is hit by a negative discrete demand shock. We then simulate the economy conditional on a certain path for the regimes. Agents do not have perfect foresight about this regime sequence, but, consistently with the model, they observe the current regime and know the probabilities of moving across the different regimes. Policymakers adopt a fiscally-led policy mix in an attempt to carry out a fiscal stimulus. The debt-to-output ratio increases and agents expect one of the following post-recession outcomes: (i) the government is committed to make the necessary fiscal adjustments to stabilize the growing debt-to-output ratio (monetary-led policy mix); (ii) the government is not committed to stabilize the post-recession debt and the central bank is expected to accommodate the government by de-emphasizing inflation stabilization (fiscally-led policy mix); (iii) the government is not committed to stabilize the post-recession debt and the central bank is expected to fight back against the fiscal authority in an attempt to stabilize inflation (non-coordination). This institutional conflict lasts only temporarily, and agents form expectations about which authority will eventually emerge victorious from the conflict. If agents expect that the fiscally-led (monetary-led) policy mix will be adopted following the conflict, we say that the fiscal (monetary) authority is expected to prevail in the conflict over the control of the rate of inflation. To simplify the exposition of the results, we assume that agents' beliefs turn out to be correct.

These four possible post-recession scenarios ($\xi_t^p = M$, $\xi_t^p = F$, $\xi_t^p = C$ with the fiscal authority expected to win, and $\xi_t^p = C$ with the monetary authority expected to win) and the out-of-the-recession outcomes are modeled by introducing eight regimes. The first two regimes capture the coordinated policy mixes under the high state of demand. The third and fourth regimes are non-coordinated regimes that differ in their probability of moving to the monetary-led policy mix as the conflict ends. The third regime is assumed to lead to the monetary-led policy mix with probability one, whereas the fourth regime is assumed to lead to the fiscally-led policy mix with probability one. The four fiscally-led regimes during the low state of demand differ on the probability of moving to the four high-demand policy combinations. This parameterization implies that during the low state of demand, agents know with certainty which policy mix will be realized once the economy moves back to the high state of demand. While this is certainly a strong assumption, it allows us to isolate the key mechanisms at work. We show how this assumption affects our results in the appendix. All in all, the evolution of these eight regimes is captured by the following transition matrix for regimes (ξ_t^d,ξ_t^p):

$$Q = \begin{bmatrix} p_{hh} Q^H & (1 - p_{ll}) \cdot I_4 \\ (1 - p_{hh})\, 0.25 \cdot \mathbf{1}_{4\times 4} & p_{ll} \cdot I_4 \end{bmatrix},$$

where $\mathbf{1}_{4\times 4}$ is a 4×4 matrix of ones, I_n denotes the $n \times n$ identity matrix, and the dynamics of the policy regimes when the recession is over (or more precisely, when the state of demand is high $\xi_t^d = \bar{d}_h$) is given by

$$Q^H = \left[\begin{array}{cc|cc} p_{MM} & 1 - p_{FF} & 1 - p_{CC} & 0 \\ 1 - p_{MM} & p_{FF} & 0 & 1 - p_{CC} \\ \hline 0 & 0 & p_{CC} & 0 \\ 0 & 0 & 0 & p_{CC} \end{array}\right].$$

Agents take into account the possibility of large recessions and the consequent changes in policymakers' behaviors.

4.1 Macroeconomic Dynamics with Lack of Coordination

Figure 3 shows the macroeconomic dynamics of the output gap, inflation, the federal funds rate, and debt-to-GDP ratio under the following sequence of events. At time $t = 0$, the economy is at the steady state and the (annualized) debt-to-GDP ratio is 77.0%. At time $t = 1$ the economy is hit by the negative demand shock until time $t = 10$ ($\xi_t^d = \bar{d}_l$ for $1 \leq t \leq 10$). This low-demand period is highlighted by the dark gray area. From period $t = 11$ through period $t = 30$, the economy switches back to the high state of demand. We consider two cases. In the first case, during the low state of demand, agents expect that policymakers will conduct a fiscally-led policy mix (coordination) once the state of demand switches back to high in period 11. This case is captured by the dashed line. In the second case, during the low state of demand, agents expect that policymakers will compete for the control over the rate of inflation once the state of demand switches back to high in period 11. Furthermore, we assume that agents expect that the fiscal authority will eventually prevail. In other words, when the conflict ends, the central bank is expected to change policy and the policy mix becomes fiscally led. This second case is captured by the solid line.

We assume that if it occurs, the conflict regime lasts for ten quarters and then the fiscally-led policy mix will stay in place from period 21 through period 30. The period of conflict between the two authorities is highlighted by the light gray area in Figure 3. Agents do not know ex-ante the exact duration of the recession (the dark gray area), how many periods the post-recession institutional conflict will last (the light gray area), and how long the high state of demand will persist (the light gray area and the white area). However, agents observe the history of regimes and know their likely durations.

Conflict and Fiscally-led Resolution. When agents expect an institutional conflict followed by the fiscally-led policy mix, agents anticipate that the large and growing stock of debt will be inflated away. Hence, inflation expectations and inflation rise. During the conflict period ($11 \leq t \leq 20$) the central bank applies the Taylor principle to rein in these inflationary pressures. The monetary tightening conducted during the conflict period determines an increase in real interest rates. As a result, the service cost of debt increases and the economy enters a recession. Both effects of the monetary policy intervention lead to further debt accumulation, exacerbating the fiscal imbalance. This, in turn, strengthens the inflationary pressures because agents expect the fiscal authority to eventually prevail and hence disregard debt stabilization for a long time. But higher inflationary pressures call for further monetary tightening, which leads to an even larger recession and greater fiscal imbalance. Therefore, when agents expect a conflict between policymakers, the economy goes through a vicious spiral of higher debt, higher

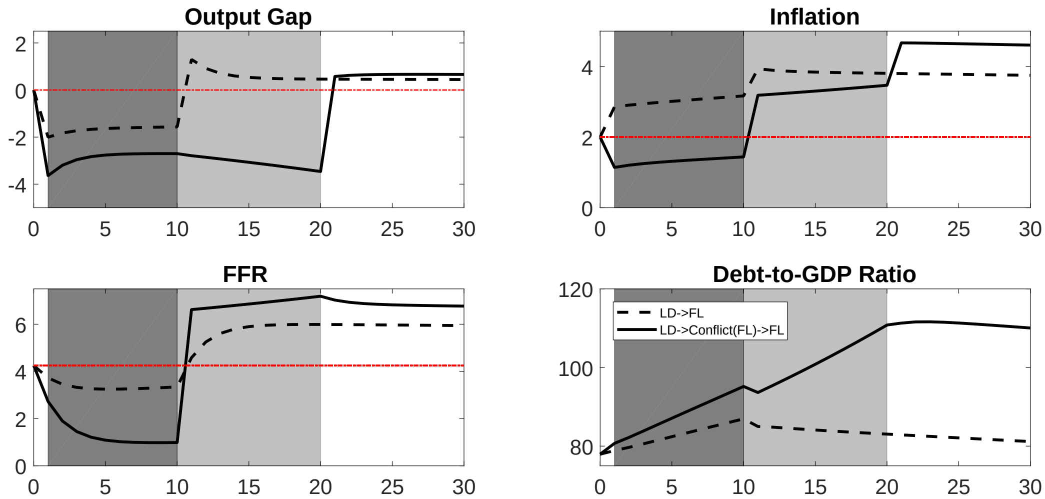

Figure 3: Dynamics of the output gap, inflation, the federal funds rate (FFR), and the debt-to-GDP ratio when a negative discrete demand shock occurs in period 1 and persists until period 10 (the dark gray area). The discrete demand shock switches back to high from period 11 through period 30. The dashed line captures the macroeconomic dynamics when agents expect that policymakers will coordinate to follow the fiscally-led policy mix once the discrete demand shock switches back to high. The solid line captures the situation when agents expect a conflict between the two authorities to break out right after the end of the low-demand period. The conflict is assumed to occur from period 11 through period 20 (the light gray area) and agents expect that the fiscal authority will win; that is, the policymakers will engage in fiscally-led policies from period 21 on. The dashed-dotted line captures the steady-state values.

inflation, higher interest rate, and lower real activity.

Monetary policy interventions, consequently, lead to a double-dip recession. The second recession is entirely due to policymakers' behaviors because the state of demand is high from period 11 on. Furthermore, during the first recession, forward-looking and rational agents anticipate the macroeconomic dynamics that will occur during the conflict. Therefore, expecting an institutional conflict causes the economic crisis to be more severe and gives rise to upward pressures on inflation during the recession period (the dark gray area). Interestingly, the dynamics of the four variables depicted in Figure 3 are temporarily explosive during the conflict period (the light gray area). As explained earlier in the paper, if these dynamics were to persist forever, they would not be consistent with a stationary solution for the model. However, the model is solved taking into account that this pattern is only temporary and that eventually the conflict will come to an end.

What is concerning is that during the institutional conflict (the light gray area), the central bank is incapable of reining in inflation. The monetary authority follows the Taylor principle and raises the interest rate aggressively to lower inflation. Nonetheless, inflation keeps growing. The lesson we learn is that when the central bank lacks the necessary fiscal backing, hawkish monetary policy is not only ineffective, but also counterproductive, as it leads to a spiral of low output and high inflation. The explosive dynamics of the interest rate and inflation during the institutional conflict can make the Federal Reserve an easy target for the media that could bring into question the central bank's ability to control inflation and the soundness of the implemented policies.

If instead agents expect that policymakers will immediately coordinate on the fiscally-led policy mix once the state of demand switches back to high, the large stock of debt leads to heightened and persistent inflation. Since heightened inflation expectations reduce the real value of debt, debt-to-GDP ratio grows only moderately during the recession. Furthermore, the dovish monetary policy keeps the real interest rate low, which contributes to mitigating the severity of the recession during the low-demand period (the dark gray area) and leads to an economic boom when the discrete demand shock becomes positive again ($t \geq 11$).

The outcomes of both the coordinated and the uncoordinated strategies are clearly far from being desirable. While the coordinated strategy clearly dominates the non-coordinated both in terms of output stabilization and in terms of achieving a lower inflation rate, in both cases policymakers miss their objective of keeping inflation low. During the low-demand period (the dark gray area) and the post-conflict period (from period 21 on) policymakers follow the same policy mix (i.e., the fiscally-led policy mix). Therefore, in Figure 3 the vertical difference between the solid line and the dashed line during the low-demand period (the dark gray area) captures the effects of expecting a conflict followed by the fiscally-led policy mix on the macroeconomy. These effects are fairly large. The recession is more severe and prolonged and the larger stock of debt pushes inflation on a higher path. The vertical difference between the solid and the dashed line from period 11 on (the light gray area) captures the macroeconomic implications of going through a conflict. These implications are also very severe especially for real activity.

Conflict and Monetary-led resolution. Figure 4 compares the scenario that we just discussed (solid line) with the opposite polar case in which the monetary authority is expected to eventually prevail (dotted line). This alternative scenario serves as a useful reference point that we will then use to discuss the consequences of relaxing the hypothesis that agents know with certainty which authority will eventually prevail. When the monetary authority is expected to prevail, the fiscal stimulus is ineffective in raising inflation expectations and, hence, to lower the real interest rate during the low-demand period. As a result, the economy goes through an output contraction and a sizable drop in inflation. Inflation moves close to the target once the demand shock switches back to the high state. Nonetheless, the central bank tries to fight the persistent inflation that arises after the recession and, in doing so, impairs the economic activity, with the output gap remaining in negative territory for the duration of the institutional conflict. Once the government gives up and switches to passive fiscal policy, economic activity improves but still remains in negative territory because of the contractionary monetary policy.

Why does output remain slightly below target after the conflict is resolved and policymakers

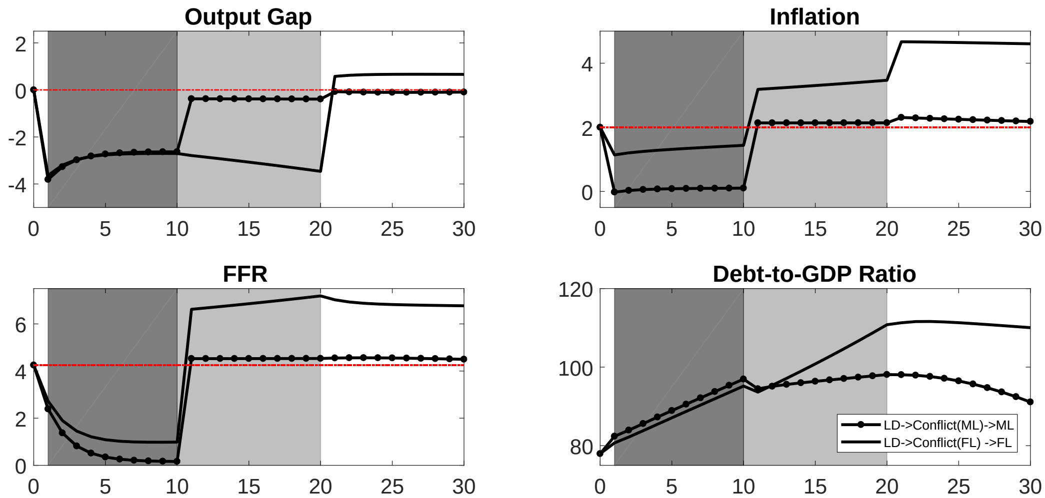

Figure 4: Dynamics of the output gap, inflation, the federal funds rate (FFR), and the debt-to-GDP ratio when a negative discrete demand shock occurs in period 1 and persists until period 10 (the dark gray area). The discrete demand shock switches back to high from period 11 through period 30. Agents expect a conflict between the two authorities following the end of the low demand shock period. The conflict is assumed to occur from period 11 through period 20 (the light gray area). The solid line captures the case in which agents expect that the fiscal authority will win the conflict and, hence, the policy mix is expected to be fiscally led after the conflict. The dotted line captures the case in which the monetary authority is expected to prevail and, hence, the policy mix is expected to be monetary led after the conflict period. The dashed-dotted line captures the steady-state values.

follow the monetary-led policy mix? This happens because the central bank conducts an active policy and tries to rein in inflation that remains persistently above target. In turn, inflation is slightly above target because of the large stock of debt accumulated during the recession and the institutional conflict. Since agents are aware of regime changes, they understand that the government can always renege on its commitment to stabilize the large stock of debt by raising taxes and move to the fiscally-led policy mix. However, the probability of this event is quite small: $1 - p_{MM} = 0.68\%$.[15] When the stock of debt is low, a low probability that the government will give up on stabilizing debt does not raise inflation expectations significantly. Nonetheless, when the stock of debt is so high as the one accumulated during the large recession (the dark gray area) and the subsequent institutional conflict (the light gray area) in Figure 4, inflation remains above its steady-state value even though the probability that policymakers will engage in the fiscally led policy mix in the future is small. This is for two reasons. First, such a large stock of debt can be stabilized only over a long period of time and the probability that policymakers will switch to the fiscally led policies during this long period of time is not negligible. Second, if the switch to fiscally-led policies happens when debt is high, the

[15] Furthermore, agents take into account that should a large recession happen again, the policy mix will turn to fiscally led. However, the probability that the demand shock switches to the low state in every period is negligible.

inflationary consequences will be very severe. Furthermore, it should be noted that the little bump in inflation after the conflict and the associated amelioration of the output gap are due to the less aggressive anti-inflationary policy conducted by the central bank under the monetary-led policy mix compared with the monetary policy carried out during the conflict period ($\psi_{\pi,M} < \psi_{\pi,C}$; see Table 1).

It is also interesting to notice that the output gap falls by a similar amount during the low-demand period regardless of the private sector's expectations about future monetary and fiscal policies. In this respect, it is worth noting that from expecting different post-conflict resolutions, there are two main effects on the output gap during the low-demand period. If agents expect a conflict followed by the fiscally-led policy mix, they also expect a double-dip recession when the demand switches to the high state from period 11 until the end of the institutional conflict. These expectations worsen the recession during the low-demand period because agents are forward looking. Note that if agents expect a conflict followed by the fiscally-led regime, the more persistent (in expectations) the fight regime, the deeper the high-demand period's recession, and the worse the low-demand period's recession. There is, however, a second effect. When agents expect that the monetary authority will prevail, policymakers fail to raise inflation and, in fact, inflation is close to zero during the low-demand period. On the contrary, when the fiscal authority is expected to prevail, inflation does not drop and remains close to target. Therefore, in the former case the real interest rate is higher and, hence, consumption and output are lower, everything else being equal.

Our calibration is for the US economy and is based on previous studies. Given this calibration, it turns out that these two effects tend to cancel each other out. Thus, the output gap during the low-demand period is remarkably similar regardless of the expected resolution of the conflict. This result is not general and implies by no means that the expected resolution of the conflict is inconsequential for the output dynamics during the low-demand period. In Appendix D, we illustrate this point via a counterexample.

Conflict and Uncertain Resolution. So far, we have considered the two polar cases in which agents expect either the monetary-led resolution to the conflict with certainty or the fiscally-led resolution with probability one. We have chosen these polar cases in order to simplify the explanation of the mechanisms at play. Nevertheless, in practice, agents are likely to be fairly uncertain about the outcome of an institutional conflict like the one studied in this paper. Furthermore, there beliefs might vary over time based on news. Figure 5 shows the two extreme cases (i.e., 100% expected fiscally-led resolution and 100% expected monetary led resolution) that we have analyzed in Figure 4 along with a case in which agents' beliefs about which authority will emerge victorious from the conflict change over time (the starred

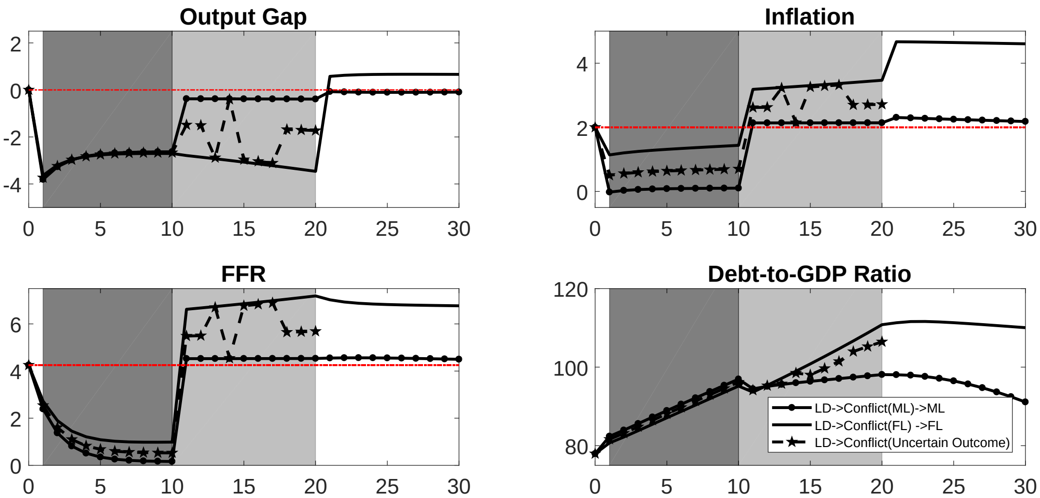

Figure 5: Dynamics of the output gap, inflation, the federal funds rate (FFR), and the debt-to-GDP ratio when a negative discrete demand shock occurs in period 1 and persists until period 10 (the dark gray area). The discrete demand shock switches back to high from period 11 through period 30. Agents expect a conflict between the two authorities following the end of the low demand shock period. The conflict is assumed to occur from period 11 through period 20 (the light gray area). The solid line captures the case in which agents expect that the fiscal authority will win the conflict and, hence, the policy mix is expected to be fiscally led after the conflict. The dotted line captures the case in which the monetary authority is expected to prevail and, hence, the policy mix is expected to be monetary led after the conflict period. The starred line captures the macroeconomic dynamics when beliefs about which authority will win the conflict varies erratically. The dashed-dotted line captures the steady-state values.

line).[16] For the sake of illustrating the mechanism, we assume that as the conflict breaks out in period 11, agents expect that the two policymakers have equal chance to win the conflict. In period 14, beliefs change abruptly with agents now believing that the fiscal authority will win for sure. In the aftermath of this change in beliefs, the recession becomes deeper while inflation increases. In period 15, agents radically change their beliefs and now feel that the monetary authority will eventually emerge victorious with a probability of one. As a result, the output gap improves but remains in the negative territory while inflation drops and becomes very close to zero. From period 16 through period 18, agents change again their beliefs and become confident that the fiscal authority will eventually win the conflict. This abrupt change in beliefs exacerbates the recession and causes inflation to suddenly rise and to start growing away from its steady-state value. After period 18 through the end of the conflict in period 20, agents are uncertain again about which authority will win and attach 50% probability to each authority to win the conflict. Once the conflict is over, agents observe which authority has won the conflict and the dynamics of the macro variables slowly converge to the realized polar case.

[16] To model these dynamics, we add one more conflict regime to the set ξ_t^p. This additional conflict regime is characterized by equal probabilities of moving to the two coordinated high-demand regimes (i.e., the monetary-led regime and the fiscally-led regime). Furthermore, we introduce a fifth low-demand (fiscally-led) regime that leads to this additional conflict regime with probability one when the state of demand switches to high.

We do not shown this convergence in Figure 5 to keep the graphs easier to read.

The exercise with erratic beliefs shown in Figure 5 illustrates that in presence of uncertainty about the resolution, changes in beliefs induce further macroeconomic volatility as the economy fluctuates between the two polar cases. As agents become convinced that one of the authorities will win the conflict, the output gap and inflation suddenly jump on the paths implied by the two polar cases (i.e., the solid and the dotted lines). The higher the probability that the fiscal (monetary) authority will win, the closer the macroeconomic dynamics will be to the solid (dotted) line. This suggests that the macro dynamics in the two polar cases (i.e., the vertical distance between the two lines in Figure 4) spans the set of possible outcomes. The set of possible outcomes turns out to be fairly large, including zero inflation and fairly high rate of inflation, severe recessions with the output gap plummeting to -4%, and moderate economic contractions with the output gap only slightly below zero. If beliefs about which authority will prevail after the conflict are erratic, macroeconomic volatility during the conflict period may be quite large.

Key insight. To summarize, if the government's commitment to make the necessary fiscal adjustments to stabilize a large stock of debt is questioned by the private sector, the central bank has two options. The central bank can accommodate these beliefs by abandoning its anti-inflationary stance, or it can fight back and reaffirm its commitment to keep inflation stable. In the former case, inflation increases substantially and remains persistently high during and after the recession. In the latter case, an institutional conflict is expected to happen after the recession and economic outcomes are largely driven by the private sector's expectations about which authority will change its policy to end the conflict. We find that institutional conflicts lead inevitably to bad outcomes and are accompanied by large macroeconomic volatility. If the central bank is expected to lose the conflict by switching to passive policies, a vicious spiral of low output, high inflation, and high debt will arise during the conflict period, which exacerbates the economic crisis and raises inflation during the recession. Quite interestingly, in this scenario the central bank raises the policy rate but fails to rein in inflation, which actually accelerates during the conflict period. This scenario seems that most relevant from an historical point of view. As a prominent example, the Fed Chairman Arthur Burns (1979) himself acknowledged that "[...] the central bank's practical capacity for curbing an inflation that is driven by political forces is very limited." However, if the central bank is expected to eventually prevail, the fiscal stimulus is ineffective in rescuing the economy from the large recession. The economy experiences a discrete and persistent drop in inflation during the low-demand period, and a large stock of debt, as well as a persistently higher-than-target inflation after the recession.

5 The Emergency-Budget Rule

In this section, we study a coordinated strategy that can be implemented when the private sector loses confidence in the government's ability/willingness to stabilize debt through fiscal adjustments. This strategy commits the central bank to accept just enough higher inflation to stabilize the debt-to-output ratio resulting from a large recession triggered by a negative demand shock. The government remains committed to making the necessary fiscal adjustments to guarantee long-run fiscal backing.

As shown here, this coordinated strategy can be implemented by explicitly projecting the debt-to-GDP ratio that the fiscal authority pledges to repay through future fiscal adjustments. No fiscal plans are instead provided to stabilize the remaining amount of the debt-to-GDP ratio, which policymakers have agreed to inflate away. This portion is defined as the debt-to-output ratio that would have prevailed absent large demand shocks, ξ_t^d. The central bank allows inflation to rise just enough to inflate away the debt that exceeds the projection. This strategy is reminiscent of President Franklin Delano Roosevelt's decision of running two types of budget deficits to fight the dire consequences of the Great Depression: A "regular budget" that he committed to balance and an "emergency budget" that he did not clearly commit to balance.[17] Henceforth, we call the strategy studied in this section "the coordinated strategy" or "the emergency-budget rule."

5.1 General Case

To model this coordinated strategy geared to inflate away the amount of debt resulting from large recessions, we assume that policymakers respond to inflation and the debt-to-output ratio according to the monetary-led policy mix all the time, except when responding to the discrete demand shock ξ_t^d. Specifically, we assume that the response of the nominal interest rate to inflation and that of primary surpluses to debt are both zero *if* movements in these variables result from the large demand shock. Furthermore, policymakers respond to all other fluctuations in inflation and the debt-to-output ratio that are driven by Gaussian shocks by following the monetary-led policy mix. As explained earlier, Gaussian shocks are assumed to be too small to raise fiscal strains that can fuel expectations that the government may be incapable of making the necessary fiscal adjustments to stabilize debt. To simplify the analysis, we also assume that policymakers respond to the output gap by following the monetary-led policy mix regardless of the nature of the shocks that have hit the economy.[18]

[17] The distinction between this two types of budgets was introduced by the Economy Act, which was passed on March 14, 1933.

[18] The last assumption is motivated by the fact that we have defined monetary and fiscal policy coordination in terms of policymakers' behaviors towards inflation and debt stabilization. However, this assumption can be relaxed by letting policymakers respond differently to the output gap depending on the nature of the shocks

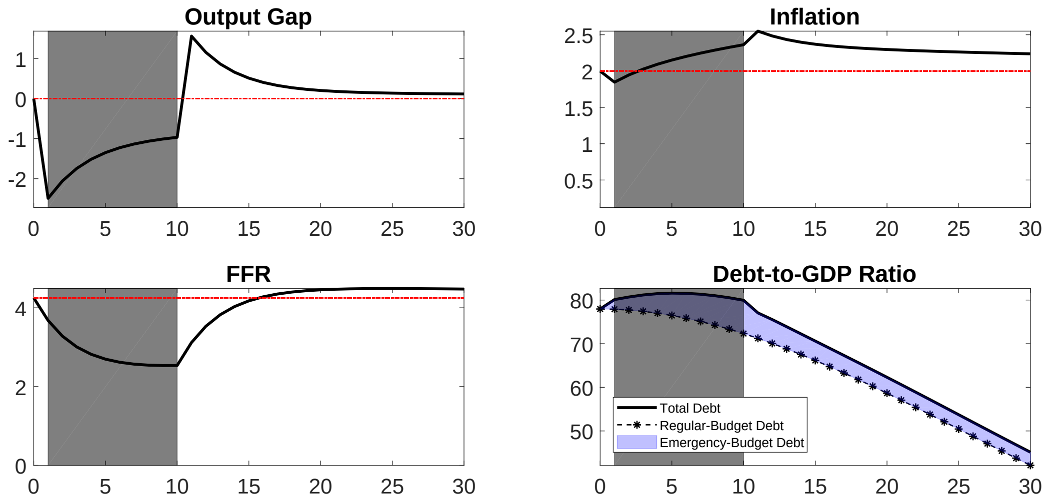

Figure 6: Dynamics of the output gap, inflation, federal funds rate (FFR), and debt-to-GDP ratio after a negative discrete demand shock that occurs in period 1 and persists until period 10 (the gray area). The state of demand switches to the high regime from period 11 through period 30. The solid line captures the macroeconomic dynamics when the emergency-budget rule is implemented. The starred line captures the regular debt-to-GDP ratio, which is the portion of the public debt policymakers are responsible to stabilize by making fiscal adjustments. The shaded area between these two lines captures the emergency-budget debt-to-GDP ratio, which will be inflated away. The dashed-dotted line captures the steady-state values.

In order to implement this policy we construct a *shadow economy* to keep track of the amount of debt and inflation resulting from the discrete preference shock. We denote the debt and inflation of the shadow economy in which discrete demand shocks are shut down as $\hat{b}_t^S$ and $\tilde{\pi}_t^S$, respectively. We then write the linearized policy rules as follows:

$$\hat{\tau}_t = \rho_{\tau,M}\hat{\tau}_{t-1} + \left(1-\rho_{\tau,M}\right)\left[\delta_{b,M}\hat{b}_{t-1}^S + \delta_{b,F}\left(\hat{b}_{t-1} - \hat{b}_{t-1}^S\right) + \delta_y\left(\tilde{y}_t - \tilde{y}_t^*\right)\right] + \sigma_\tau\epsilon_{\tau,t}, \quad (29)$$

$$\tilde{R}_t = \rho_{R,M}\tilde{R}_{t-1} + \left(1-\rho_{R,M}\right)\left(\psi_{\pi,M}\tilde{\pi}_t^S + \psi_{\pi,F}\left(\tilde{\pi}_t - \tilde{\pi}_t^S\right) + \psi_{y,M}\left(\tilde{y}_t - \tilde{y}_t^*\right)\right) + \sigma_R\epsilon_{R,t}, \quad (30)$$

where we assume $\delta_{b,F} = \psi_{b,F} = 0$. The shadow economy is initialized by setting the initial stock of debt equal to the one in the actual economy. These policy rules imply that the government is not responsible for stabilizing the emergency-budget debt-to-output ratio $\left(\hat{b}_{t-1} - \hat{b}_{t-1}^S\right)$, which is due to the discrete demand shock, and the central bank allows inflation to rise by $\left(\tilde{\pi}_t - \tilde{\pi}_t^S\right)$, just enough to stabilize that portion of debt-to-output ratio. More details on how to write the model equations when policymakers follow the rules (29)-(30) are in Appendix E.

The solid line in Figure 6 captures the macroeconomic implications of adopting the coordinated strategy. The starred line shows the regular-budget debt-to-GDP ratio, which is pinned down by the shadow economy. The fiscal authority is committed to stabilize the regular-budget debt-to-GDP ratio through higher taxes and hence, this portion of debt does not bring about

that have hit the economy.

any inflationary pressure. The shaded area between these two lines captures the emergency-budget debt-to-GDP ratio that the fiscal authority do not pledge to stabilize. The monetary authority will passively accommodate the inflationary pressures needed for stabilizing the emergency-budget debt-to-GDP ratio. Contrary to the non-coordinated case, this coordinated strategy successfully raises inflation expectations during the recession by promising that the debt resulting from the economic downturn will be inflated away. Consequently, this promise puts downward pressures on the real interest rate, and hence, the drop in the output gap is mitigated compared with the cases where an institutional conflict is expected to break out after the recession. Given that the recession is contained, the emergency-budget debt-to-GDP ratio $\left(\hat{b}_t - \hat{b}_t^S\right)$ grows only moderately and so does inflation necessary to stabilize it. As the emergency-budget debt-to-GDP ratio is slowly reabsorbed, the price dynamics slow down and inflation gets closer to its two-percent target.

The coordinated policy rules (29)-(30) imply that policymakers follow the fiscally-led policy mix only in response to the debt-to-output ratio and inflation resulting from the low state of demand. The policy rules imply that the central bank always follows an active monetary policy in response to output gap fluctuations. This is the reason why the interest rate falls during the recession in Figure 6. This feature of the coordinated policy rules can be relaxed with little effects on the results of the paper.

Finally, as shown in Appendix F, the dynamics of the output gap, inflation, and nominal interest rate are totally unaffected by the pre-crisis size of the debt-to-GDP ratio, which will be stabilized by taking the necessary fiscal measures. This makes it clear that the proposed policy separates the issue of long-run fiscal sustainability from the need to intervene during exceptional events. This is a feature of the coordinated strategy that we will investigate further in the following section.

5.2 Avoiding Liquidity Traps

The zero floor for nominal interest rates can be a significant constraint on the ability of a central bank to combat deflation. Krugman (1998) and Eggertsson and Woodford (2003) propose the use of forward guidance, which are announcements about the likely future path of the policy rate, to ease this constraint on monetary policy. These scholars suggest promising a period of monetary accommodation once the recession is over. In doing so, the central bank is promising a boom and higher inflation after the recession, leading to a fall in the real rate that mitigates the recession as well as the drop in inflation.

Our coordinated strategy can be regarded as an alternative way of promising higher inflation after a period of very low demand. The distinctive feature of our approach is the coordination between monetary and fiscal policies so as to rule out zero lower bound episodes by generating

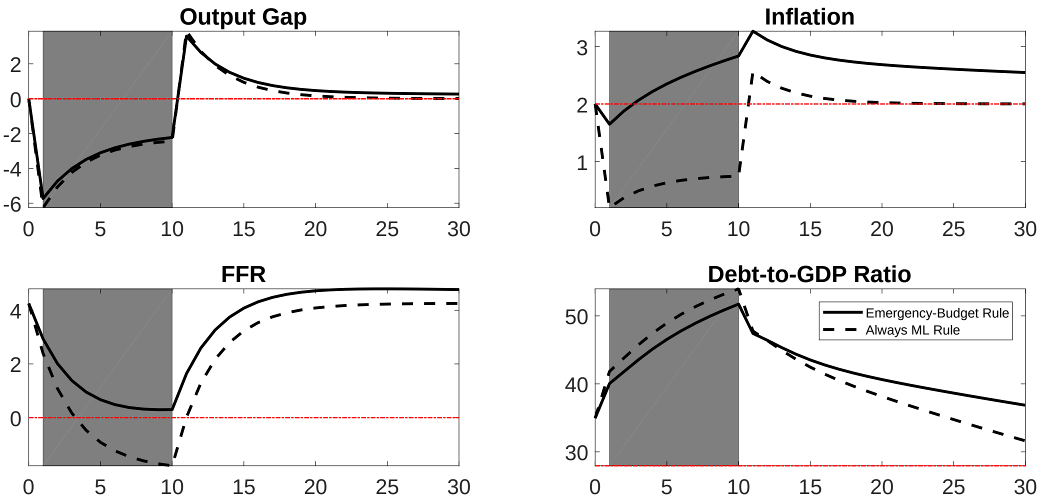

Figure 7: Dynamics of the output gap, inflation, federal funds rate (FFR), and debt-to-GDP ratio after a negative discrete demand shock that occurs in period 1 and persists until period 10 (the gray area). The magnitude of this shock is comparable to the demand shock that caused the Great Recession (Bianchi and Melosi 2017). The state of demand switches to the high regime from period 11 through period 30. The solid line captures the dynamics when the emergency-budget rule is implemented. The dashed line captures the macroeconomic dynamics when the monetary-led policy mix is implemented in every state of the world. The dashed-dotted line captures the steady-state values.

inflationary pressures from fiscal imbalances. As for forward guidance, higher inflation lowers the real interest rate and, in doing so, stimulates economic activity, reducing the size of the output contraction and stabilizing the price dynamics during periods of extremely low demand. As we shall show, this mechanism can be strong enough to prevent the economy from hitting the zero lower bound. At the same time, agents understand that the increase in inflation is the result of a well-defined, exceptional contractionary event, which policymakers are not responsible for, while policy strategies to cope with business cycle (Gaussian) disturbances are unchanged.

Figure 7 shows the dynamics of the output gap, inflation, federal funds rate, and debt-to-GDP ratio following a very large negative demand shock, which is calibrated to be as big as the one that caused the Great Recession based on estimates by Bianchi and Melosi (2017). We calibrate the initial debt to be 35% of GDP, which was the debt-to-GDP ratio in the U.S. before the Great Recession according to CBO's estimates.[19] The dashed line captures the macroeconomic dynamics when policymakers follow a monetary-led policy mix during the low-demand period (the gray area) and agents expect that this policy mix will be followed in every future period. We observe that this strong commitment to monetary dominance would

[19]Changing the size of the initial debt-to-GDP ratio is inconsequential for the results that follow. See Appendix F, where we show that changing the initial stock of debt is inconsequential if policymakers coordinate to inflate away only the portion of debt resulting from the large recession. Furthermore, if the monetary-led policy mix is followed in every state of the world, the macroeconomy is fully insulated from fiscal developments.

lead monetary policy to become constrained by the zero lower bound during the recession.[20] The solid line captures the macroeconomic dynamics when policymakers are not committed to stabilizing the debt-to-GDP ratio resulting from the large recession (i.e., the emergency-budget rule). This coordinated commitment allows the central bank to avoid the zero lower bound by raising inflation expectations.

The proposed monetary and fiscal policy strategy is in line with the policies advocated by Sims (2016) who suggests replacing ineffective monetary policies at the zero lower bound with an "effective fiscal policy." According to Sims, effective fiscal policy at the zero lower bound requires that both the monetary and fiscal authorities clearly announce that fiscal accommodation will not be removed until inflation will attain a given inflation target. Sims also argues that a commitment to generate inflation that involves the fiscal authority might also be more credible than one that relies solely on the behavior of the monetary authority, given the time that it takes to revert fiscal decisions. We consider this as an interesting direction for future research.

Our shock-specific rule is also related to Correia et al. (2013), who show how distortionary taxes can be used to replicate the effects of negative nominal interest rates, and Galí (2014), who analyzes the effects of a fiscal stimulus financed through money creation. Both these papers work under the assumption that a monetary-led policy mix is always in place. Our mechanism is based on a systematic policy response to exceptionally large shocks and does not require using distortionary taxation or printing money (even if, of course, we could introduce money and derive its implied path.) Instead, our shock-specific rule works by making debt fiscally unsustainable by specifying the way policymakers react to exceptionally large shocks. In this respect, our shock-specific rule is in the spirit of Benhabib, Schmitt-Grohe, and Uribe (2002) who, following Woodford (2003), work in a deterministic environment to show that a deflationary steady state can be made fiscally unsustainable.

6 Conclusions

This paper studies the implication of the lack of coordination between the monetary and fiscal authorities. By lack of coordination we mean a situation in which both authorities are trying to control the rate of inflation. When agents expect that policymakers will not coordinate their policies after a large recession, two outcomes can arise. One possible outcome is that policymakers appear to be incapable of raising inflation expectations to rescue the economy from the recession. The other possible outcome is also dire. The economy enters a spiral of growing debt, declining output, and raising inflationary pressures as a result of the monetary tightening that is not backed by future fiscal consolidations. Which case will prevail depends

[20] Monetary policy does not become constrained exactly when the recession starts but only a few quarters after because the central bank adjusts the interest rate smoothly ($\rho_{R,M} = 0.8697$).

on which authority is expected to change its policy to coordinate with the other.

We then consider a coordinated policy strategy that is capable of mitigating the recession by raising inflation expectations in an orderly manner. This strategy consists of a commitment to inflating away only the portion of debt that exceeds an announced projection. This projection is defined as the debt-to-output ratio that would have prevailed absent the large contractionary shock. In practice, an approximate measure of such a debt-to-GDP ratio can be obtained by projecting the pre-recession stock of debt into the future. The central bank allows inflation to rise just enough to inflate away the portion of debt that exceeds the projected level of debt. This strategy succeeds in mitigating deep recessions because it affects agents' beliefs about policymakers' *long-run* behavior in response to a specific large shock. In fact, policymakers are committing to *never* increasing taxes in response to the amount of debt accumulated during large contractions and, at the same time, to not combating the resulting increase in inflation. This policy triggers an increase in *short-run* inflation expectations and an immediate increase in inflation as large demand shocks hit the economy. The proposed strategy has the virtue of clearly separating short-run policy interventions from the issue of long-run fiscal sustainability. This coordinated strategy can also be used to promise a rate of inflation after a severe recession so as to avoid hitting the zero lower bound for the nominal interest rate.

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Appendix

A The Fisherian Model: Analytical Derivation

Steady State. Let us assume that the real surplus in steady state is given by $\tau_* = b_*^\gamma$. Then the steady state can be derived as follows:

$$\begin{aligned}
i_* &= \beta^{-1}\Pi_*, && (31)\\
\tau_t + i_t^{-1} b_t &= \frac{b_{t-1}}{\Pi_t}, \\
\tau_* + i_*^{-1} b_* &= \frac{b_*}{\Pi_*}, \\
\tau_* &= \left[\frac{1}{\Pi_*} - \frac{1}{i_*}\right] b_*, && (32)\\
b_* &= \tau_* \left[\frac{1}{\Pi_*} - \frac{1}{i_*}\right]^{-1}, \\
b_* &= \tau_* \left[1 - \frac{\Pi_*}{i_*}\right]^{-1} \Pi_*, && (33)\\
b_* &= \tau_* \frac{\beta^{-1}}{\beta^{-1} - 1} \Pi_*, && (34)\\
\frac{b_*}{\Pi_*} &= \frac{\beta^{-1}}{\beta^{-1} - 1} \tau_*. && (35)
\end{aligned}$$

Notice that inflation or the real value of debt cannot be separately pinned down.

Model Solution Under Fiscal Dominance. If $\psi \leq 1$ and $\delta < 1$ (passive monetary/active fiscal or just PM/AF), the system of equations (16) has one explosive eigenvalues associated with the fiscal equation. Unlike the previous case, inflation expectations directly affect debt dynamics as the autoregressive matrix in equation (16) is lower triangular. This implies that the unique stable REE does not necessarily imply that $\hat{b}_t = 0$ at all times t. In fact, debt dynamics is made stable by the action of inflation expectations.

To find the stable REE, we take the Jordan decomposition of the autoregressive matrix[21] of the dynamic system (16) and define the vector

[21] $\begin{bmatrix} \psi & 0 \\ b\left(\psi - \beta^{-1}\right) & \beta^{-1} - \delta \end{bmatrix} =$

$$\begin{bmatrix} \frac{1}{b\psi - b\beta^{-1}}\left(\delta - \beta^{-1} + \psi\right) & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} \psi & 0 \\ 0 & r - \delta \end{bmatrix} \begin{bmatrix} b\frac{\psi}{\delta - \beta^{-1} + \psi} - b\frac{\beta^{-1}}{\delta - \beta^{-1} + \psi} & 0 \\ b\frac{\beta^{-1}}{\delta - \beta^{-1} + \psi} - b\frac{\psi}{\delta - \beta^{-1} + \psi} & 1 \end{bmatrix}.$$

$$
\begin{bmatrix} p_t \\ \beta_t \end{bmatrix} \equiv \begin{bmatrix} \frac{b}{\delta-\beta^{-1}+\psi}\left(\psi-\beta^{-1}\right) & 0 \\ \frac{b}{\delta-\beta^{-1}+\psi}\left(\beta^{-1}-\psi\right) & 1 \end{bmatrix} \begin{bmatrix} \mathbb{E}_t\tilde{\pi}_{t+1} \\ \hat{b}_t \end{bmatrix}.
$$

The system (16) can then be equivalently written as

$$
\begin{aligned}
\begin{bmatrix} p_t \\ \beta_t \end{bmatrix} &= \begin{bmatrix} \psi & 0 \\ 0 & \beta^{-1}-\delta \end{bmatrix} \begin{bmatrix} p_{t-1} \\ \beta_{t-1} \end{bmatrix} \\
&+ \begin{bmatrix} \frac{b}{\beta\left(\delta+\psi-\frac{1}{\beta}\right)} - b\frac{\psi}{\delta+\psi-\frac{1}{\beta}} & 0 \\ b\frac{\psi}{\delta+\psi-\frac{1}{\beta}} - \frac{b}{\beta\left(\delta+\psi-\frac{1}{\beta}\right)} & -1 \end{bmatrix} \begin{bmatrix} \epsilon_t^d \\ \epsilon_t^\tau \end{bmatrix} \\
&+ \begin{bmatrix} -\psi\left(\frac{b}{\beta\left(\delta+\psi-\frac{1}{\beta}\right)} - b\frac{\psi}{\delta+\psi-\frac{1}{\beta}}\right) \\ \psi\left(\frac{b}{\beta\left(\delta+\psi-\frac{1}{\beta}\right)} - b\frac{\psi}{\delta+\psi-\frac{1}{\beta}}\right) + b\left(\psi-\frac{1}{\beta}\right) \end{bmatrix} \eta_t.
\end{aligned} \tag{36}
$$

Now the laws of motion for p_t and β_t are disjoint equations (one stable and one unstable) and hence, for stability we need to impose $\beta_t = 0$ at all times. Inflation expectations move so as to keep debt on a stable path. The exact link between these two endogenous variables can be obtained by the following equation

$$
\beta_t \equiv \begin{bmatrix} \frac{b}{\delta-\beta^{-1}+\psi}\left(\beta^{-1}-\psi\right) & 1 \end{bmatrix} \begin{bmatrix} \mathbb{E}_t\tilde{\pi}_{t+1} \\ \hat{b}_t \end{bmatrix} \overset{!}{=} 0, \tag{37}
$$

which implies equation (18) in the main text.

Assuming $\delta - \beta^{-1} + \psi \neq 0$, then the following holds true

$$
\mathbb{E}_t\tilde{\pi}_{t+1} = \frac{\delta-\beta^{-1}+\psi}{b\left(\psi-\beta^{-1}\right)}\hat{b}_t. \tag{38}
$$

Now that we know the law of motion for inflation expectations, we can use the monetary-block equation (14) to work out the law of motion for inflation, which is

$$
\tilde{\pi}_t = \psi^{-1}\frac{\delta-\beta^{-1}+\psi}{b\left(\psi-\beta^{-1}\right)}\hat{b}_t + \psi^{-1}\epsilon_t^d. \tag{39}
$$

Combining this equation with equation (15) yields:

$$
\tilde{\pi}_t = \underbrace{\frac{\delta-\beta^{-1}+\psi}{b\left(\psi-\beta^{-1}\right)}}_{\xi}\hat{b}_{t-1} - \frac{\xi}{\beta^{-1}-\delta}\epsilon_t^\tau + \left[\beta^{-1}-\delta\right]^{-1}\epsilon_t^d. \tag{40}
$$

Analogously, combining the law of motion for inflation with the fiscal-block equation (15) we obtain

$$\hat{b}_t = \left[\left(\beta^{-1}-\delta\right)+b_*\left(\psi-\beta^{-1}\right)\xi\right]\hat{b}_{t-1}+b_*\left(\psi-\beta^{-1}\right)\left[-\delta+\beta^{-1}\right]^{-1}\epsilon_t^d+ \tag{41}$$

$$-\left[1+\frac{\xi b_*\left(\psi-\beta^{-1}\right)}{\left[-\delta+\beta^{-1}\right]}\right]\epsilon_t^\tau. \tag{42}$$

Note that

$$\left[\left(\beta^{-1}-\delta\right)+b_*\left(\psi-\beta^{-1}\right)\xi\right]=\psi,$$

and hence,

$$\left[1+\frac{\xi b_*\left(\psi-\beta^{-1}\right)}{\left[-\delta+\beta^{-1}\right]}\right]=\left[\frac{\psi}{-\delta+\beta^{-1}}\right].$$

Therefore,

$$\hat{b}_t=\psi\hat{b}_{t-1}-\frac{b_*\left(\beta^{-1}-\psi\right)}{\beta^{-1}-\delta}\epsilon_t^d-\left[\frac{\psi}{-\delta+\beta^{-1}}\right]\epsilon_t^\tau. \tag{43}$$

The system of linear equations (40)-(43) can be written in matricial form as follows:

$$\begin{bmatrix}\tilde{\pi}_t\\ \hat{b}_t\end{bmatrix}=\begin{bmatrix}0 & \xi\\ 0 & \psi\end{bmatrix}\begin{bmatrix}\tilde{\pi}_{t-1}\\ \hat{b}_{t-1}\end{bmatrix}+\begin{bmatrix}\frac{1}{\beta^{-1}-\delta} & -\frac{\xi}{-\delta+\beta^{-1}}\\ -\frac{b_*\left(\beta^{-1}-\psi\right)}{\beta^{-1}-\delta} & -\left[\frac{\psi}{-\delta+\beta^{-1}}\right]\end{bmatrix}\begin{bmatrix}\epsilon_t^d\\ \epsilon_t^\tau\end{bmatrix}.$$

B Log-linearization of the DSGE Model

The Markov-switching process for d_t represents a non-Gaussian shock. In order to log-linearize the model, we follow these steps (for more details see Schorfheide 2005; Liu, Waggoner, and Zha 2011; Bianchi and Ilut 2017; and Bianchi, Ilut, and Schneider 2017):

1. Compute the ergodic mean $\overline{d}$ for the preference shock d_t.
2. Verify that the zero lower bound is not binding at $\overline{d}$.
3. Define the regimes in terms of policymakers' behavior and the value for the preference shock: $\xi_t \equiv \left(\xi_t^d, \xi_t^p\right)$.
4. Conditional on each regime, linearize/log-linearize all equations around the deterministic steady state and define deviations of the preference shock from its ergodic mean as $\widetilde{d}_t = d_t - \overline{d}$ and $\widetilde{\overline{d}}_{\xi_t^d} = \overline{d}_{\xi_t^d} - \overline{d}$. Notice that $\widetilde{d}_t$ can assume only two values $\widetilde{\overline{d}}_h$ and $\widetilde{\overline{d}}_l$ and that the non-linearity associated to a regime change is retained.
5. Use the methods developed by Farmer et al. (2009) to solve the model. The solution algorithm returns a MS-VAR whose parameters depend on the probability of moving

Parameter	Value	Parameter	Value
$\psi_{\pi,M}$	1.7890	p_{hh}	0.9999
$\psi_{y,M}$	0.4413	p_{ll}	0.9465
$\rho_{R,M}$	0.8697	p_{MM}	0.9902
$\delta_{b,M}$	0.0778	p_{FF}	0.9932
$\rho_{\tau,M}$	0.9666	p_{CC}	0.9000
$\psi_{\pi,F}$	0.6903	δ_y	0.2814
$\psi_{y,F}$	0.2655	ϕ_y	-2.0000
$\rho_{R,F}$	0.6576	ρ_{tr}	0.4620
$\delta_{b,F}$	0.0000	$\overline{d}_h$	0.0429
$\rho_{\tau,F}$	0.6501	$\overline{d}_l$	-0.1300
$\psi_{\pi,C}$	2.0000	κ	0.0072
$\psi_{y,C}$	0.0000	$b_*/4$	0.2795
$\delta_{b,C}$	0.0000	$100\ln\gamma$	0.4120
$\rho_{R,C}$	0.0000	$100\ln\Pi$	0.5000
$\rho_{\tau,C}$	0.6501	$100\ln R$	1.0628
$100\sigma_r$	0.1912	$100\sigma_\tau$	0.4448
ρ_d	0.3926	$100\sigma_d$	7.4484
ρ_{tr}	0.4620	$100\sigma_{tr}$	0.2976
ρ_g	0.9796	$100\sigma_g$	0.2806
ρ_a	0.5005	$100\sigma_a$	0.6189
ρ_{tr^*}	0.9900	$100\sigma_{tr^*}$	0.1000
ρ_μ	0.4823	$100\sigma_\mu$	0.1749

Table 2: Parameter values and transition matrix elements calibrated based on Bianchi and Melosi (2017).

across regimes H, the structural parameters θ, and the current state ξ_t:

$$Z_t = c\left(\xi_t, H, \theta\right) + T\left(\xi_t, H, \theta\right) Z_{t-1} + R\left(\xi_t, H, \theta\right) Q\epsilon_t,$$

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

Unlike other papers that have used the technique described here, our model allows for non-orthogonality between policymakers' 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, including the zero lower bound, and the ensuing exit strategies. This proposed method is general and can be applied to other cases in which a shock induces a change in the structural parameters.

C Parameter Values

Table 2 reports the parameter values we have used to calibrate the model that we have studied in the main text of the paper. These are based on the posterior mode estimated by Bianchi and Melosi (2017).

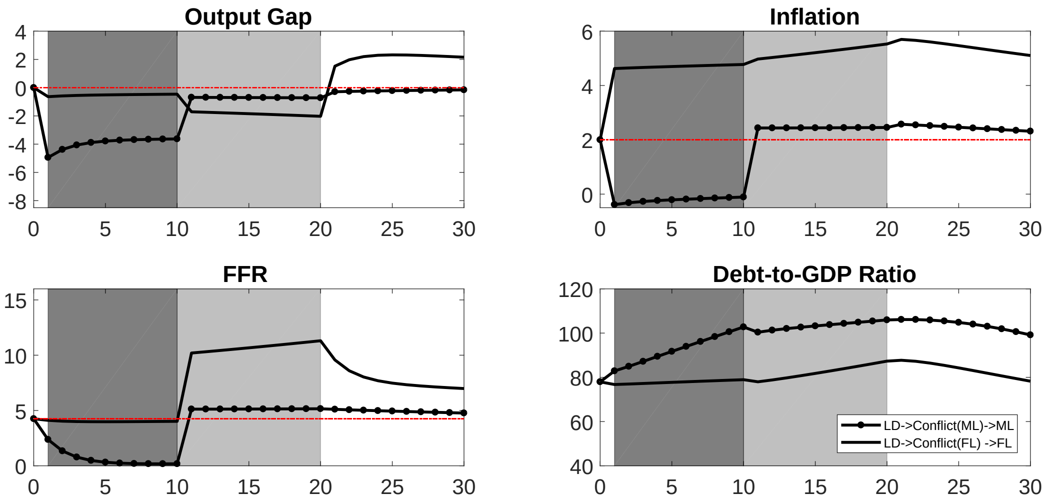

Figure 8: Dynamics of the output gap, inflation, the federal funds rate (FFR), and the debt-to-GDP ratio when a negative discrete demand shock occurs in period 1 and persists until period 10 (the dark gray area). The discrete demand shock switches back to high from period 11 through period 30. Agents expect a conflict between the two authorities following the end of the low-demand shock period. The conflict is assumed to occur from period 11 through period 20 (the light gray area). The solid line captures the case in which agents expect that the fiscal authority will win the conflict and, hence, the policy mix is expected to be fiscally led after the conflict. The dotted line captures the case in which the monetary authority is expected to prevail and, hence, the policy mix is expected to be monetary led after the conflict period. Unlike in the main text (Figure 4), the probability of staying in the conflict regime is 0.75 and the central bank's response to inflation under the fiscally-led regime is 0.1. The dashed-dotted line captures the steady-state values.

D Expected Resolution and the Low-Demand Period's Output Gap

As shown in Figure 4, the output gap during the low-demand period is remarkably similar regardless of the expected resolution of the conflict. This result is not general and does not imply that the expected resolution of the conflict is always inconsequential for the output dynamics during low-demand periods.

To illustrate this point, we tweak the value of two key parameters. One parameter is the probability p_{CC}, which controls the expected duration of the institutional conflict. We lower this parameter from 0.90 (as noted in Table 1) to 0.75. This has the effect of mitigating the expected double-dip recession for the case in which agents expect a fiscally-led resolution of the conflict (i.e., the fiscal authority is expected to emerge from the institutional conflict victorious). Furthermore, we lower the central bank's response to inflation under the fiscally-led policy mix ($\psi_{\pi,F}$) from 0.6903 to 0.1. This alternative parameterization makes the central bank less aggressive when it comes to adjusting the nominal rate to stabilize inflation in the fiscally-led regime.

Figure 8 shows the outcomes under these alternative values assigned to the probability p_{CC}

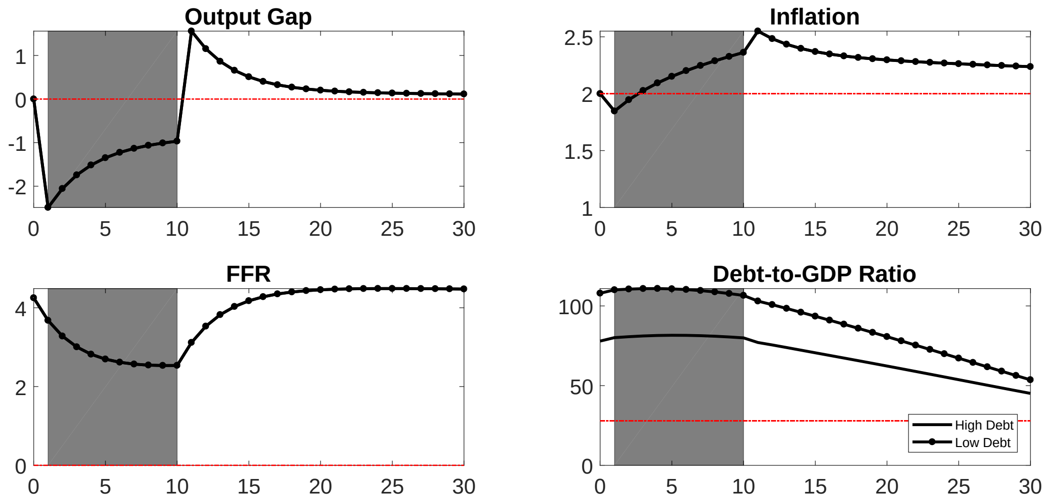

Figure 9: Dynamics of the output gap, inflation, federal funds rate (FFR), and debt-to-GDP ratio after a negative discrete demand shock that occurs in period 1 and persists until period 10 (the gray area). The state of demand switches to the high regime from period 11 through period 30. The lines capture these dynamics when the emergency-budget rule is implemented under two different initial debt-to-GDP ratios. The economy described by the dotted line starts with a higher initial debt. The dashed-dotted line captures the steady-state values.

and the policy parameter $\psi_{\pi,F}$. Contrary to Figure 4, different expectations about how the conflict will be resolved lead to radically different implications for the dynamics of the output gap during the low-demand period (the dark gray area). If agents expect the the fiscal authority will emerge victorious from the institutional conflict (solid line in both Figure 4 and Figure 8), the inflation generated from the fiscal imbalance leads to a lower real interest rate and, hence, to stronger economic activity compared with the case in which the central bank is relatively more hawkish when the fiscally-led regime is in place ($\psi_{\pi,F} = 0.6903$ as in Table 1). Since forward-looking agents anticipate these effects, the recession is greatly mitigated and inflation jumps above target during the low-demand period. Furthermore, expecting a shorter lasting conflict following the low-demand period further improves economic activity during the low-demand period.

E Model with an Emergency-Budget Rule

To do the exercise in Section 5, we write the linearized equations derived from the model of Section 3. Nonetheless, we use the policy rules (29)-(30) to describe the policymakers' behavior. This set of equations describe the actual economy. For the model to be mathematically well specified, we need to add the equations that capture the law of motion for the debt and inflation in the shadow economy, which are denoted by $\hat{b}_t^S$ and $\tilde{\pi}_t^S$. This set of equations is exactly the same as the one of the actual economy with the exception of the Euler equation that reads

$$\tilde{y}_t^S = -\left[\tilde{R}_t^S - \mathbb{E}_t \tilde{\pi}_{t+1}^S - (1-\rho_d)\, d_t\right] + \rho_a a_t + \mathbb{E}_t \tilde{y}_{t+1}^S + \left(1-\rho_g\right)\tilde{g}_t, \tag{44}$$

and the fiscal and monetary rules that read

$$\hat{\tau}_t^S = \rho_{\tau,M}\hat{\tau}_{t-1} + \left(1-\rho_{\tau,M}\right)\left[\delta_{b,M}\hat{b}_{t-1}^S + \left(1-\rho_{\tau,M}\right)\delta_y\left(\tilde{y}_t^S - \tilde{y}_t^{*S}\right)\right] + \sigma_\tau \epsilon_{\tau,t}, \tag{45}$$

$$\tilde{R}_t^S = (1-\rho_{R,M})\left(\psi_{\pi,M}\tilde{\pi}_t^S + \psi_{y,M}\left(\tilde{y}_t^S - \tilde{y}_t^{*S}\right)\right) + \sigma_R \epsilon_{R,t}. \tag{46}$$

Notice that the Euler equation of the shadow economy (44) does not feature the discrete demand shock $\overline{d}_{\xi_t^d}$. Furthermore, the policy rules (45)-(46) feature the monetary-led parameterization. Furthermore, note that the discrete preference shock does not affect potential output. Thus, $\tilde{y}_t^{*S} = \tilde{y}_t^*$.

F Higher Initial Debt-to-Output Ratio

Figure 9 shows the dynamics of the output gap, inflation, the federal funds rate, and the debt-to-GDP ratio when the coordinated strategy of inflating away only the portion of debt resulting from the recession is implemented. We consider two cases that differ from the initial level of debt. As one can see, the initial level of debt does not affect the dynamics of the output gap, inflation, and interest rate whatsoever. This is because policymakers are committed to following the monetary-led policy mix to stabilize the pre-existing level of debt. Since taxation is assumed to be non-distorsive, there are no consequences of fiscal adjustments for the macroeconomy in these cases.

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