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Seemingly Irresponsible but Welfare Improving Fiscal Policy at the Lower Bound*

Roberto M. Billi
Sveriges Riksbank

Carl E. Walsh
University of California
Santa Cruz

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Abstract

In this paper, we evaluate the consequences of *super-active* fiscal policy rules—that is, rules that call for tax cuts and/or spending increases as the government's debt level rises—in a standard New Keynesian model subject to an occasionally-binding zero lower bound on the monetary policy interest rate. We show that such seemingly irresponsible, debt-financed fiscal stimulus at the ZLB, unbacked by any promise of future tax increases or spending cuts, not only improves economic stability by acting as an automatic stabilizer, but also, somewhat paradoxically, reduces government debt accumulation. When evaluated using a model-consistent measure of welfare, fiscal rules calibrated to the U.S. response during both the Great Recession and COVID recession, combined with a weak monetary policy response to inflation, outperform a monetary policy that responds strongly to inflation *and* reduce the frequency of episodes at the ZLB.

Keywords: automatic stabilizers, fiscal and monetary interactions, government debt.

JEL: E31, E52, E63.

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*E-mail: roberto.billi@riksbank.se and walshc@ucsc.edu. We thank for valuable comments Guido Ascari, Francesco Bianchi, John Cochrane, Richard Harrison, Eric Leeper, Athanasios Orphanides, Bruce Preston, and seminar participants at Sveriges Riksbank. The views expressed herein are solely the responsibility of the authors and should not be interpreted as reflecting the views of Sveriges Riksbank.

1 Introduction

We use a stylized, calibrated New Keynesian model to study the role that active fiscal policies in the form of debt-financed fiscal expansions might play in stabilizing inflation and output when the zero lower bound (ZLB) on nominal interest rates can render monetary policy ineffective. In line with the recent research on new monetary-policy frameworks to deal with the ZLB, which assumes that central banks can commit to rules responding to inflation, we extend the standard approach by incorporating simple fiscal rules governing purchases and taxes net of transfers in response to the government debt level.

In contrast to the standard approach, however, we consider policy regimes in which it is fiscal policy that stabilizes inflation while monetary policy responds weakly (or not at all) to inflation. We find that, in the face of contractionary aggregate-demand shocks that occasionally drive the nominal interest rate to the ZLB, a regime of passive monetary policy and active fiscal policy can reduce both the frequency of the ZLB and the welfare costs of inflation fluctuations when rising debt levels trigger an *increase* in government purchases and/or a *cut* in taxes net of transfers.

Our paper makes three primary contributions. First, we evaluate the consequences of adopting simple fiscal rules that would normally be viewed as prescribing “irresponsible” fiscal behavior: debt-financed fiscal expansions unbacked by any promise of future tax increases or spending cuts. We refer to these policies as *super-active* fiscal policies. The resulting debt expansions generate expectations of higher future inflation. If combined with a weak monetary policy response to inflation, the rise in expected inflation lowers the real interest rate and boosts aggregate demand. To ensure a unique, stationary rational-expectations equilibrium, such fiscal rules must be combined with monetary policy responses to inflation that violate the Taylor principle.

Importantly, the ZLB places no constraint on the government’s ability to tax less and spend more to offset contractionary shocks to aggregate demand. In contrast, an active monetary policy seeking to stabilize current inflation will fail to raise inflation expectations if the ZLB binds; active monetary policy becomes ineffective. Away from the ZLB, however, active monetary policy can stabilize inflation and output without any fiscal stimulus. Thus, a welfare comparison of whether monetary policy or fiscal policy should be active will depend on their relative performances both at the ZLB and away from it and on the frequency of the ZLB under each policy alternative.

Our second contribution is to carry out such a welfare comparison employing a model-consistent measure of the welfare costs of fluctuations. We show that super-active fiscal policies can dominate less active fiscal policies as well as active monetary policies. This remains the case when the debt target is increased and when the government issues long-term debt. However, super-active fiscal policies are most effective with a high debt target and when debt is short-term. The normative assessment suggests that both the existing literature and policy discussions based on conventional wisdom have focused too exclusively on the role of active monetary policies in the face of the ZLB.

Our third contribution is to calibrate the fiscal rules to reflect the size of the fiscal responses seen in the U.S. during the Great Recession and the COVID recession, and thus show that super-active fiscal policies are effective in stabilizing inflation and output in the face of the ZLB. Accounting for the ZLB, the welfare costs of fluctuations under these policies are slightly lower than achieved by active monetary policy. The fiscal response during the Great Recession was concentrated on tax cuts and transfer increases, while that in 2020 during the COVID pandemic represented a more balanced increase in purchases and cut in net taxes. In the model simulations, the COVID response reduced inflation volatility and resulted in a welfare improvement relative to the fiscal response during the Great Recession. Both examples of super-active fiscal policies are particularly effective if they are combined with a passive monetary policy that pegs the nominal interest rate to its steady state, eliminating the occurrence of the ZLB.

The paper is organized as follows. Section 2 reviews the relevant literature and highlights our contribution therein. We employ a simple New Keynesian model for our analysis, and this is set out in Section 3, which also discusses the policy rules we consider, reviews the intuition for why active fiscal polices might improve outcomes facing the ZLB, and discusses the calibration of the model. We use the model in Section 4 to investigate the effects of active fiscal polices in the face of a contractionary shock to aggregate demand. In Section 5 we investigate whether our results depend on the debt-to-GDP target and on the introduction of long-term debt. Section 6 evaluates the impact of a negative demand shock when the fiscal responses are calibrated to those seen in the U.S. during the Great Recession and the COVID recession. Conclusions are summarized in Section 7.

2 Related Literature

Our paper contributes to the large literature on designing policies to achieve macroeconomic stability in the face of the ZLB. This literature has been prompted by the extended periods of low and even negative interest rates experienced in many countries and by evidence of a declining natural rate of interest (see for example Holston, Laubach and Williams (2017)), which increase the likelihood of future ZLB episodes. Early work on optimal monetary policy at the ZLB, such as Eggertsson and Woodford (2003, 2006), Adam and Billi (2006), and Nakov (2008), showed that central banks should promise to keep their policy rate at zero for longer, not raising rates as soon as doing so might become feasible. If credible, such promises induce expectations of higher future inflation, helping to mitigate the policy limitations arising from the ZLB.

Policies that involve promising higher future inflation to make up for past deviations below target, so-called "make-up" strategies such as price-level targeting or average inflation targeting, are, in general, time inconsistent.[1] A number of these strategies were discussed in Svensson (2020) as part of the Federal Reserve's recent review of its policy framework, and in August 2020 the Federal Open Market Committee (FOMC) announced it "seeks to achieve inflation that averages 2 percent over time." That is, periods of below (above) 2 percent inflation are expected to be followed by periods during which inflation rises (falls) above 2 percent.

The research on new monetary policy rules and goals to deal with the ZLB has, however, generally ignored the role of fiscal policy.[2] Nevertheless, monetary policy actions have implications for the government's budget, and the ability of a central bank to achieve its inflation target depends on the behavior of the fiscal authority. Standard analyses of monetary policy assume, in the terminology of Leeper (1991), an *active monetary* policy (AM) aimed at controlling inflation, implicitly combined with a *passive fiscal* policy (PF) that ensures debt sustainability.[3] The Fed's policy framework review, for example, took as given that any candidate framework would involve just such an active monetary policy and passive fiscal policy (AM/PF) arrangement.

Several authors have emphasized the role that active fiscal policy might play at the ZLB. According to Sims (2016) (p. 315) the key question is: "Can fiscal deficit finance replace ineffective

[1] For an analysis of price-level targeting in an environment away from the ZLB, see Nessén and Vestin (2005) and Vestin (2006). The ZLB and its implications for the choice of central-bank goals are investigated in Billi (2017, 2018, 2020), Billi, Söderström and Walsh (2020), and Budianto, Nakata and Schmidt (2020), among others.

[2] As part of the FOMC's review of its policy framework, in June 2019 a research conference was held at the Federal Reserve Bank of Chicago. The papers from the conference were published in the *International Journal of Central Banking*, vol. 16(1), February 2020. However, none of the papers discussed the interactions between monetary and fiscal policies, or the role fiscal rules might play if monetary policy is limited in achieving its goals due to the ZLB.

[3] Leeper and Leith (2016) discuss the literature on interactions between monetary and fiscal policies and their role in determining macroeconomic outcomes, particularly the aggregate price level. Sablik (2019) provides a discussion of active and passive policies, budget deficits and inflation, linking active fiscal policies to the fiscal theory of the price level (FTPL) and to modern monetary theory (MMT). For a detailed introduction to FTPL and its relation to New Keynesian analysis, see Cochrane (2021).

monetary policy" at the ZLB? He concludes the answer is yes, but stresses that "fiscal expansion is not the same thing as deficit finance. It requires deficits aimed at, and conditioned on, generating inflation. The deficits must be seen as financed by future inflation, not future taxes or spending cuts." Hence, monetary policy that is ineffective at controlling inflation requires fiscal expansion that is not accompanied by any promise to generate future primary surpluses to finance those deficits; "budget balancing can become bad policy" (Sims (2000) p. 970). Similarly, Eggertsson (2006) calls for the government to "commit to being irresponsible" during periods at the ZLB by creating money to fund a fiscal expansion, inducing expectations of higher future inflation. At the ZLB, creating money and debt financing a fiscal expansion are equivalent, see Galí (2020).

Thus, an era with frequent periods at the ZLB may require a more fundamental change in policy than simply maintaining an active monetary and passive fiscal (AM/PF) regime while adopting a make-up rule based on a price-level target or average inflation. Passive monetary policy and active fiscal policy (PM/AF) regimes also need to be considered. There is some evidence that switches between policy regimes in the U.S. have occurred in the past. Kim (2003) argued that VAR evidence from the U.S. on the inflation and output responses to demand and supply shocks is consistent with a PM/AF regime during the 1940s and 1950s. Davig and Leeper (2011) estimate a regime switching model and find that monetary and fiscal policies in the U.S. have alternated between active and passive regimes. They argue that the pre-1980 period was one of passive monetary policy while the post-1980 period saw episodes during which each of the four possible combinations of active and passive, monetary and fiscal policies prevailed.[4]

Jacobson, Leeper and Preston (2019) offer an historical example of active fiscal policy being employed during the Great Depression in the U.S. They focus on President Franklin Roosevelt's distinction between the *regular* budget, which was governed by conventional budget-balancing concerns, and the temporary *emergency* budget, for which there was no promise that future taxes would be raised to fund the deficit, in arguing that Roosevelt's fiscal policies helped generate the recovery of 1933. The emergency budget constituted active fiscal policy, and was an example of the type of unfunded fiscal expansion that Sims (2016) has called for as necessary at the ZLB to replace ineffective

[4]Davig and Leeper (2011) use an estimated model to explore the impact of shocks to government purchases (such as the 2008 American Recovery and Reemployment Act) in different policy regimes, where the regimes are determined by the properties of policy rules for the nominal interest rate and lump-sum taxes net of transfers. Ascari, Florio and Gobbi (2020) also employ a regime-switching framework that allows for "timid" departures from regimes, ensuring determinacy as long as private agents anticipate a future return to either an AM/PF or PM/AF regime. They define fiscal rules in terms of lump-sum taxes, and their focus is primarily on issues of determinacy and the effects of regimes on the impact of fiscal-spending shocks.

monetary policy. Bianchi, Faccini and Melosi (2020) analyze temporary shock-specific polices (emergency budgets and temporary inflation targets) that can also be interpreted as capturing Roosevelt's distinction between the regular and emergency budgets.

While emergency budgets represent temporary adoption of an active fiscal policy, we examine the welfare implications of permanently adopting a PM/AF regime in an environment in which episodes at the ZLB are frequent under a standard inflation-targeting AM/PF regime.[5] Our analysis is therefore consistent with most of the recent work investigating alternative monetary rules for dealing with the ZLB, where regimes are analyzed as permanent choices among a variety of policy frameworks.[6] To rank alternatives, we use a model-consistent welfare measure of the costs of economic fluctuations. Thus, our measure of the performance of AM/PF and PM/AF policies will depend on their welfare costs at the ZLB and away from it, as well as on the incidence of ZLB episodes.

In related work, Ascari, Florio and Gobbi (2021) examine the relative performance of inflation targeting (IT) and price-level targeting (PLT) in AM/PF and PM/AF regimes.[7] They employ a quadratic loss function to evaluate alternative outcomes with instrument rules for the nominal interest rate and for net taxes (short for *lump-sum taxes net of transfers*). They find that AM/PF dominates PM/AF under PLT, while the comparison of AM/PF and PM/AF under IT depends on the size of the interest rate response to inflation. They show that with an active fiscal policy in which the primary surplus is fixed, performance under IT is improved if monetary policy responds *negatively* to inflation. That is, in the face of a fall in inflation, the policy rate is increased. Our paper is complementary in that they consider a seemingly irresponsible IT regime (raising rates as inflation falls) under active fiscal policy, while our focus is on super-active fiscal policies that reduce the primary surplus as debt levels rise.

Bhattarai, Lee and Park (2014) provide an analytical characterization of inflation dynamics under AM/PF and PM/AF when not constrained by the ZLB. Their focus is primarily on how inflation

[5] Bianchi and Melosi (2019) considered how conflict between active fiscal policy and active monetary policy can lead to "dire" consequences in which the economy enters a spiral of growing debt and declining output in the face of adverse shocks.

[6] An exception is the proposal of *temporary* price-level targeting. Bernanke, Kiley and Roberts (2019) provide an evaluation of temporary price-level targeting (and other strategies implemented as instrument rules) using the Fed's FRB/US model. Svensson (2020) warns that such a strategy, if only applied occasionally and temporarily and when economic agents are not already used to it, would impose challenges for policy communication and may not be credible.

[7] PLT is defined by an interest rate rule expressed in terms of a response to the price level. Defining regimes in terms of what variables appear in an instrument rule contrasts with the approach that defines alternative regimes in terms of the objectives or goals adopted by the central bank. IT and PLT are defined in terms of the objectives in Vestin (2006) and Billi (2017, 2018); see also Svensson (2003) and Walsh (2003, 2019). For a discussion of the choice between rules and goals in the context of monetary policy design, see Walsh (2015).

responds to a change in the central bank's inflation target under the two different regimes, and they ignore issues associated with the ZLB. Our focus is on endogenous responses of government purchases and taxes net of transfers to movement in the level of debt, caused by aggregate demand shocks, when the ZLB can bind. Most relevant for our analysis, however, is their demonstration that "a more active fiscal policy leads to a weaker response of inflation to non-policy shocks." As they explain, this inflation dampening arises due to wealth effects generated by rising debt levels that are not associated with any rise in future primary surpluses.

For the type of super-active fiscal policies we consider, a negative demand shock, by reducing inflation and *increasing* the real value of government debt, induces a *fall* in taxes and/or a *rise* in purchases that further increases outstanding debt. Under a PM/AF regime this rise in government debt held by the public has a positive wealth effect as the government does not plan to raise future taxes or cut purchases. This wealth effect can partially offset the initial negative demand shock.

While we follow much of the literature on active fiscal policy in assuming one-period debt, we also generalize the analysis to consider the role of long-term government debt. Recently, Caramp and Silva (2021) and Leeper (2021) emphasize how the presence of long-term debt implies revaluation effects on existing debt that affect the wealth channel of monetary policy under active fiscal policies. Leeper and Zhou (2021) investigate optimal commitment policies when debt is long-term, while Leeper, Leith and Liu (2021) consider discretionary policies, as does Harrison (2021), who highlights how debt sustainability becomes a constraint on the actions of the central bank when fiscal policy is active. Harrison's work is complementary to ours in that he uses, as we do, a model-consistent quadratic loss function to rank outcomes and specifies fiscal policy as setting an exogenous primary surplus, which as he notes, is one of the specifications we investigate. We differ in adopting a simple rule for monetary policy, while he derives optimal monetary policy, and we consider super-active fiscal policies.

Our focus is on endogenous responses of government purchases and taxes net of transfers to movements in the level of debt caused by aggregate demand shocks. We do not consider the effects of shocks to fiscal spending or taxes. Nor do we focus on the consequences of creating money to finance expenditures; thus our analysis of active fiscal policy is not related to the positions advocated by proponents of modern monetary theory. Bianchi, Faccini and Melosi (2020) consider emergency budgets and temporary inflation targets and analyze a transfer shock based on the 2020 CARES Act with nominal interest rates positive throughout the experiment. Instead, we focus on the role of fiscal rules in contributing to macroeconomic stabilization in the face of aggregate demand shocks that can push the economy to the ZLB, employing fiscal rules for both net taxes and government purchases in a stylized, calibrated New Keynesian model with a ZLB constraint. The rules allow us to study the consequences of systematic differences in how net taxes and government purchases respond to debt levels.

We compare the results of super-active fiscal rules that cut net taxes as the debt level rises, raise government purchases as debt levels rise, or hold the primary surplus constant as debt levels rise. Unlike lump-sum taxes, government purchases affect the natural rate of interest (and natural level of output). We, thus, consider a spending channel through which an active fiscal policy can directly affect aggregate demand and inflation, besides the impact of taxes and purchases on the government's flow-budget constraint. Because we allow net taxes to decrease and government purchases to increase as debt levels rise under a super-active fiscal policy, we can calibrate fiscal expansions to those seen during the Great Recession and COVID recession under the assumption that fiscal authorities are not committing to any future tax increases or spending cuts to fund the fiscal expansion.

3 The Model

We conduct our analysis using a simple version of the New Keynesian model, augmented with a ZLB constraint and with fiscal policy rules in which net taxes and purchases respond to the level of government debt. In this section, we introduce the equations describing the model's equilibrium, discuss how the fiscal rules affect inflation stabilization in a regime of passive monetary policy and active fiscal policy, and then calibrate the model to recent U.S. data.

3.1 Private Sector

The behavior of the private sector is described by the equilibrium conditions that correspond to the closed-economy New Keynesian model with staggered price setting à la Calvo, flexible wages, and without capital accumulation. Government purchases are financed through lump-sum taxes and the issuance of debt. All equations are log-linearized around a steady state with no trend growth, zero government purchases and zero price inflation, and with a subsidy that exactly offsets the steady-state distortions arising from price markups. Derivations can be found in Galí (2015) chapter 3, Walsh (2017) chapter 8, and Galí (2020).

The supply side of the economy is described by a New Keynesian Phillips curve:

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \kappa \tilde{y}_t, \tag{1}$$

where π_t is the rate of price inflation between periods $t-1$ and t. The parameter β denotes the household's discount factor. $\tilde{y}_t \equiv \hat{y}_t - \hat{y}_t^n$ denotes the output gap, where $\hat{y}_t \equiv \log(Y_t/Y)$ denotes (log) output in deviation from its steady state, and where $\hat{y}_t^n \equiv \log(Y_t^n/Y)$ represents the (log) deviation of the natural level of output, i.e. output's equilibrium level in the absence of nominal rigidities, as a deviation around its steady state.

The natural (flexible-price) level of output is given by $\hat{y}_t^n \equiv \Gamma \hat{g}_t$, where $\Gamma \equiv \frac{\sigma(1-\alpha)}{\alpha+\varphi+\sigma(1-\alpha)}$ and $\hat{g}_t \equiv (G_t - G)/Y$ denotes the deviation of (real) government purchases from its steady state as a share of steady-state output. The parameters α, σ and φ denote the degree of decreasing returns to labor in production, the household's coefficient of relative risk aversion and the curvature of labor disutility, respectively. In the neighborhood of a steady state with zero government purchases ($G=0$), the goods-market equilibrium condition is given by $\hat{y}_t = \hat{c}_t + \hat{g}_t$, where $\hat{c}_t \equiv \log(C_t/C)$ denotes (log) private consumption expressed as a deviation from its steady state. In addition, the slope of the Phillips curve is given by $\kappa \equiv \lambda\left(\sigma + \frac{\alpha+\varphi}{1-\alpha}\right)$, where $\lambda \equiv \frac{(1-\theta)(1-\beta\theta)(1-\alpha)}{\theta(1-\alpha+\alpha\epsilon)}$. The parameter $\theta \in [0,1)$ denotes the Calvo index of price rigidity (the probability that a firm does not reset its price in a given period), and $\epsilon > 1$ denotes the elasticity of substitution among varieties of goods.

The demand side of the economy is described by a dynamic IS equation:

$$\tilde{y}_t = E_t \{\tilde{y}_{t+1}\} - \frac{1}{\sigma}\left(\hat{\imath}_t - E_t\{\pi_{t+1}\} - \hat{r}_t^n\right), \tag{2}$$

where $\hat{\imath}_t \equiv i_t - \rho$ denotes the short-term nominal interest rate expressed as a deviation from its steady state, and the latter corresponds to the discount rate $\rho \equiv 1/\beta - 1 > 0$. The short-term real interest rate is given by $\hat{r}_t \equiv \hat{\imath}_t - E_t\{\pi_{t+1}\}$. The natural rate of interest is given by $\hat{r}_t^n \equiv (1-\rho_z) z_t - \sigma(1-\Gamma) E_t\{\Delta \hat{g}_{t+1}\}$, where z_t is a preference shifter (aggregate-demand shock) which follows an exogenous $AR(1)$ process with autoregressive coefficient ρ_z and standard deviation σ_z.[8]

A key objective of our analysis is the evaluation of fiscal and monetary policy from a welfare

[8] This shock's innovation is an i.i.d. normally distributed process with zero mean and standard deviation given by $\sigma_{ez} = \sigma_z\sqrt{1-\rho_z^2}$. Furthermore, z_t is interpreted as a shock to the effective discount factor; it affects the household's marginal utility of consumption and marginal value of leisure, while leaving unaffected the marginal rate of substitution between consumption and leisure. Thus, z_t affects $\hat{r}_t^n$ but not $\hat{y}_t^n$ in the model.

perspective. For that purpose, we use as a welfare metric the second-order approximation of the average welfare loss experienced by the representative household as a consequence of fluctuations around an efficient steady state with zero inflation and zero government purchases. We express this social welfare loss as a fraction of steady-state consumption:

$$\mathbb{L} = \frac{1}{2}\left[\frac{\epsilon}{\lambda} var\left(\pi_t\right) + \frac{\kappa}{\lambda} var\left(\tilde{y}_t\right) + \frac{\gamma\kappa}{\lambda} var\left(\hat{g}_t\right)\right], \tag{3}$$

where $\gamma \equiv \Gamma\left(1 - \Gamma + \frac{\delta}{\sigma}\right)$, and where δ denotes the curvature of utility from government purchases. The welfare loss has three components, respectively associated with the volatilities of inflation, the output gap, and government purchases. A discussion can be found in Woodford (2011).

3.2 Government Budget and Policy Regimes

The fiscal authority finances its spending through two sources: net taxes (*lump-sum taxes net of transfers*) and the issuance of nominally riskless one-period bonds with a nominal yield i_t. (Section 5 extends the model to include long-term debt.) After log-linearization around a steady state with no trend growth and zero inflation, the following difference equation describes the evolution of real government debt as a share of steady-state output, thereby representing the government's flow-budget constraint:[9]

$$\hat{b}_t = \beta^{-1}\hat{b}_{t-1} + \beta^{-1} b\left(\hat{\imath}_{t-1} - \pi_t\right) + \hat{g}_t - \hat{\tau}_t, \tag{4}$$

where $\hat{b}_t \equiv \left(B_t - B\right)/Y$ and $\hat{\tau}_t \equiv \left(T_t - T\right)/Y$ denote, respectively, deviations of (real) government debt and net taxes from their steady state, expressed as a fraction of steady-state output. B_t denotes the (real) market value of government debt. The parameter $b \equiv B/Y$ denotes the long-run debt target as a share of steady-state output.

In (4) the government debt issuance for the current period, $\hat{b}_t$, is determined by three cost components expressed as deviations from their steady state. The first part is the cost to refinance (roll over) the outstanding debt, $\beta^{-1}\hat{b}_{t-1}$. The second part is the (real) interest cost to service the debt outstanding, $\beta^{-1} b\left(\hat{\imath}_{t-1} - \pi_t\right)$. And the third part captures the "primary surplus" (defined in official statistics as the fiscal balance net of any interest payments) which may be in surplus or deficit. Let $\hat{s}_t \equiv \hat{\tau}_t - \hat{g}_t$ denote the *primary surplus*, then $\hat{s}_t < 0$ (i.e. $\hat{\tau}_t < \hat{g}_t$) indicates that the fiscal balance excluding interest payments is in *deficit* rather than surplus.

[9] See, for example, Walsh (2017) chapter 4 and Galí (2020) for a discussion.

The fiscal authority controls the primary balance with rules that specify how both net taxes and government purchases respond to deviations of the outstanding stock of government debt from its steady state. When log-linearized, the fiscal rules take the form:

$$\hat{\tau}_t = \psi_\tau \hat{b}_{t-1}, \tag{5}$$

$$\hat{g}_t = \psi_g \hat{b}_{t-1}. \tag{6}$$

These fiscal policy rules together imply a rule for the primary surplus in response to the debt level, $\hat{s}_t = \psi_s \hat{b}_{t-1}$, where $\psi_s \equiv \psi_\tau - \psi_g$. Moreover, combining (4) through (6), we obtain:

$$\hat{b}_t = \left(\beta^{-1} - \psi_s\right) \hat{b}_{t-1} + \beta^{-1} b \left(\hat{\imath}_{t-1} - \pi_t\right). \tag{7}$$

Hence, as this combined version of the government's flow budget shows, the choice of coefficients in the fiscal rules, ψ_τ and ψ_g, allows the fiscal authority to affect directly the accumulation of government debt through the response of the primary surplus $\psi_s \equiv \psi_\tau - \psi_g$. In particular, a lower ψ_τ and/or a higher ψ_g increase the outstanding debt from period $t-1$ that must be refinanced. All else equal, the lower ψ_s would lead to a higher debt issuance in period t to satisfy the government's budget. The government debt issuance, however, is not determined by fiscal policy alone; rather it is the result of the joint behavior of the fiscal authority and the central bank that will determine inflation and the nominal interest rate. To close the model economy, we need also a description of monetary policy.

We adopt a standard rule for the nominal interest rate, namely a truncated Taylor-type rule that incorporates explicitly a ZLB constraint ($i_t \geq 0$ implying $\hat{\imath}_t \geq -\rho$):

$$\hat{\imath}_t = \max\left[-\rho, \phi \pi_t\right]. \tag{8}$$

In our analysis we have two policy regimes, characterized by the configuration of the response coefficients ϕ, ψ_g and ψ_τ in the above monetary and fiscal rules. Namely, in the terminology of Leeper and Leith (2016), we study regimes M and F. Under *regime M*, active monetary policy (AM) aimed at controlling inflation is combined with a passive fiscal policy (PF) ensuring debt sustainability: $\phi > 1$ and $\psi_s \equiv \psi_\tau - \psi_g > \rho$. That is, in regime M, with $\phi > 1$ in rule (8), the nominal interest rate responds more than one-for-one to movement in inflation and therefore the Taylor principle is satisfied. With $\psi_s > \rho$, the coefficient on the lagged debt stock in (7) is smaller than unity, $\beta^{-1} - \psi_s = 1 + \rho - \psi_s < 1$, which ensures the debt level converges to its long-run target. Conversely, in *regime F*, active fiscal policy (AF) controls inflation and monetary policy responds passively (PM) to ensure debt sustainability: $\phi < 1$ and $\psi_s < \rho$.

Consistent with the standard analysis of policy rules in the monetary policy literature, we assume that both the fiscal authority and the central bank are able to credibly commit to follow the policy rules (5), (6), and (8). At the same time, private agents in the economy form expectations knowing that the policy authorities will abide by those policy rules. A discussion of the feasibility of implementing such a set of policy rules is postponed until our concluding section. We next discuss how active fiscal policy in regime F and the choice of fiscal instrument affects the response of inflation to demand shocks.[10]

3.3 Inflation Stabilization in Regime F

To discuss inflation stabilization under regime F, we investigate how the fiscal rules for net taxes and government purchases influence the economy's adjustment to a negative demand shock. Under regime F, $\phi < 1$ and $\psi_s < \rho$ in the policy rules (PM/AF). It will simplify the discussion to set $\phi = 0$ in the monetary policy rule, implying the nominal interest rate is pegged to its steady state and does not react at all to inflation: $\hat{\imath}_t = 0$ and $i_t = \rho > 0$ for all t. We relax this assumption in Section 4 when we report simulation results for passive monetary policy with $0 \leq \phi < 1$. Because our focus is on the consequences of negative aggregate-demand shocks, we review the key mechanism through which debt dynamics affect the inflation response to such shocks.

The equilibrium conditions for regime F consist of the Phillips curve and IS equation, (1) and (2), together with the debt accumulation equation, (7). As is well-known, with the nominal interest rate pegged, (1) and (2) fail the Blanchard-Kahn conditions and are consistent with multiple stationary equilibria (see Leeper (1991)). However, (7) pins down the unique equilibrium level of inflation consistent with stationarity of the government debt level as a share of output. To highlight the role played by inflation in an PM/AF regime in ensuring debt sustainability, we proceed with two

[10] One could add exogenous stochastic components to the policy rules (5), (6), and (8) without qualitatively affecting our results. We restrict attention to simple rules for both fiscal and monetary policy. At the ZLB, monetary policy is effectively constrained to be passive, and Burgert and Schmidt (2014) show that government spending and debt rise under the optimal discretionary policy. They find that the rise in government spending when the ZLB is hit depends negatively on the initial level of debt. Nakata (2017) studies the optimal commitment policy in a similar environment. He finds that the ability to commit to future policies implies a higher initial debt level leads to a larger spending response. In both these papers, fiscal and monetary instruments are optimally chosen by a single policymaker.

examples of active fiscal policies in the face of a contractionary shock to aggregate demand.

Case 1. No fiscal response. One example of an active fiscal policy in regime F involves setting $\psi_\tau = \psi_g = 0$. That is, neither net taxes nor government purchases respond to deviations of debt from its steady state.[11] As a consequence, neither does the primary surplus react to the debt level, $\psi_s = 0$. In this case, as the nominal interest rate is pegged, $\hat{\imath}_t = 0$ for all t, the debt accumulation equation (7) reduces to

$$\hat{b}_t = \beta^{-1}\hat{b}_{t-1} - \beta^{-1}b\pi_t. \tag{9}$$

Consider a negative demand shock that causes a fall in the output gap and inflation. The fall in π_t increases the (real) interest expense to service the outstanding debt, $-\beta^{-1}b\pi_t$ rises, worsening the fiscal authority's debt outlook. Moreover, the impact of inflation on the debt outlook, conditional on the lagged debt stock, is increasing in the debt target b. Because $\beta^{-1} > 1$, we solve the debt equation forward to obtain

$$\hat{b}_{t-1} = b\sum_{i=0}^{\infty}\beta^i\pi_{t+i} + \lim_{i\to\infty}\beta^{i+1}\hat{b}_{t+i}. \tag{10}$$

For a stationary equilibrium, the discounted future debt level must converge to zero, implying

$$\hat{b}_{t-1} = b\left[\pi_t + \sum_{i=1}^{\infty}\beta^i\pi_{t+i}\right]. \tag{11}$$

With monetary policy nonreactive ($\hat{\imath}_{t+j} = 0$ for $j \geq 0$), the present discounted value of inflation is fixed at $\hat{b}_{t-1}/b$. The fall in current inflation, $\pi_t < 0$, due to the negative demand shock, must therefore generate higher future inflation to ensure a stationary debt process. This reasoning is similar to the "unpleasant monetarist arithmetic" of Sargent and Wallace (1981), though they focused on the need for future seigniorage revenue to rise to balance the intertemporal government budget, while here debt sustainability is accomplished through the impact of inflation on the real value of the outstanding debt.[12] In the face of a negative demand shock, however, raising expectations of future inflation helps to stabilize the economy when the nominal interest rate fails to adjust. For this reason, regime F may help stabilize the economy when monetary policy is unable to respond.

In an active monetary policy regime, the rise in real debt holdings of households resulting from

[11] This is equivalent to making fiscal policy exogenous and is the active fiscal policy considered by Ascari, Florio and Gobbi (2021) and by Harrison (2021).

[12] A discussion can be found in Bhattarai, Lee and Park (2014).

the fall in inflation is offset by the negative wealth effect generated as households anticipate a rise in the present value of future tax payments. Under active fiscal policy with $\psi_s = 0$, there is no negative wealth effect from future taxes offsetting the rise in the real value of household debt holdings.

Case 2. Tax cuts or spending increases if debt rises. The same qualitative results hold if active fiscal policy involves setting $\psi_s < \rho$. This includes the case we describe as super-active fiscal policy in which $\psi_\tau < 0$ (taxes are cut as the debt level rises) and $\psi_g > 0$ (spending increases as the debt level rises). With $\psi_s < \rho$ so that $\beta^{-1} - \psi_s > 1$, the debt accumulation equation (9) is modified to become

$$\begin{aligned} \hat{b}_t &= \left(\beta^{-1} - \psi_s\right) \hat{b}_{t-1} - \beta^{-1} b \pi_t \\ &= \beta^{-1} \left(1 - \beta\psi_s\right) \hat{b}_{t-1} - \beta^{-1} b \pi_t. \end{aligned} \tag{12}$$

Solving this forward yields

$$\left(1 - \beta\psi_s\right) \hat{b}_{t-1} = b \left[\pi_t + \sum_{i=1}^{\infty} \left(\frac{\beta}{1 - \beta\psi_s} \right)^i \pi_{t+i} \right]. \tag{13}$$

The left side is the amount of debt that needs to be repaid, while the right side is the present value of the inflation needed to ensure debt does not explode. Consider a super-active fiscal policy in which the primary surplus rises as debt rises. With $\psi_s < 0$, the debt to be repaid is $\beta^{-1} \left(1 - \beta\psi_s\right) \hat{b}_{t-1} > \beta^{-1} \hat{b}_{t-1}$. Under a super-active fiscal policy, $\psi_s < 0$, a marginal increase in debt generates a fall in the primary surplus, leading to additional borrowing; the left side of (13) rises, increasing the amount, in present value terms, that inflation must rise to ensure debt sustainability.

The parameter ψ_s also appears on the right side of (13), where it affects the discount factor used in calculating the present discounted value of future inflation in contributing toward debt sustainability. The present discounted value of inflation depends *negatively* on ψ_s. Decreasing ψ_s decreases $\beta / \left(1 - \beta\psi_s\right)$, implying for any given fall in current inflation, $\pi_t < 0$, a larger rise in future inflation is required to ensure the stock of debt remains stationary. To the extent current inflation does not reduce the real value of outstanding debt, primary surpluses in the future will be smaller, implying higher future levels of debt that must be inflated away. The higher expected inflation helps to offset a current negative demand shock. Hence, in regime F, an active fiscal policy that *cuts* the primary surplus by cutting net taxes or increasing spending as the debt level rises may help stabilize the economy to a greater extent than a policy that holds all fiscal instruments constant (Case 1).

Because $\psi_s \equiv \psi_\tau - \psi_g$, one may ask which fiscal instrument, net taxes or government purchases, may be more effective at stabilizing the economy if debt levels rise? For any given $\psi_s < 0$, *cutting* net taxes ($\psi_\tau < 0$ and $\psi_g = 0$) or *increasing* government purchases ($\psi_\tau = 0$ and $\psi_g > 0$) both imply a larger rise in future inflation. However, unlike net taxes that appear only in the debt accumulation equation, government purchases also affect the natural rate of interest (and natural level of output) and therefore directly affect aggregate demand and inflation.

Recall, on the demand side of the model economy, the natural interest rate is given by $\hat{r}_t^n \equiv (1-\rho_z) z_t - \sigma (1-\Gamma) E_t \{\Delta \hat{g}_{t+1}\}$, where $\Gamma \in (0,1)$. Expected changes in government purchases affect $\hat{r}_t^n$, which, in turn, influences aggregate demand in the IS equation, (1). This is a well-known spending channel of fiscal policy in the New Keynesian model; we link it directly to the debt level in our analysis. Using fiscal rule (6), the last term in $\hat{r}_t^n$ can be rewritten as $\Psi \equiv -\sigma (1-\Gamma) \psi_g \left(\hat{b}_t - \hat{b}_{t-1}\right)$, where $\psi_g > 0$ in our example. Because the government debt initially rises in the face of the negative demand shock, due to the fall in inflation and larger expense to service the debt outstanding, Ψ acts to amplify the effects of the demand contraction and so affects the initial adjustment of inflation. However, because the debt stock returns to its steady state in a stationary equilibrium, Ψ eventually reverses sign and boosts future demand.[13]

In summary, active fiscal policy, through a credible commitment to fiscal rules such as (5) and (6), serves as an automatic stabilizer and helps to offset demand shocks buffeting the economy. A fall in inflation under passive monetary policy generates expectations of higher future inflation. This increase in inflation expectations acts to partially offset the initial fall in inflation, serving to help stabilize inflation and the output gap in the face of contractionary aggregate-demand shocks.

A rule-based, active fiscal policy—that is, a credible commitment to behave in ways that to many academics and policymakers would appear to be irresponsible and shortsighted—can endogenously generate movement in expected inflation that serves to stabilize the economy. This is an advantage if, due to the ZLB, monetary policy's response is limited. However, the economy is likely to experience periods when the ZLB binds and periods when it doesn't. Even if the PM/AF policy of regime F

[13] Government purchases also affect the supply side of the model economy. The natural output level is given by $\hat{y}_t^n \equiv \Gamma \hat{g}_t = \Gamma \psi_g \hat{b}_{t-1}$. If $\psi_g > 0$, the fact that the government debt initially rises in the face of a negative demand shock implies that natural output increases. Thus, given $\tilde{y}_t \equiv \hat{y}_t - \hat{y}_t^n$, the actual level of output will fall less than the decline in the output gap. However, because $\Delta \hat{y}_t^n / \Delta \hat{g}_t = \Gamma = 0.125$ in the model's calibration, the supply-side effect of government purchases is negligible in our analysis. Government purchases, unlike taxes, also enter the welfare-based loss function (3).

performs best when at the ZLB, it may perform much worse than AM/PF when the ZLB is not a constraint on monetary policy. To assess under which policy regime social welfare is highest, we turn to a calibrated version of the model that can be used to conduct stochastic simulations.

3.4 Baseline Calibration

The simulations of the model reported in the next sections use the following baseline parameter values. We set the discount factor $\beta = 0.995$ which implies a steady-state real interest rate ρ equal to 2% annual. We set $\sigma = 1$, $\varphi = 5$ and $\alpha = 0.25$. Setting $\delta = 1$ implies the utility of government purchases decreases at the same rate as the marginal utility of private consumption. Setting $\epsilon = 9$ implies a steady-state price markup of 12.5%. And we set $\theta = 0.75$ which is consistent with an average duration of price spells of one year (four periods in the model).

In the policy rules, *under a standard regime M*, we set $\phi = 2$ for AM policy. We set $\psi_\tau = 0.3$ and $\psi_g = 0$ for PF, implying any increase in the debt-to-GDP ratio above its target is corrected about three quarters in one year by future taxes, in the absence of further deficits.[14] We set $b = 2.4$, which corresponds to a debt target equal to 60% of annual GDP. This value of b is chosen to be quantitatively comparable to the onset of the Great Recession and COVID recession, as we discuss later in Section 6. Finally, we calibrate the aggregate-demand shock in this benchmark AM/PF regime, by setting $\rho_z = 0.8$ to generate persistence and $\sigma_z = 0.027$ to obtain a frequency of the ZLB near 25%. Our baseline calibration of regime M is summarized in Table 1. We next present the outcomes of the model's stochastic simulations.[15]

4 The Effects of Irresponsible Fiscal Stimulus Facing the ZLB

We use the stylized, calibrated New Keynesian model, given by equations (1) through (8), as a framework to study whether, as argued by Sims (2016), fiscal deficit finance can replace ineffective monetary policy when the economy faces frequent periods at the ZLB. We examine the implications of permanently adopting a rule-based PM/AF regime that would appear to be "fiscally irresponsible"

[14] That is, given $\beta = 0.995$, $\psi_\tau = 0.3$, and $\psi_g = 0$, the debt condition (7) implies $\left(\beta^{-1} - \psi_\tau + \psi_g\right)^4 \approx 0.25$.

[15] The model outcomes are obtained with Dynare (`https://www.dynare.org`). To obtain the dynamic responses shown in the figures, we use the perfect-foresight, deterministic simulations algorithm implemented with the 'simul' command. To generate simulated equilibrium paths needed to compute the welfare losses shown in the tables, we employ the stochastic simulations algorithm (agents believe there will be no more shocks in the following periods) implemented with the 'extended_path' command. These long simulations are used to compute the variances of inflation, the output gap, and government purchases that determine the welfare losses associated with each policy regime and parameter configuration considered.

but serves as an automatic stabilizer that helps to offset aggregate-demand shocks when monetary policy is unable to respond. We compare the model's outcomes, with and without the ZLB, under fiscal rules that cut net taxes as the debt level rises, raise government purchases as debt levels rise, or hold the primary surplus constant as debt levels rise. Under each of these policy alternatives, we analyze the economy's adjustment to a contractionary shock that pushes down the natural rate of interest, aggregate demand and inflation. To rank the policy alternatives, we use (3), the model-consistent welfare measure of the costs of economic fluctuations arising from shocks buffeting the economy. In the following section, we also analyze whether the government's long-run debt target and the presence of long-term debt matter for the predictions of the model.

4.1 Effects of Regime F and ZLB without a Fiscal Response

The various policy scenarios we investigate are summarized in Table 2. Scenario 1 is our benchmark representation of regime M (the baseline calibration from Section 3.4). Monetary policy is active with a response to inflation given by $\phi = 2$. With $\psi_\tau = 0.3$ and $\psi_g = 0$, passive fiscal policy ensures net taxes adjust positively to movements in the level of debt. Given the discount factor β is 0.995, the coefficient on the lagged debt stock in the debt accumulation equation (7) is then smaller than unity, $\beta^{-1} - \psi_s \approx 0.7$, which ensures the debt level converges to the government's long-run debt target for any stationary inflation path. Scenario 2 represents a PM/AF policy that holds both fiscal instruments constant. It sets $\phi = 0.8$ so monetary policy responds less than one-for-one to movement in inflation. We assume no fiscal response to the debt level by setting $\psi_\tau = \psi_g = 0$, implying $\psi_s = 0$. Hence, the coefficient on the lagged debt stock in the debt accumulation equation is larger than unity, $\beta^{-1} \approx 1.005$, implying an "irresponsible" debt outlook that will endogenously generate movement in expected inflation to ensure debt sustainability.

To illustrate the implications of these policy scenarios, we report the dynamic responses when the economy experiences a negative three standard-deviation demand shock, with and without the ZLB constraint in the model. Figure 1 shows the responses of key variables without the ZLB constraint.[16] Not surprisingly, regime M succeeds in stabilizing both inflation and the output gap much better than the PM/AF policy of scenario 2. This difference in the responses of those variables can be seen in the top row of the figure. The superior performance of regime M is reflected in a much-lower welfare loss from fluctuations, measured as a fraction of permanent consumption reported in Table

[16] In all the figures, variable are shown in quarterly rates (not annualized).

3. Without the ZLB in the model, the total welfare loss in regime M is less than a quarter of that in scenario 2 (0.31% versus 1.38%). Of note in the figure, however, under scenario 2 inflation first becomes negative in the face of the contractionary demand shock but then rises and turns positive before converging to zero (its steady state). It overshoots, and the higher expected inflation this generates serves to ensure debt remains stationary. By contrast, in regime M inflation falls and then converges to zero from below. The inflation overshooting in scenario 2 means that expected future inflation will eventually be higher than in regime M.

Higher expected inflation is desirable at the ZLB, because it helps to stabilize the economy. This suggests that scenario 2 may deliver improved performance relative to regime M once the ZLB is taken into account. As Figure 2 shows, when the ZLB is accounted for, both inflation and the output gap fall much *less* in the face of the negative demand shock in scenario 2 than in scenario 1 (regime M). Under scenario 2, inflation recovers more quickly and overshoots. In the second row of the figure, the nominal interest rate hits the ZLB, but it remains there for a much-shorter period of time in scenario 2. As a result, the real interest rate rises much less in scenario 2 than in regime M. Regarding the welfare implications of these policies, as Table 3 reports, regime M still performs better than scenario 2 but the difference becomes much smaller when facing the ZLB. Under regime M, the total welfare loss triples when accounting for the ZLB (from 0.31% to 1.00%). Instead in scenario 2, the total welfare loss *falls* moderately due to the ZLB (from 1.38% to 1.22%); the reason is that, at the ZLB, monetary policy is effectively constrained and so unable to offset the expectations of higher future inflation generated by active fiscal policy to ensure debt sustainability.

Policy scenario 2 held both fiscal instruments constant by setting $\psi_\tau = \psi_g = 0$. We next examine how the model outcomes are affected when these response coefficients are allowed to differ from zero in ways that would normally be considered "fiscally irresponsible," such as committing to cut net taxes and/or increase government purchases as the level of debt increases.

4.2 Seemingly Irresponsible Tax Cuts and Spending Hikes

We begin with two examples of super-active fiscal responses, scenarios 3 and 4 in Table 2. One involves cutting net taxes as the level of debt rises; the other involves increasing government purchases as debt increases. To focus on the differences between using taxes or spending as the fiscal instrument, scenario 3 sets $\psi_\tau = -0.3$ and $\psi_g = 0$, while scenario 4 sets $\psi_\tau = 0$ and $\psi_g = 0.3$. In both cases, the primary surplus is then given by $\hat{s}_t = \left(\psi_\tau - \psi_g\right)\hat{b}_{t-1} = -0.3\hat{b}_{t-1}$. These values of ψ_τ and ψ_g

are chosen to make them quantitatively comparable to the fiscal responses seen during the Great Recession and COVID recession, as we discuss later in Section 6. Both scenario 3 and 4 result in the primary surplus falling as the debt level rises, the opposite of conventional wisdom that seeks to stabilize the level of debt by increasing the primary surplus if debt increases. When debt levels rise, the two scenarios correspond, therefore, to using further debt issuance to finance the endogenous cut in taxes or increase in spending. We pair these active fiscal rules with a passive monetary policy; $\phi = 0.8$, the same PM policy as in scenario 2 in the previous section.

Figure 3 shows the dynamic effects of these policies with the ZLB. Regime M is also shown for comparison. Despite the effect of government purchases on the natural interest rate, these "irresponsible" tax and spending rules lead to very similar effects on inflation and the output gap.[17] Inflation falls only 1% under either AF rule, compared to a fall of more than 4% in regime M; the output gap declines less than 5%, compared to 10% in regime M. The superior performance of both AF rules is due to the behavior of the real interest rate. Under regime M, a negative demand shock that drives the nominal interest rate to the ZLB, combined with the resulting fall in inflation, leads to a sharp rise in the real interest rate above 2%. The ZLB further contracts demand and amplifies the decline in the output gap and inflation. In contrast, under the AF rules, the nominal interest rate immediately rises from the ZLB. Combined with the smaller decline in inflation, the real interest rate falls below its steady state. By keeping the real interest rate low, the AF rules help to stabilize both inflation and the output gap when the economy experiences a large, contractionary demand shock. As a result, despite a modest decline in the primary surplus of 0.6% necessary to fuel the debt-financed fiscal expansion, the AF rules actually help to *stabilize* the level of debt. In the bottom row of the figure, the debt-to-GDP ratio rises only 2.5% under the AF rules, while it reaches 13% in regime M.

The welfare implications of policy scenarios 3 and 4 are reported in Table 3. If the ZLB is taken into account, both these super-active fiscal policies *reduce* the welfare costs arising from fluctuations in inflation and the output gap. Of the two polices, the welfare costs are lower in scenario 4, that is, when government purchases rather than net taxes are employed as the fiscal instrument. The main source of the gain is due to the significantly improved inflation stability relative to regime M, particularly when government purchases are the fiscal instrument. That is, when the ZLB is frequently binding under regime M, the welfare costs of inflation are notably *lower* if active fiscal

[17] For our calibration, $\sigma = 1$ and $\Gamma = 0.125$, which implies $\Delta\hat{r}_t^n / E_t \{\Delta\hat{g}_{t+1}\} = -\sigma(1-\Gamma) = -0.875$.

policy replaces active monetary policy as the means of controlling inflation. With the ZLB, the total welfare loss is almost one-third *lower* in scenario 4 than in regime M (0.72% versus 1.00%). This welfare improvement is achieved from the better stabilizing effects at the ZLB. Furthermore, active fiscal policy leads to a *reduced* incidence of episodes at the ZLB. As the last column of the table reports, the frequency of the ZLB falls from 25.0% in regime M to only 11.1% in scenario 4.

So far in the analysis, tax cuts and spending hikes were debt financed, causing a fall in the primary surplus. As a further example, we consider a balanced-budget rule in which any spending is tax financed.[18] Scenario 5 sets $\psi_g = \psi_\tau = 0.3$, again paired with $\phi = 0.8$ for PM policy. In this case, given that both fiscal instruments adjust positively to movement in the level of debt, the primary surplus is held constant, $\psi_s = 0$. Figure 4 shows the dynamic effects of scenario 5 with the ZLB, compared to the previous scenario 4 in which government purchases are debt financed in the face of a contractionary demand shock. Not surprisingly, under scenario 5, the combination of expansionary spending and contractionary taxes does a worse job in stabilizing inflation and the output gap than debt-financed spending. Preventing the primary surplus from falling, and the expectations of inflation from rising, leads to a larger increase in the debt level. The debt-to-GDP ratio rises 2% in scenario 4 and near 5% in scenario 5. Regarding the welfare implications of such a policy, as Table 3 reports, scenario 5 performs worse than scenario 4. With the ZLB, the total welfare costs of fluctuations increase by one sixth (from 0.72% to 0.83%) if net taxes are used to finance the endogenous movement in government purchases. Thus, budget-balancing is less effective than debt-financing of the fiscal expansion. Put differently, the more “irresponsible” fiscal policy performs better.

5 The Role of the Debt Level and Its Duration

In this section, we evaluate the robustness of our results to the long-run debt target and extend the model to include long-term debt. We find that, in the face of contractionary aggregate-demand shocks that occasionally drive the nominal interest rate to the ZLB, a regime of active fiscal and passive monetary policy can become more effective when the government adopts a high debt target and issues debt of short duration.

[18] Given that PM/AF policy breaks Ricardian equivalence, spending financed by taxes or by debt may not have the same impact on output and inflation.

5.1 Does the Debt Target Matter?

We next analyze whether the government's long-run debt target affects the predictions of the model. Recall, from the debt accumulation equation, the effect of the real interest rate on the debt process depends on the long-run debt target, b. As (9) showed, when the nominal interest rate is pegged, the impact of inflation on debt, conditional on the lagged debt stock, is increasing in b. This observation suggests that, under an active fiscal and passive monetary policy, the fluctuations in the inflation rate necessary to ensure debt remains stationary may be smaller when the debt target is higher.

With the ZLB, Figure 5 compares the responses to a negative demand shock for scenarios 4 and 6 which differ only in the calibrated value of b. In both cases, the policy regime sets $\psi_\tau = 0$ and $\psi_g = 0.3$ for AF, combined with $\phi = 0.8$ for PM. In scenario 4 the baseline value of $b = 60\%$ as a share of annual GDP, whereas scenario 6 sets $b = 200\%$ as a share of annual GDP. Despite the much-higher debt target in scenario 6, the output gap responds similarly under either scenario. However, the responses of inflation differ slightly, with inflation overshooting less when b is higher. With a higher b, the debt-to-GDP ratio is more volatile and, as a consequence, so are government purchases. The larger increase in debt, given that the inflation responses are very similar for the first five quarters after the shock, is due to the larger coefficient on the real interest rate in the debt accumulation equation. That is, with a fall in inflation, the larger stock of debt amplifies the (real) interest expense to service the debt. From a welfare perspective, the higher debt target *improves* stabilization policy, due to the lower inflation volatility, as Table 3 reports. With the ZLB, the total welfare costs of fluctuations *fall* one quarter (from 0.72% to 0.54%) if the debt target takes the higher value. Moreover, because the higher debt target renders the active fiscal policy more effective in stabilizing inflation, the frequency of the ZLB is *reduced* (from 11.1% to 7.9%).

Overall, not surprisingly, a higher debt target increases debt volatility. However, the implications for inflation stability are quite the opposite of conventional wisdom that seeks to stabilize the level of debt by increasing the primary surplus if debt increases. Under a credible commitment to an "irresponsible" fiscal rule that raises government purchases when debt levels rise, a higher debt target helps to stabilize inflation and to improve welfare both at the ZLB and away from it.

5.2 Does the Presence of Long-Term Debt Matter?

The previous analysis was based on the assumption that all government debt took the form of one-period discount bonds. We next investigate whether the conclusions are affected if the government issues long-term debt. Harrison (2021), for example, finds that the presence of long-term debt can lessen the recessionary impact of a negative demand shock. Following Woodford (2001), we assume government bonds are perpetuities whose coupon declines at rate $\eta \in [0, 1]$ in each period.[19] We denote the price of the bond by Q_t.

In addition to these perpetuities, assume there are one-period bonds in zero net supply. The representative household's first-order conditions for the two types of bond imply

$$1 = \beta \mathrm{E}_t \left(\frac{1 + i_t}{1 + \pi_{t+1}} \right) \left(\frac{MUC_{t+1}}{MUC_t} \right) = \beta \mathrm{E}_t \left(\frac{1 + \eta Q_{t+1}}{Q_t} \right) \left(\frac{1}{1 + \pi_{t+1}} \right) \left(\frac{MUC_{t+1}}{MUC_t} \right), \tag{14}$$

where MUC_t denotes the marginal utility of consumption at time t. When these two Euler conditions are linearized around a zero inflation steady state, the relationship between the deviation of the one-period rate from its steady state, $\hat{\imath}_t$, and the deviation from steady-state of the one-period holding return on the perpetuity is given by

$$\hat{\imath}_t = \eta \beta \mathrm{E}_t \left\{ \hat{Q}_{t+1} \right\} - \hat{Q}_t, \tag{15}$$

where $\hat{Q}_t \equiv (Q_t - Q)/Q$ denotes the percent deviation of the bond price from its steady state, and the steady-state bond price is given by $Q \equiv \beta/(1 - \eta\beta)$. The average duration of the bond is $1/(1 - \eta\beta)$, which is increasing in η. The recent literature typically assumes the average duration of U.S. government debt is 5 years. Given that our model is calibrated at a quarterly frequency and $\beta = 0.995$, this implies a value for η of 0.955.

In addition, the flow budget constraint for the government, when log-linearized around a steady state with no trend growth and zero inflation, now takes the more general form:

$$\hat{b}_t = \beta^{-1} \hat{b}_{t-1} + \beta^{-1} b \left(\eta \beta \hat{Q}_t - \hat{Q}_{t-1} - \pi_t \right) + \hat{g}_t - \hat{\tau}_t. \tag{16}$$

When all debt is one-period, as in the previous analysis, $\eta = 0$ and $\hat{\imath}_{t-1} = -\hat{Q}_{t-1}$, implying (16)

[19] Declining perpetuities of this form have been used by, for example, Chen, Cúrdia and Ferrero (2012), Bianchi, Faccini and Melosi (2020), Caramp and Silva (2021), and Harrison (2021), among others.

reduces to (4).

When $\eta > 0$, there are two key difference that distinguish (16) from (4). First, the (real) interest cost to service the debt outstanding is *increasing* in η. Namely, while a rise in the past bond price reflects a fall in the nominal yield, a rise in the current bond price results in a revaluation of long-term debt that increases the government's liabilities. Second, long-term debt also *amplifies* the impact of monetary policy on the bond price itself. Solving (15) forward gives

$$\hat{Q}_t = -\sum_{i=0}^{\infty} (\eta\beta)^i \, \hat{\imath}_{t+i}, \tag{17}$$

which shows that the current bond price depends negatively on the future path of the short-term nominal interest rate. But this relationship reduces to $\hat{Q}_t = -\hat{\imath}_t$ when $\eta = 0$.

With the ZLB, Figure 6 shows the dynamic effects of a negative demand shock under scenario 4 (G with one-period debt) and scenario 7 (G with long-term debt). With one-period debt, the nominal interest rate rises and remains above its steady-state level before converging back to the steady state. The bond price $\hat{Q}_t$ mirrors (with opposite sign) the path of the nominal interest rate. With long-term debt, the bond price falls more to reflect the discounted value of the entire path of the nominal interest rate, see (17). The lower bond price generates a revaluation effect that initially reduces the value of outstanding debt. This initial decline in the debt-to-GDP ratio, in turn, implies less fiscal spending, so inflation and the output gap fall more. The ZLB becomes more of a constraint with long-term debt, leading to an initial rise in the real interest rate and, like the lower fiscal spending, contributes to the larger fall in inflation and the output gap when debt is long-term. Regarding the welfare consequences of long-term debt, as Table 3 reports, scenario 7 performs *worse* than scenario 4 due to the ZLB constraint. Facing the ZLB, the total welfare costs of fluctuations *increase* by one quarter (from 0.72% to 0.90%) if debt is long-term. However, scenario 7 with long-term debt still performs better than regime M, the AM/PF regime (which generates a welfare loss of 1.00%).[20]

In sum, facing the ZLB, the presence of long-term debt can increase the recessionary impact of adverse demand shocks in a regime of active fiscal and passive monetary policy. This outcome is the opposite of conventional wisdom that seeks to stabilize the government's burden of debt repayments by issuing debt instruments with longer maturity. Long-term debt renders the unfunded fiscal ex-

[20] As Table 3 shows, the presence of long-term debt *improves* welfare if the ZLB is ignored. Removing this constraint prevents the rise in the real interest rate that occurs in scenario 7. Harrison (2021) finds that with an active fiscal policy setting an exogenous primary surplus ($\psi_g = \psi_\tau = 0$) and assuming prices are extremely rigid (average duration of price spells near two years), long-term debt leads to a welfare improvement regardless of the ZLB.

pansion less effective, because long-term debt dampens the wealth effects generated by rising debt levels in the face of the ZLB.

6 Irresponsible Policy Responses in Recent Recessions

During both the Great Recession that followed the 2008-09 global financial crisis and the COVID induced recession of early 2020, large fiscal expansions occurred accompanied by increases in debt-to-GDP levels. As is well-known, the U.S. federal debt held by the public as a percent of GDP has been rising steadily since 2007; it was 35% at the start of the Great Recession (2007Q4) and had risen to 80% at the onset of the COVID recession (2019Q4).[21] To illustrate the size and composition of the U.S. federal response during these recessions, Figure 7 shows the change in government *purchases* and *net taxes* as a share of GDP, divided by the change in debt as a share of GDP.[22] Also shown is the change in the *primary surplus* (net taxes minus purchases) relative to the change in debt. The bars on the left refer to the fiscal response during the Great Recession (2007Q4 to 2009Q2), while the bars on the right show the response in the COVID recession (2019Q4 to 2020Q2).

As the figure reports, most of the fiscal response in the U.S. during the Great Recession took the form of tax cuts and increases in transfers, with the fall in net taxes equaling 42% of the rise in debt. Government purchases (consumption plus investment) rose only 6% of the change in debt, implying the primary surplus fell by 48% of the rise in debt. During the COVID recession, the fiscal response was *larger overall* measured relative to the debt level, with the primary surplus falling by 91% of the rise in debt *and* with the debt level at the end of 2019 much higher than during the Great Recession. Government purchases rose notably more during COVID (24% of the rise in debt) and cuts in net taxes were larger (67% of the rise in debt) compared to the previous recession.

We use these values to calibrate ψ_τ and ψ_g to study the consequences of "irresponsible" fiscal

[21] The Great Recession in the U.S. lasted from December 2007 until June 2009, while the COVID recession peak occurred 2019Q4 and the trough was April 2020, according to the NBER's Business Cycle Dating Committee (`https://www.nber.org`). Because we interpret the budget constraint (4) as applying to the consolidated government sector, the relevant definition of debt in the model is government debt held outside the government sector, i.e. federal debt held by the public.

[22] The data source is the Federal Reserve Bank of St. Louis FRED database (`https://fred.stlouisfed.org`). The variables we use (and their FRED identifiers) are the following: U.S. federal government receipts (FGRECPT), expenditures (FGEXPND), interest payments (A091RC1Q027SBEA), transfer payments (W014RC1Q027SBEA), debt held by the public as a percent of GDP (FYGFGDQ188S), and GDP (GDP). *Net taxes* are equal to receipts minus transfers, while government *purchases* are equal to expenditures minus transfers minus interest payments. And the *primary surplus* is equal to net taxes minus government purchases. In Figure 7, for example, the bar shown for government purchases is given by (g(end) - g(start))/(debt(end) - debt(start)), where g and debt are expressed as a percent of GDP and where 'start' and 'end' refer to the quarter in which the recession begins and ends.

policies during the two recessions. Table 4 summarizes the experiments. In panel A, the Great Recession (GR) scenario sets $\psi_\tau = -0.42$ and $\psi_g = 0.06$, combined with a passive monetary policy described by $\phi = 0.8$. The COVID scenario sets $\psi_\tau = -0.67$ and $\psi_g = 0.24$, maintaining $\phi = 0.8$.[23] We calibrate the debt target b to the debt-to-GDP level in the data at the start of each recession episode; this implies $b = 35\%$ for GR and $b = 80\%$ for COVID, each as a share of annual GDP. In both scenarios, the debt duration is set to five years ($\eta = 0.955$).

With the ZLB, Figure 8 compares the responses to a negative demand shock for the GR and COVID specifications of the fiscal rules. Measured by the fall in the primary surplus as debt rises, the GR policy, with $\psi_s = -0.48$, might be expected to be less expansionary than the COVID policy, with $\psi_s = -0.91$. However, the two policies do a very similar job in stabilizing inflation and the output gap. Differences appear in the behavior of the fiscal variables themselves. Under the COVID policy, debt and the primary surplus move more. The reason is that a higher debt target increases the volatility in debt and government purchases, which serves to stabilize inflation under an active fiscal and passive monetary policy (see Section 5.1). Panel A of Table 5 reports the welfare implications of the two policies, with and without the ZLB. As expected, the higher debt target of the COVID policy serves to reduce inflation volatility, improve welfare both at the ZLB and away from it, and reduce the frequency of the ZLB.

Macroeconomic outcomes depend on the fiscal rules *and* on the monetary policy rule, that is, on the value of ϕ, the response of the nominal interest rate to inflation. The GR and COVID scenarios considered so far set $\phi = 0.8$, implying that when the economy is away from the ZLB, the nominal interest rate adjusts with inflation but by less than one-for-one. While this behavior constitutes a passive monetary policy, it will have consequences for the economy when at the ZLB. The expectation of a future recovery from the ZLB will also generate expectations of a rise in the nominal interest rate, which, in turn, will *weaken* the current expansionary impact of higher expected inflation. In panel B of Table 4, therefore, we consider scenarios that differ from those of panel A by setting $\phi = 0$ to investigate the consequences of the central bank pegging the nominal interest rate.[24]

[23] The Coronavirus Aid, Relief, and Economic Security (CARES) Act of 2020 was enacted during the COVID recession that ended in 2020Q2, while the American Rescue Plan (ARP) of 2021 was enacted after the recession ended. If the COVID period is extended to 2021Q2 to include the ARP, the calibration of the COVID scenario would be $\psi_\tau = -0.38$ and $\psi_g = 0.15$, implying $\psi_s = -0.53$, which is overall quite similar to the GR scenario.

[24] With $\phi = 0$, (17) pins the bond price to steady state, $\hat{Q}_t = \hat{\imath}_t = 0$ for all t, so the debt condition (16) reduces to (12) of Case 2, which means that the duration of government debt is irrelevant for the outcomes under the nominal rate peg. Ascari, Florio and Gobbi (2021) find that with an active fiscal policy in which $\psi_g = \psi_\tau = 0$, setting $\phi < 0$ can lead to a welfare improvement.

Imposing the ZLB, Figure 9 shows the responses to a negative demand shock for the COVID policy with $\phi = 0.8$ and with $\phi = 0$. The latter scenario is labeled "COVID no M" to indicate no response of monetary policy. The impact of the nominal rate peg on inflation is large. While inflation falls 2% when $\phi = 0.8$, it declines only 0.3% and returns to zero more quickly when $\phi = 0$. Under the nominal rate peg, the output gap also falls less and returns more quickly to zero. Because the nominal interest rate cannot adjust under the peg, the bond price remains at its steady state—that is, the duration of government debt plays no role under the peg. The resulting larger (real) interest expense to service the debt causes a larger rise in the debt-to-GDP ratio. With a larger rise in debt, government purchases rise more and net taxes fall more under the peg. Panel B of Table 5 reports the welfare implications of the nominal rate peg for both the GR and COVID fiscal policies. Under either set of fiscal rules, a monetary policy that pegs the nominal interest rate results in a large welfare improvement, due to the lower inflation volatility. As a result, the GR and COVID fiscal rules achieve the same welfare when the nominal interest rate is pegged. The nominal rate peg, by definition, also eliminates the occurrence of the ZLB.

These results lead us to a final question that brings us back to our benchmark policy. Would an active fiscal policy combined with a peg on the nominal interest rate perform better than a standard regime of active monetary policy and passive fiscal policy? As we discussed earlier in this paper, scenario 1 is a standard representation of AM/PF policy, or regime M. The welfare results of that policy were reported in Table 3. Under regime M, the total welfare loss from fluctuations was 1.00% and 0.31% respectively with and without the ZLB. The total welfare loss is reduced to only 0.19% under both the GR and COVID fiscal rules when the nominal interest rate is pegged (Table 5). Hence, even if the ZLB is ignored in the analysis, an active fiscal policy combined with a peg results in a large welfare improvement relative to regime M. The welfare gain achieved by an active fiscal policy and a peg is *several times larger* once the consequences of the ZLB are taken into account. Furthermore, while the ZLB inexorably binds frequently under an AM/PF regime, an active fiscal policy combined with a peg on the nominal interest rate would rule out episodes at the ZLB.

7 Concluding Remarks

The challenges facing central banks in a low interest rate environment, when episodes at the ZLB may be frequent and long lasting, are well known. Much is also known about the relative performance of alternatives to inflation targeting such as price-level targeting and average inflation targeting. The research on alternative policy frameworks has typically assumed the central bank can credibly commit to a policy rule and has *almost always* assumed that the broad framework of policy is one of active monetary policy and passive fiscal policy (AM/PF). It is this last assumption that we question. We show that, in the face of aggregate demand shocks and the ZLB, a commitment to active fiscal policy and passive monetary policy (AF/PM) can yield welfare gains. The superior performance of such a policy regime when monetary policy is constrained by the ZLB outweighs the advantages of active monetary policy when the ZLB is not a threat.

Absent the ZLB constraint, the traditional framework of AM/PF dominates, but this is no longer the case when the constraint is present. In fact, we find that the incidence of the ZLB is reduced to zero *and* the welfare costs of economic fluctuations are the lowest under an active fiscal policy and a nominal interest rate peg among the scenarios we consider.

The model we employ and the policy rules we analyze are stylized, but we think the results call into question the exclusive focus on monetary policy as the means of achieving inflation targets and maintaining macroeconomic stability. The fiscal rules we study involve seemingly irresponsible fiscal actions, that is, raising spending or cutting taxes as debt levels rise. Such actions generate expectations of the higher inflation necessary to ensure the government's real debt level remains stationary. Higher expected inflation helps offset a negative demand shock by reducing the real interest rate. At the ZLB, monetary policy is limited in its ability to generate higher expected inflation; central banks can talk, but they cannot backup their statements if their primary policy instrument cannot be reduced. In contrast, the fiscal authority can always act because its instruments are not constrained by the ZLB.

These results were robust to whether the government's long-run debt target was calibrated to equal 60% of annual GDP or to the much higher level of 200% of annual GDP. They were also robust to whether government debt was assumed to be of one-period duration or calibrated to match an average duration of 5 years. The advantage of super-active fiscal policy over active monetary policy was greatest when the debt target was high and the maturity of debt was short.

As is common in the literature, we assume for both AM/PF and PM/AF that policymakers can commit to simple, implementable rules. While this assumption is widely accepted for independent central banks, a host of political issues arise in the case of fiscal policy. Changes in taxes and spending raise the issue of which taxes and which spending will be adjusted. The resulting choices have distributional implications whose political consequences may limit the ability to precommit to future fiscal actions. The debates over debt limits in the Euro area and in the U.S. are well known. Cutting taxes or raising spending when debt levels rise in a recession may gain more political popularity than implementing austerity as debt levels rise. However, the fiscal rules we analyze would call for tax increases and spending cuts when debt levels fall. Such policies might be feasible if debt levels are falling during economic booms. Regardless, one can question the ability of fiscal authorities to credibly commit to the types of policies we find would perform well in an environment of low interest rates and frequent episodes at the ZLB.

Monetary policy actions also have distributional consequences, which, in the past, were generally ignored. However, there is now increasing discussion of how monetary policy might contribute to broader social welfare beyond simply targeting inflation. If the mandates of central banks are widened, while the consequences of active fiscal policy are less well known, it may become increasingly difficult not only to defend central bank independence but also to commit to future policy actions necessary to achieve macroeconomic stability facing the ZLB.

Our analysis was conducted within the context of a standard New Keynesian model under the usual assumption that private agents in the economy form expectations rationally. Rational expectations are key to why seemingly irresponsible fiscal actions may generate stabilizing movement in inflation expectations; they are also key to the performance of active monetary policy under "make-up" strategies such as price-level targeting or average inflation targeting.

At a minimum, our results suggest the need for further analysis of passive monetary and active fiscal regimes in a low-inflation, low interest rate environment.

References

ADAM, K., AND R. M. BILLI (2006): "Optimal Monetary Policy under Commitment with a Zero Bound on Nominal Interest Rates," *Journal of Money, Credit and Banking*, 38(7), 1877–1905.

ASCARI, G., A. FLORIO, AND A. GOBBI (2020): "Controlling Inflation With Timid Monetary-Fiscal Regime Changes," *International Economic Review*, 61(2), 1001–1024.

——— (2021): "Price Level Targeting under Fiscal Dominance," *Working Paper*.

BERNANKE, B. S., M. T. KILEY, AND J. M. ROBERTS (2019): "Monetary Policy Strategies for a Low-Rate Environment," *AEA Papers and Proceedings*, 109, 421–426.

BHATTARAI, S., J. W. LEE, AND W. Y. PARK (2014): "Inflation Dynamics: The Role of Public Debt and Policy Regimes," *Journal of Monetary Economics*, 67, 93–108.

BIANCHI, F., R. FACCINI, AND L. MELOSI (2020): "Monetary and Fiscal Policies in Times of Large Debt: Unity is Strength," *NBER Working Paper No. 27112*.

BIANCHI, F., AND L. MELOSI (2019): "The Dire Effects of the Lack of Monetary and Fiscal Coordination," *Journal of Monetary Economics*, 104, 1–22.

BILLI, R. M. (2017): "A Note on Nominal GDP Targeting and the Zero Lower Bound," *Macroeconomic Dynamics*, 21(8), 2138–2157.

——— (2018): "Price Level Targeting and Risk Management," *Economic Modelling*, 73(6), 163–173.

——— (2020): "Unemployment Fluctuations and Nominal GDP Targeting," *Economics Letters*, 188, 108970.

BILLI, R. M., U. SÖDERSTRÖM, AND C. E. WALSH (2020): "The Role of Money in Monetary Policy at the Lower Bound," *Sveriges Riksbank Working Paper No. 390*.

BUDIANTO, F., T. NAKATA, AND S. SCHMIDT (2020): "Average Inflation Targeting and the Interest Rate Lower Bound," *ECB Working Paper No. 2394*.

Burgert, M., and S. Schmidt (2014): "Dealing with a Liquidity Trap when Government Debt Matters: Optimal Time-Consistent Monetary and Fiscal Policy," *Journal of Economic Dynamics and Control*, 47, 282–299.

Caramp, N., and D. H. Silva (2021): "Fiscal Policy and the Monetary Transmission Mechanism," *Working Paper*.

Chen, H., V. Curdia, and A. Ferrero (2012): "The Macroeconomic Effects of Large-Scale Asset Purchase Programmes," *Economic Journal*, 122(564), 289–315.

Cochrane, J. H. (2021): *The Fiscal Theory of the Price Level*. Book Draft.

Davig, T., and E. M. Leeper (2011): "Monetary-Fiscal Policy Interactions and Fiscal Stimulus," *European Economic Review*, 55(2), 211–227.

Eggertsson, G. B. (2006): "The Deflation Bias and Committing to Being Irresponsible," *Journal of Money, Credit and Banking*, 38(2), 283-321.

Eggertsson, G. B., and M. Woodford (2003): "The Zero Bound on Interest Rates and Optimal Monetary Policy," *Brookings Papers on Economic Activity*, 34(1), 139–235.

——— (2006): "Optimal Monetary and Fiscal Policy in a Liquidity Trap," *NBER International Seminar on Macroeconomics 2004*, pp. 75–144.

Galí, J. (2015): *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and its Applications*. Princeton University Press, Princeton NJ, second edn.

——— (2020): "The Effects of a Money-Financed Fiscal Stimulus," *Journal of Monetary Economics*, 115, 1–19.

Harrison, R. (2021): "Flexible Inflation Targeting with Active Fiscal Policy," *Bank of England Working Paper No. 928*.

Holston, K., T. Laubach, and J. C. Williams (2017): "Measuring the Natural Rate of Interest: International Trends and Determinants," *Journal of International Economics*, 108(S1), 59–75.

Jacobson, M. M., E. M. Leeper, and B. Preston (2019): "Recovery of 1933," *NBER Working Paper No. 25629*.

Kim, S. (2003): "Structural Shocks and the Fiscal Theory of the Price Level in the Sticky Price Model," *Macroeconomic Dynamics*, 7(5), 759–782.

Leeper, E. M. (1991): "Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policies," *Journal of Monetary Economics*, 27(1), 129–147.

——— (2021): "Shifting Policy Norms and Policy Interactions," *Federal Reserve Bank of Kansas City, Jackson Hole Symposium Proceedings*, pp. 1–20.

Leeper, E. M., and C. Leith (2016): "Understanding Inflation as a Joint Monetary-Fiscal Phenomenon," in *Handbook of Macroeconomics*, ed. by J. B. Taylor, and H. Uhlig, vol. 2, chap. 30, pp. 2305–2415. Amsterdam: Elsevier B.V.

Leeper, E. M., C. Leith, and D. Liu (2021): "Optimal Time-Consistent Monetary, Fiscal and Debt Maturity Policy," *Journal of Monetary Economics*, 117, 600–617.

Leeper, E. M., and X. Zhou (2021): "Inflation's Role in Optimal Monetary-Fiscal Policy," *Journal of Monetary Economics*, 124, 1–18.

Nakata, T. (2017): "Optimal Government Spending at the Zero Lower Bound: A Non-Ricardian Analysis," *Review of Economic Dynamics*, 23, 150–169.

Nakov, A. (2008): "Optimal and Simple Monetary Policy Rules with Zero Floor on the Nominal Interest Rate," *International Journal of Central Banking*, 4(2), 73–127.

Nessen, M., and D. Vestin (2005): "Average Inflation Targeting," *Journal of Money, Credit and Banking*, 37(5), 837–863.

Sablik, T. (2019): "Do Budget Deficits Matter?," *Federal Reserve Bank of Richmond, Econ Focus*, Second/Third Quarter, 4–6.

Sargent, T. J., and N. Wallace (1981): "Some Unpleasant Monetarist Arithmetic," *Federal Reserve Bank of Minneapolis, Quarterly Review*, 5(Fall), 1–17.

Sims, C. A. (2000): "Comment on Three Lessons for Monetary Policy in a Low-Inflation Era," *Journal of Money, Credit and Banking*, 32(4), 967–972.

——— (2016): "Fiscal Policy, Monetary Policy and Central Bank Independence," *Federal Reserve Bank of Kansas City, Jackson Hole Symposium Proceedings*, pp. 313–325.

Svensson, L. E. O. (2003): "What Is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules," *Journal of Economic Literature*, 41(2), 426–477.

——— (2020): "Monetary Policy Strategies for the Federal Reserve," *International Journal of Central Banking*, 16(1), 133–193.

Vestin, D. (2006): "Price-Level Versus Inflation Targeting," *Journal of Monetary Economics*, 53(7), 1361–1376.

Walsh, C. E. (2003): "Speed Limit Policies: The Output Gap and Optimal Monetary Policy," *American Economic Review*, 93(1), 265–278.

——— (2015): "Goals and Rules in Central Bank Design," *International Journal of Central Banking*, 11(4), 295–352.

——— (2017): *Monetary Theory and Policy.* MIT Press, Cambridge MA, fourth edn.

——— (2019): "Alternatives to Inflation Targeting in Low Interest Rate Environments," *Bank of Japan, Monetary and Economic Studies*, 37, 41–70.

Woodford, M. (2001): "Fiscal Requirements for Price Stability," *Journal of Money, Credit and Banking*, 33(3), 669–728.

——— (2011): "Simple Analytics of the Government Expenditure Multiplier," *American Economic Journal: Macroeconomics*, 3(1), 1–35.

Table 1: Baseline calibration of regime M.

Parameter	Description	Value
β	Discount factor	0.995
σ	Curvature of consumption utility	1
δ	Curvature of government purchases utility	1
φ	Curvature of labor disutility	5
ϵ	Elasticity of substitution of goods	9
α	Index of decreasing returns to labor	0.25
θ	Calvo index of price rigidities	0.75
ϕ	Monetary policy response to inflation	2
ψ_τ	Fiscal policy, net taxes response to debt	0.3
ψ_g	Fiscal policy, purchases response to debt	0
b	Debt-to-GDP target	2.4
η	Bond coupon decay rate	0
ρ_z	Persistence of aggregate-demand shock	0.8
σ_z	Std. deviation of aggregate-demand shock	0.027

Notes: Values are shown in quarterly rates.

Table 2: Policy scenarios under regimes M and F.

	Policy coefficients						
Scenario	ϕ	ψ_τ	ψ_g	b	η	Regime	Implications for a rise in debt
1. Regime M	2	0.3	0	2.4	0	M	$\hat{\tau}_t$ hike
2. No tax or G	0.8	0	0	2.4	0	F	No fiscal response
3. Tax	0.8	-0.3	0	2.4	0	F	$\hat{\tau}_t$ cut, debt financed
4. G	0.8	0	0.3	2.4	0	F	$\hat{g}_t$ hike, debt financed
5. G balanced	0.8	0.3	0.3	2.4	0	F	$\hat{g}_t$ and $\hat{\tau}_t$ hike, balanced budget
6. G high b	0.8	0	0.3	8.0	0	F	$\hat{g}_t$ hike, debt financed
7. G long debt	0.8	0	0.3	2.4	0.955	F	$\hat{g}_t$ hike, debt financed

Notes: In regime F, $\phi < 1$ and $\psi_s \equiv \psi_\tau - \psi_g \leq 0$, i.e. super-active fiscal. The debt duration is one quarter if $\eta = 0$ and 5 years if $\eta = 0.955$.

Table 3: Welfare loss under regimes M and F.

	$\mathbb{L}$(%) no ZLB				$\mathbb{L}$(%) with ZLB				
Scenario	Tot.	π_t	$\tilde{y}_t$	$\hat{g}_t$	Tot.	π_t	$\tilde{y}_t$	$\hat{g}_t$	ZLB freq. (%)
1. Regime M	0.31	0.30	0.01	0.00	1.00	0.92	0.07	0.00	25.0
2. No tax or G	1.38	1.29	0.10	0.00	1.22	1.12	0.10	0.00	15.3
3. Tax	1.05	0.99	0.05	0.00	0.83	0.78	0.05	0.00	12.7
4. G	0.88	0.83	0.05	0.00	0.72	0.66	0.05	0.00	11.1
5. G balanced	0.90	0.82	0.08	0.00	0.83	0.74	0.09	0.00	11.7
6. G high b	0.63	0.56	0.05	0.01	0.54	0.48	0.05	0.01	7.9
7. G long debt	0.84	0.77	0.07	0.00	0.90	0.82	0.08	0.00	14.2

Notes: $\mathbb{L}$ is the permanent consumption loss from fluctuations. The total loss may differ from the sum of its components due to rounding.

Table 4: Great Recession and COVID, regime F scenarios.

	Policy coefficients						
	ϕ	ψ_τ	ψ_g	b	η	Regime	Implications for a rise in debt
Panel A: Scenarios with a monetary policy response							
GR	0.8	−0.42	0.06	1.4	0.955	F	$\hat{\tau}_t$ cut and $\hat{g}_t$ hike, debt financed
COVID	0.8	−0.67	0.24	3.2	0.955	F	Idem
Panel B: Scenarios without monetary policy response							
GR no M	0	−0.42	0.06	1.4	0.955	F	Idem
COVID no M	0	−0.67	0.24	3.2	0.955	F	Idem

Notes: In regime F, $\phi < 1$ and $\psi_s \equiv \psi_\tau - \psi_g \leq 0$, i.e. super-active fiscal. The debt duration is five years.

Table 5: Welfare loss under Great Recession and COVID, regime F scenarios.

	$\mathbb{L}$(%) no ZLB				$\mathbb{L}$(%) with ZLB				
	Tot.	π_t	$\tilde{y}_t$	$\hat{g}_t$	Tot.	π_t	$\tilde{y}_t$	$\hat{g}_t$	ZLB freq. (%)
Panel A: Scenarios with a monetary policy response									
GR	0.95	0.88	0.07	0.00	1.01	0.92	0.08	0.00	16.1
COVID	0.89	0.82	0.07	0.00	0.98	0.89	0.08	0.00	15.4
Panel B: Scenarios without monetary policy response									
GR no M	0.19	0.16	0.03	0.00	0.19	0.16	0.03	0.00	0
COVID no M	0.19	0.16	0.02	0.00	0.19	0.16	0.02	0.00	0

Notes: $\mathbb{L}$ is the permanent consumption loss from fluctuations. The total loss may differ from the sum of its components due to rounding. In panel B, $\phi = 0$ implies the policy rate is pegged to its steady state and therefore the ZLB has no effects.

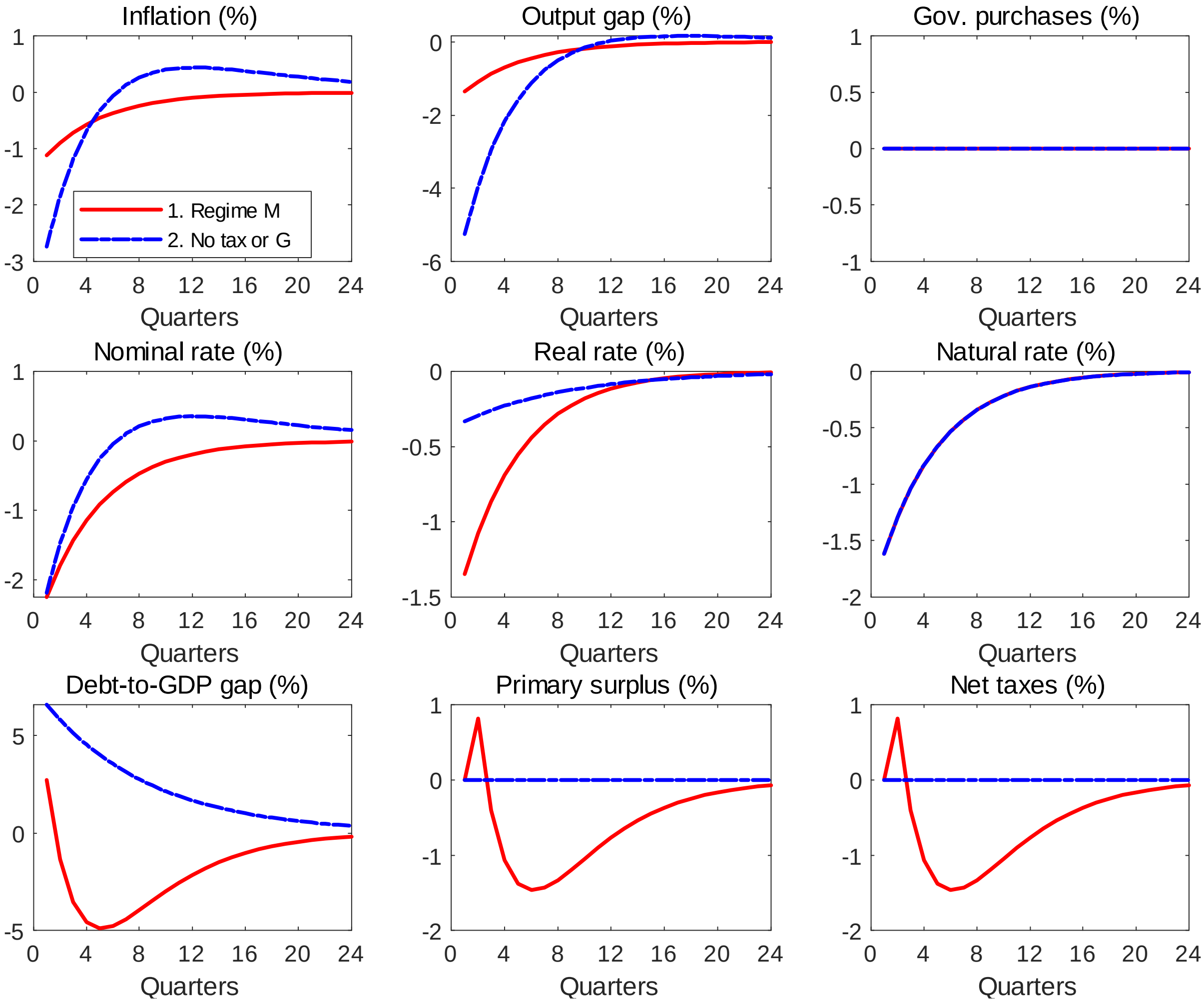

Figure 1: Dynamic effects of regime F (no tax or G) without ZLB. Deviation from steady state in response to $-3sd$ demand shock.

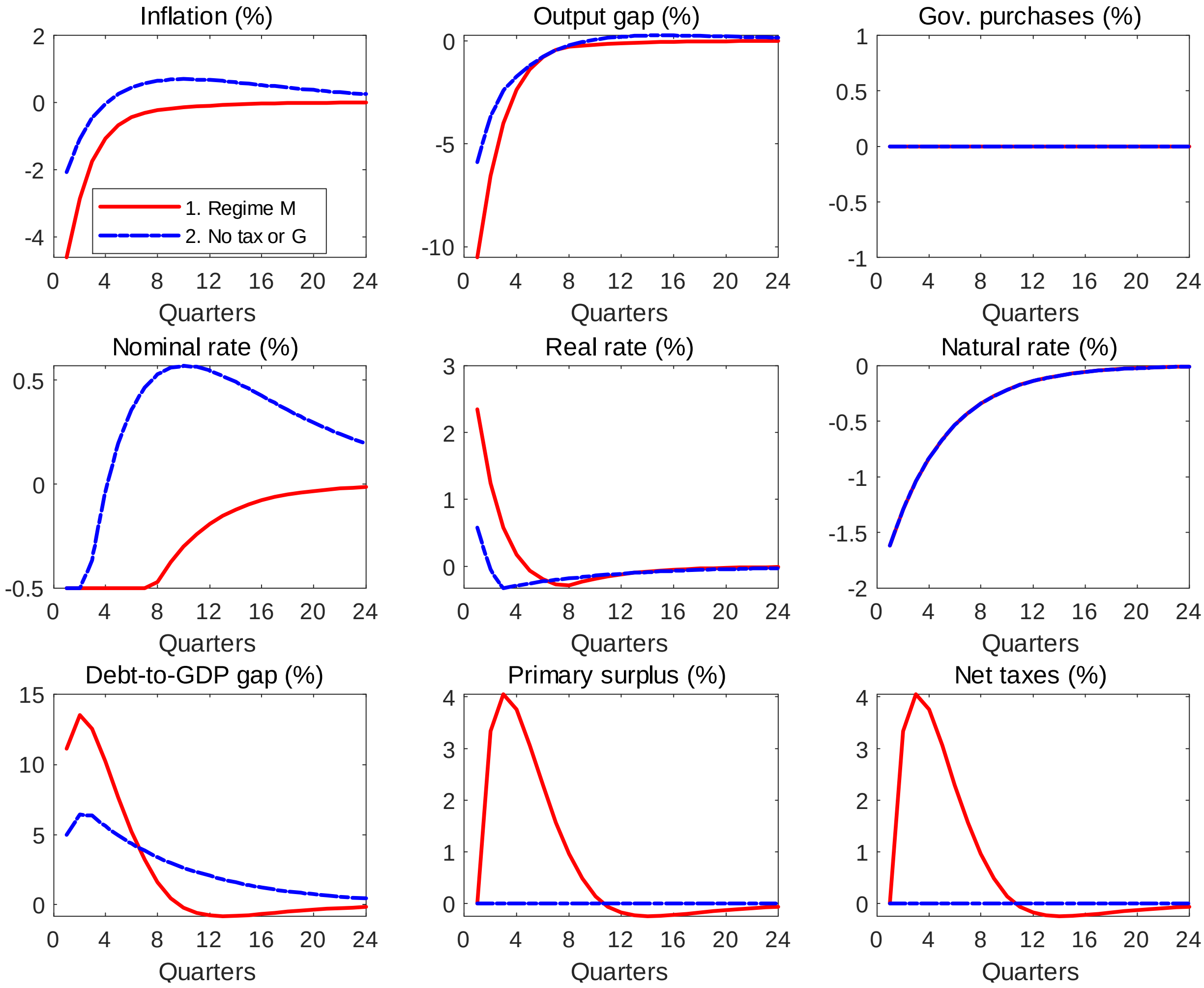

Figure 2: Dynamic effects of regime F (no tax or G) with ZLB. Deviation from steady state in response to $-3sd$ demand shock.

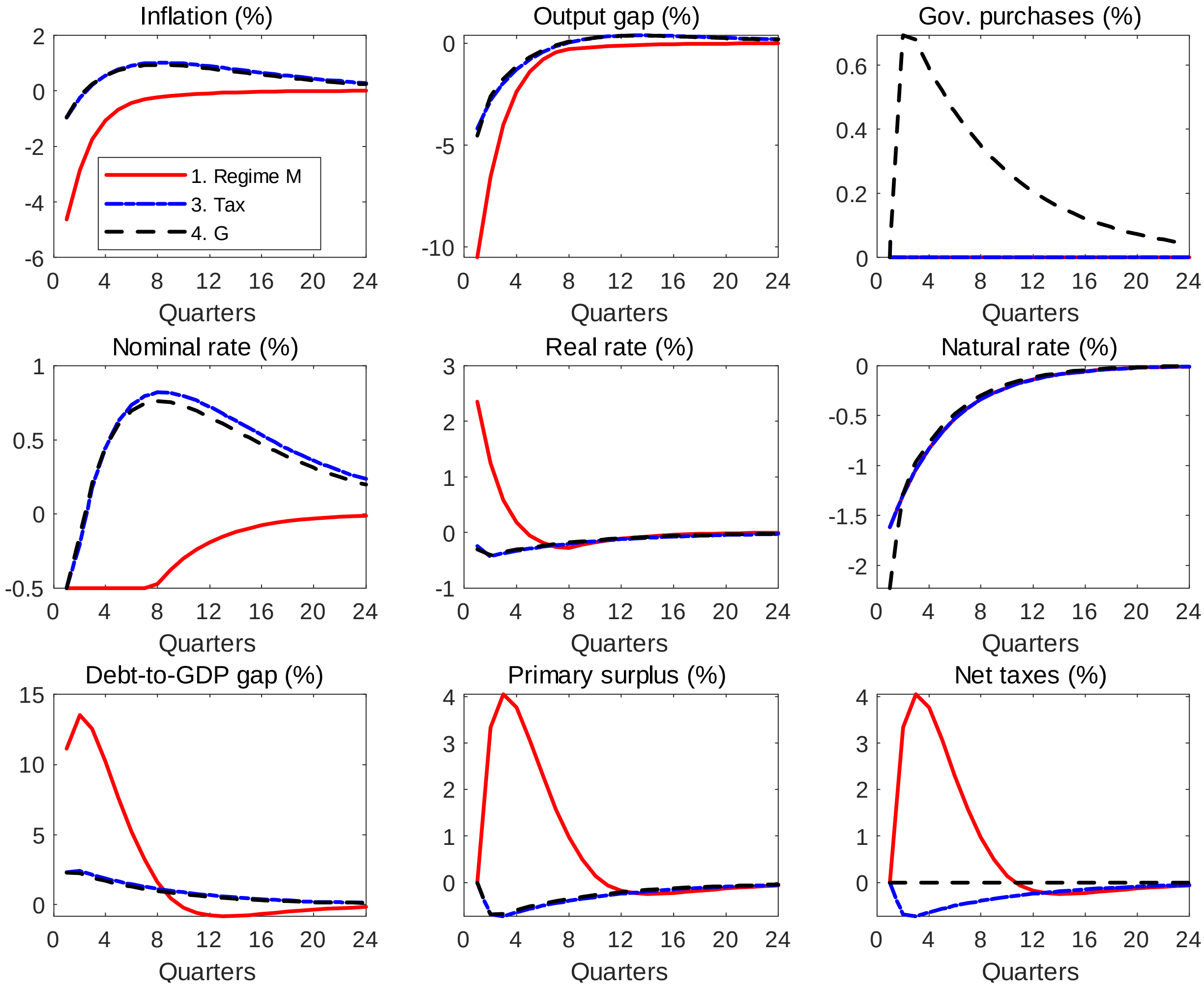

Figure 3: Dynamic effects of a tax cut or G hike with ZLB. Deviation from steady state in response to $-3sd$ demand shock.

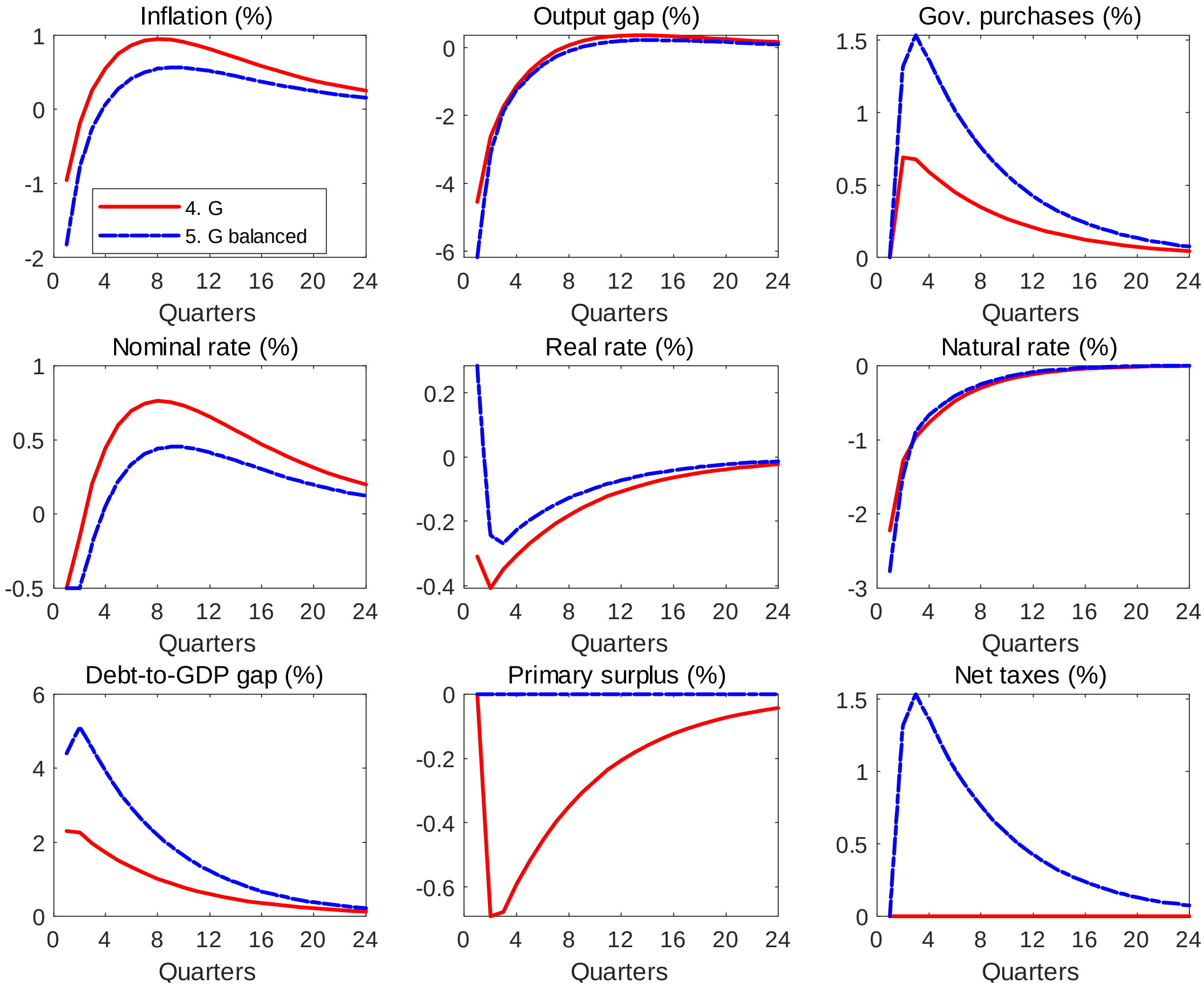

Figure 4: Dynamic effects of G under balanced budget with ZLB. Deviation from steady state in response to $-3sd$ demand shock.

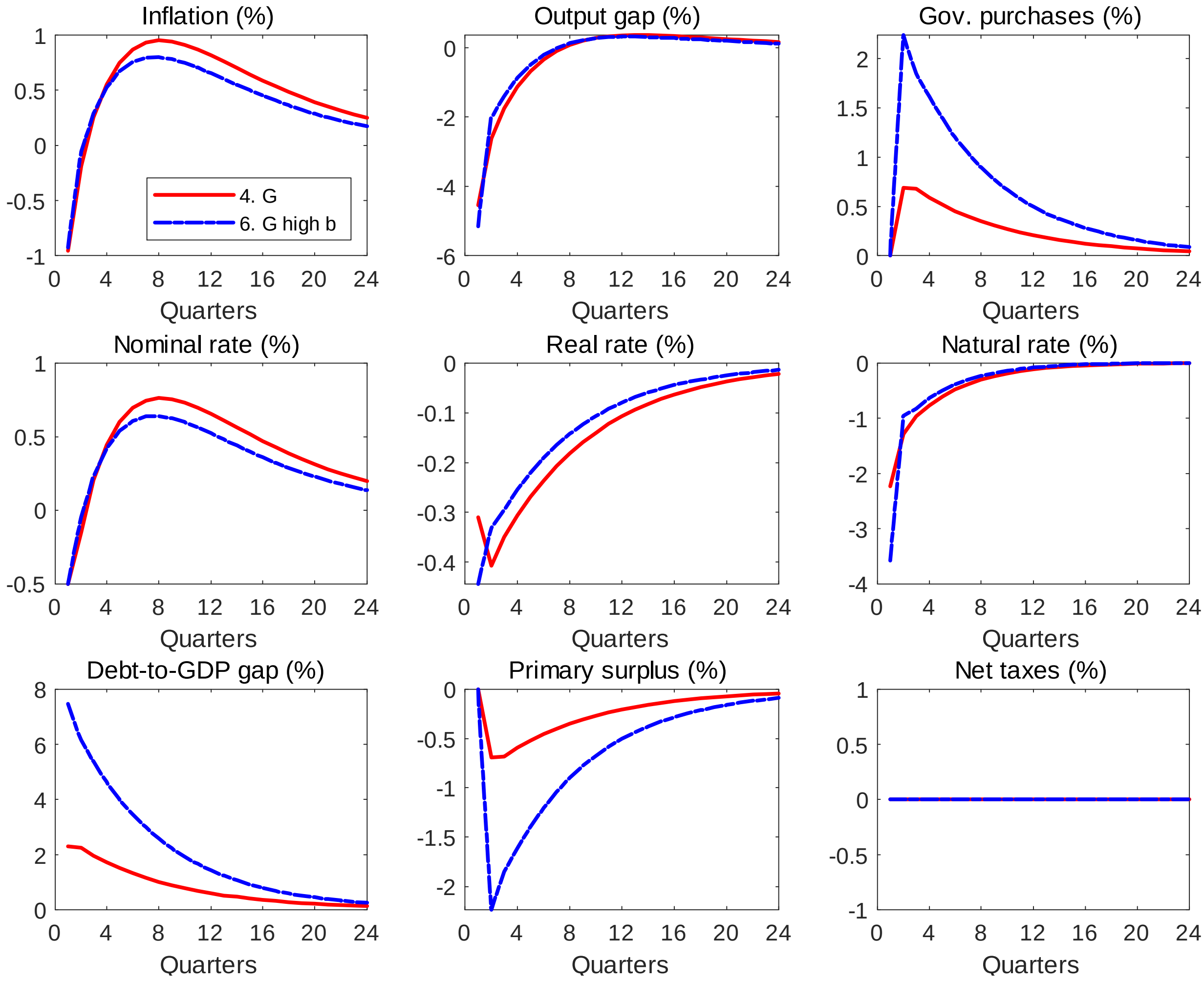

Figure 5: Dynamic effects of G and higher debt target with ZLB. Deviation from steady state in response to $-3sd$ demand shock.

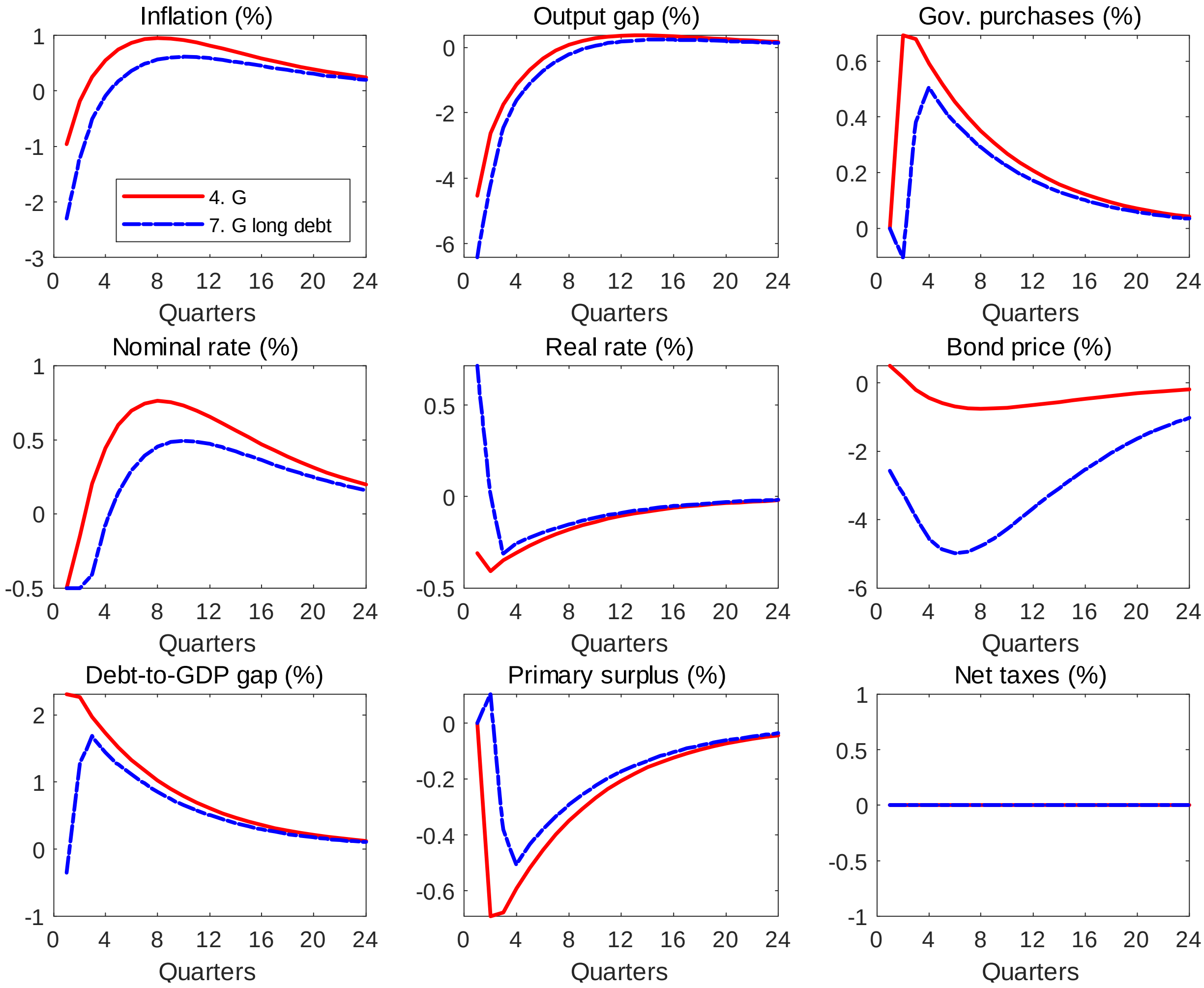

Figure 6: Dynamic effects of G and long-term debt with ZLB. Deviation from steady state in response to $-3sd$ demand shock.

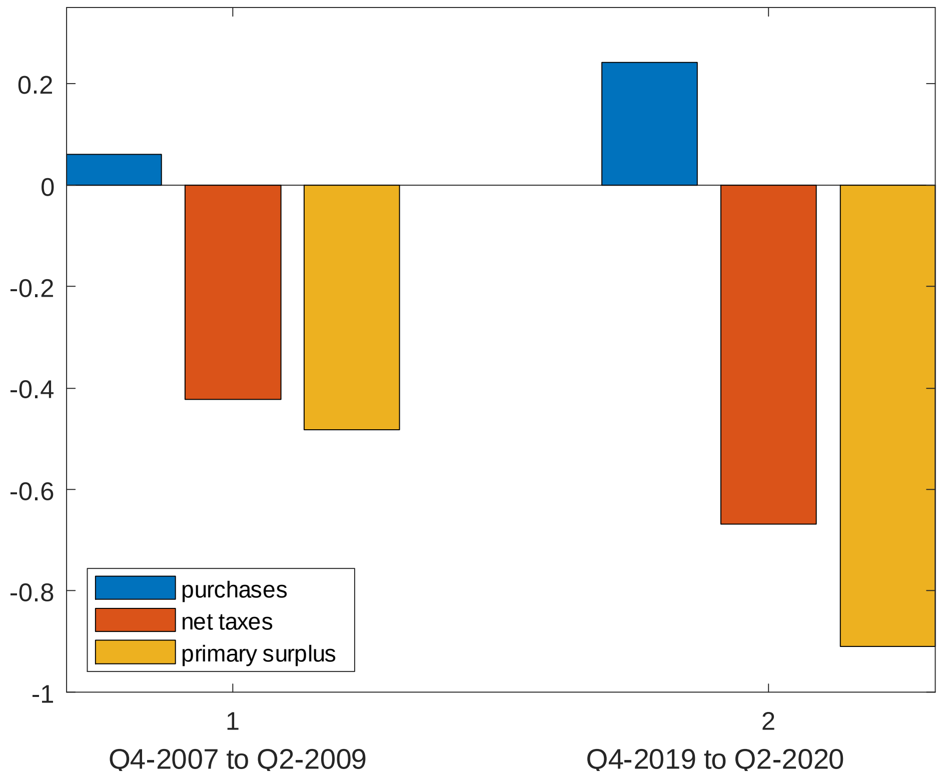

Figure 7: Composition of U.S. federal responses during Great Recession (1) and COVID (2). Each bar is the change in category divided by change in debt held by the public. Data source: FRED.

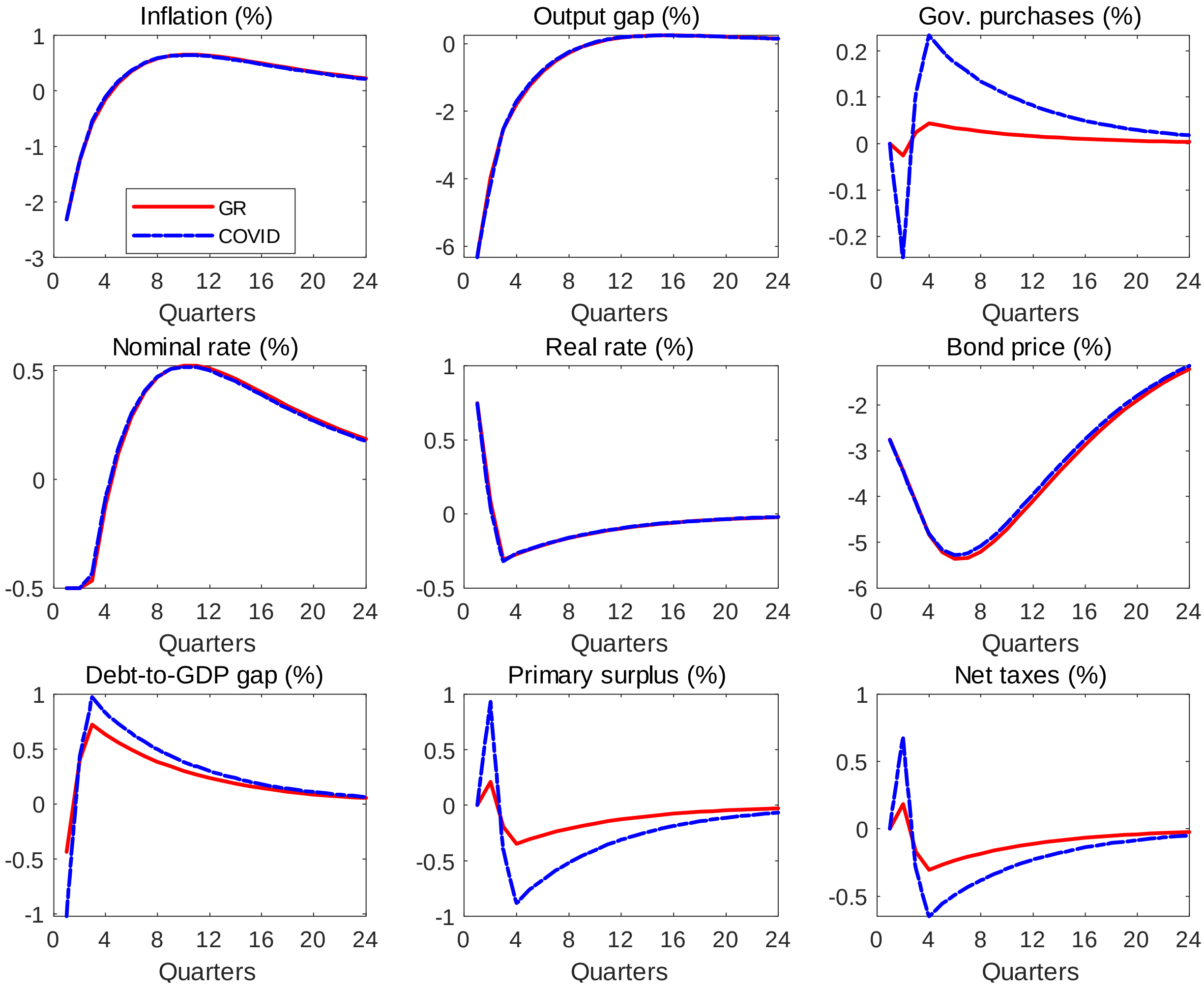

Figure 8: Dynamic effects of irresponsible fiscal stimulus as during Great Recession and COVID facing the ZLB. Deviation from steady state in response to $-3sd$ demand shock.

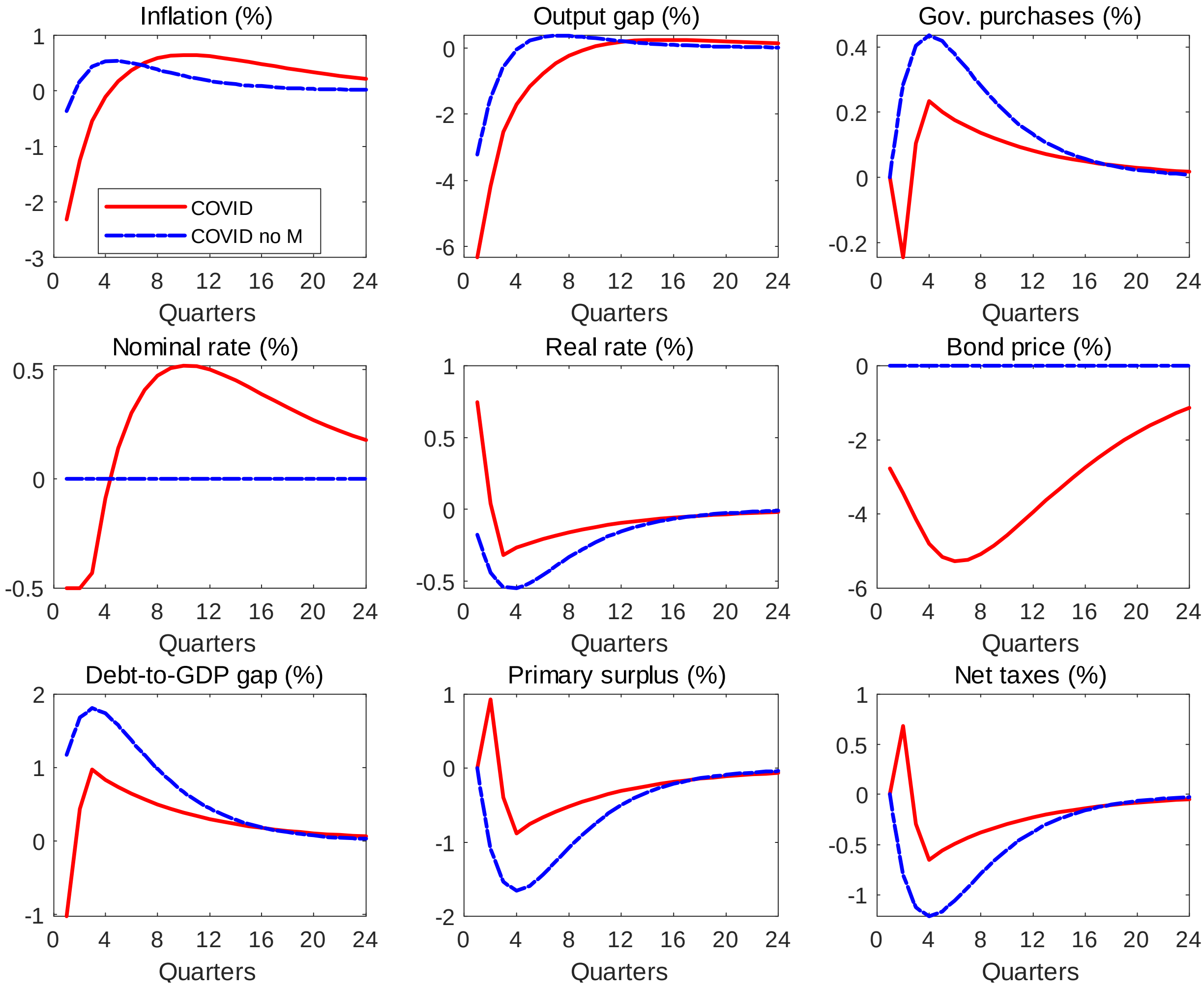

Figure 9: Dynamic effects of irresponsible fiscal stimulus as during COVID facing the ZLB, with and without a monetary policy response. Deviation from steady state in response to $-3sd$ demand shock.

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Sveriges Riksbank
Visiting address: Brunkebergs torg 11
Mail address: se-103 37 Stockholm

Website: www.riksbank.se
Telephone: +46 8 787 00 00, Fax: +46 8 21 05 31
E-mail: registratorn@riksbank.se