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

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Abstract

In this paper, we evaluate the consequences of "irresponsible" fiscal policy rules in a standard New Keynesian model subject to an occasionally-binding zero lower bound on the monetary policy interest rate. We show that 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. 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.

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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 credibly abide by 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 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 show that, in the face of contractionary aggregate-demand shocks occasionally driving 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 if rising debt levels trigger an *increase* in government purchases and/or a *cut* in taxes net of transfers.

The intuition for this striking result is straightforward. Under an active fiscal policy and passive monetary policy, a negative demand shock leads to a fall in inflation, causing a rise in the *real* interest expense incurred by the government to service its debt outstanding. With fiscal policy promising not to raise taxes or cut spending, inflation expectations will rise, which serves to boost aggregate demand. Importantly, the ZLB places no constraint on the government's ability to tax less and spend more to offset the contractionary demand shock. 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. But away from the ZLB, 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.

When the fiscal rules are calibrated to the size of the fiscal responses seen in the U.S. during the Great Recession and the COVID recession, 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 is slightly lower than that achieved instead 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 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 contribution of this paper is to extend the literature on active monetary policy in the context of a stylized New Keynesian model, by reporting 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, causing expectations of higher future inflation. 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*, allowing for a weak monetary policy response to inflation. Employing a model-consistent measure of the welfare costs of fluctuations, the performance of these "irresponsible" fiscal policies 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.

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, provides 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. Section 5 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 6.

2 Related Literature

Our paper contributes to the large literature on designing policies to achieve macroeconomic stability in the face of the ZLB. The research 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. Work on optimal 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. Such a policy involves responding to inflation outcomes below target at the ZLB with the promise that inflation will temporarily rise above target. If credible, this promise induces expectations of higher future inflation, helping to mitigate the policy limitations arising from the ZLB.

Policies that involve making up for past target deviations, so-called "make-up" strategies, can be implemented in a variety of frameworks. One approach, exemplified by Reifschneider and Williams (2000), studies instrument rules that allow past target misses to influence current policy rates. Another approach emphasizes adopting different goals than inflation targets, such as a price-level target, average inflation targeting, nominal GDP targeting, or monetary aggregate targeting.[1] A number of these strategies were discussed in Svensson (2020) as part of the Federal Reserve's recent review of its policy framework. 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 2 percent inflation are expected to be followed by periods during which inflation rises above 2 percent.[2]

The research on new rules and new goals to deal with the ZLB has generally ignored the role of fiscal policy. 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) to ensure debt sustainability.[3] The Fed's policy framework review, for example, took as given that any policy framework under consideration 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]See the FOMC's updated "Statement on Longer-Run Goals and Monetary Policy Strategy" of 27 August 2020 (`https://www.federalreserve.gov/newsevents/pressreleases/monetary20200827a.htm`). 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 printing money to fund a fiscal expansion, inducing expectations of higher future inflation.[4]

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 need to also be considered. Under a PM/AF regime, fiscal policy controls inflation and monetary policy responds passively to ensure debt sustainability. There is evidence that such switches have occurred in U.S. policy in the past.[5] 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; the post-1980 period saw episodes during which each of the four possible combinations of active and passive, monetary and fiscal policies prevailed.[6]

Jacobson, Leeper and Preston (2019) offer an historical example of active fiscal policy in the U.S. In arguing that President Roosevelt's fiscal policies during the Great Depression helped generate the recovery of 1933, they focus on 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. 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 monetary policy. Bianchi, Faccini

[4]At the ZLB, printing money and debt financing a fiscal expansion are equivalent, see Galí (2020).

[5]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.

[6]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 (2020a) 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.

and Melosi (2020) analyze temporary shock-specific polices that can be interpreted as capturing Roosevelt's distinction between the regular and emergency budgets. They focus primarily on how the existence of an emergency budget affects the economy's response to a fiscal shock, modeled as a shock to transfer payments. They do not, however, investigate how variations in the rules governing the response of fiscal variables to debt levels in a PM/AF regime can affect the economy's reaction to a demand shock that drives the nominal interest rate to the ZLB.[7]

While Jacobson, Leeper and Preston (2019) and Bianchi, Faccini and Melosi (2020) consider 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. Our analysis is therefore consistent with most of the recent work investigating new rules and new goals to control inflation and deal with the ZLB, where regimes are analyzed as permanent choices among a variety of policy frameworks.[8] 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.

The paper closest to ours is Ascari, Florio and Gobbi (2020b). Their primary focus is on the relative performance of inflation targeting (IT) and price-level targeting (PLT) in AM/PF and PM/AF regimes. 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*), although they place a larger weight on output gap stabilization than implied by a welfare interpretation of the loss function. PLT is not defined in terms of the central bank's objectives but rather by an interest rate rule expressed in terms of a response to the price level.[9] By varying the response coefficient in the rule for the nominal interest rate, they find that AM/PF dominates PM/AF under PLT;

[7] In Bianchi, Faccini and Melosi (2020) debt arising as part of the regular budget induces adjustments in spending, transfers, and taxes, consistent with passive fiscal policy. Under the emergency budget, only debt up to a target level carries a promise to be repaid by adjustments in future spending or net taxes. Neither spending nor net taxes respond to deviations of debt from its target level. Their general model includes a range of shocks calibrated from Leeper, Traum, and Walker (2017). Bianchi and Melosi (2019) considered how conflict between the fiscal and monetary authorities, if fiscal policy does not act to stabilize debt while the central bank attempts to control inflation, can lead to "dire" consequences in the face of adverse shocks; the economy enters a spiral of growing debt and declining output.

[8] 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.

[9] 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).

the comparison of AM/PF and PM/AF under IT depends on the size of the interest rate response to inflation. While they briefly consider the ZLB, it is primarily in the context of a comparison of IT and PLT and they do not allow net taxes (or spending) to respond to movement in the debt level under active fiscal policy.

Finally, our framework is related to the "unpleasant monetarist arithmetic" of Sargent and Wallace (1981) in that we treat the lagged *real* stock of debt as a state variable. This contrasts with the approach in the fiscal theory of the price level (FTPL) in which the lagged stock of *nominal* debt is predetermined. Our focus, as in New Keynesian analysis more generally, is on the determination of the inflation rate rather than the price level itself. The key insight of Sargent and Wallace carries over to our analysis: with a passive monetary policy, lower inflation today requires higher inflation in the future to ensure intertemporal budget balance. And 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. We do not consider the effects of shocks to fiscal spending or taxes, nor do we focus on the consequences of printing money to finance expenditures.[10]

We, instead, analyze AM/PF and PM/AF 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 how net taxes and government purchases respond to debt levels. We compare the results of "irresponsible" policies 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.[11] Because we allow net taxes to decrease and government purchases to increase as debt levels rise under an 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.

[10] Thus, our analysis of active fiscal policy is not related to the positions advocated by proponents of MMT.

[11] Absent the ZLB constraint, spending financed by taxes or by debt would have the same impact on output and inflation under a standard AM/PF regime as *Ricardian equivalence* holds. That is, the output gap and inflation are determined under AM/PF by the IS and Phillips curve; the path of government spending matters only through its impact on the natural interest rate and the natural output level. However, at the ZLB, the debt equation also matters for determining the output gap and inflation. Therefore, the equilibrium is not independent of the path of taxes.

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, 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:[12]

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

where π_t is the rate of price inflation between periods $t-1$ and t. Moreover, $\tilde{y}_t \equiv \hat{y}_t - \hat{y}_t^n$ 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 σ, φ and α denote the household's coefficient of relative risk aversion, the curvature of labor disutility and the degree of decreasing returns to labor in production, 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)

[12] Eq. (1) is derived from the aggregation of the price setting decisions of firms, in an environment in which such re-optimization takes place with probability $1-\theta$ in any given period.

private consumption expressed in 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. And the parameter β denotes the household's discount factor.

The demand side of the economy is described by a dynamic IS equation:[13]

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

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 $\rho \equiv -\log\beta > 0$. 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.[14]

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

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

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. After log-

[13] Eq. (2) is derived from the optimality condition of the representative household's utility maximization problem.

[14] 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.

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:[15]

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

where $\hat{b}_t \equiv (B_t - B)/Y$ and $\hat{\tau}_t \equiv (T_t - T)/Y$ denote, respectively, deviations of (real) government debt and net taxes from their steady state, expressed as a fraction of steady-state output. 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, $(1+\rho)\,\hat{b}_{t-1}$. The second part is the (real) interest expense to service the debt outstanding, $b\,(1+\rho)\,(\hat{\imath}_{t-1} - \pi_t)$. And the third part captures the "primary balance" (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*, which consists of current revenue from taxes less current spending, and excludes any interest expenses on debt outstanding; when $\hat{s}_t$ is negative, $\hat{\tau}_t < \hat{g}_t$, it indicates that the primary balance is in *deficit* rather than surplus.

The fiscal authority controls the primary balance with rules that specify how both net taxes and government purchases respond to deviations of government debt from its steady state:[16]

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

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

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:

$$\hat{b}_t = (1+\rho-\psi_\tau+\psi_g)\,\hat{b}_{t-1} + b\,(1+\rho)\,(\hat{\imath}_{t-1} - \pi_t)\,. \tag{7}$$

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

[16] One could add responses to inflation in the fiscal rules, (5) and (6), without affecting the performance ranking of the regimes in our analysis. Fiscal rules that increase spending and/or cut taxes when inflation falls below target could be motivated by the need for fiscal support at the ZLB to stabilize inflation under AM/PF, or by the fact that inflation control becomes a fiscal responsibility under PM/AF. With a response to inflation in the fiscal rules, both AM/PF and PM/AF would become more effective at controlling inflation. By excluding such a response, our ranking of policies is weighted against PM/AF.

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. In particular, a lower ψ_τ and/or a higher ψ_g increase the cost of refinancing the debt outstanding from period $t-1$, which, all else equal, 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 central bank. To close the model economy, we need also a description of monetary policy.

The conduct of monetary policy follows a truncated Taylor-type rule, which incorporates explicitly a ZLB constraint:[17]

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

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 $\psi_\tau - \psi_g > \rho$.[18] Conversely, in *regime F*, active fiscal policy (AF) controls inflation and monetary policy responds passively (PM) to ensure debt sustainability: $\phi < 1$ and $\psi_\tau - \psi_g < \rho$.

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.[19] We next discuss how active fiscal policy in regime F and the choice of fiscal instrument affects the response of inflation to demand shocks.[20]

[17] The ZLB constraint applies to the *level* of the nominal interest rate and takes the form $i_t \geq 0$ for all t. Given that $\hat{\imath}_t \equiv i_t - \rho$, the ZLB can then be written as $\hat{\imath}_t \geq -\rho$ for all t.

[18] 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 $\psi_s \equiv \psi_\tau - \psi_g > \rho$, the coefficient on the lagged debt stock in (7) is smaller than unity, which ensures the debt level converges to its long-run target.

[19] Also in line with the standard analysis of interactions between monetary and fiscal policies (see Leeper and Leith (2016)), we assume the nominal interest rate responds to the *current* inflation rate while the fiscal instruments react to the *lagged* stock of debt. This approach introduces an asymmetry. However, one could use a version of rule (8) in which the nominal interest rate responds to lagged inflation. Such inertia in the monetary policy rule would induce at the ZLB expectations of higher future inflation, serving to partially stabilize inflation in the face of negative demand shocks under both AM/PF and PM/AF, without affecting the performance ranking of the regimes in our analysis.

[20] 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

3.3 Inflation Stabilization in Regime F

To discuss inflation stabilization under regime F, we focus on 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 $\psi_s \equiv \psi_\tau - \psi_g < \rho$ 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.

The equilibrium conditions for regime F then 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 understand the role played by inflation in ensuring debt sustainability, we proceed with three examples of debt-financed fiscal expansions in the face of a contractionary aggregate-demand shock.

Case 1. No fiscal response. One example of an active fiscal policy in regime F involves setting $\psi_\tau = \psi_g = 0$; neither net taxes nor government purchases respond to deviations of debt from its steady state.[21] 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:

$$\hat{b}_t = (1+\rho)\,\hat{b}_{t-1} - b\,(1+\rho)\,\pi_t. \tag{9}$$

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 debt outstanding, $-b\,(1+\rho)\,\pi_t$ rises, and therefore worsens 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. Solving the debt equation forward:

$$\hat{b}_{t-1} = b\sum_{i=0}^{\infty}\left(\frac{1}{1+\rho}\right)^{i}\pi_{t+i} + \lim_{i\to\infty}\left(\frac{1}{1+\rho}\right)^{i+1}\hat{b}_{t+i}. \tag{10}$$

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.

[21] This is, for example, the active fiscal policy considered by Ascari, Florio and Gobbi (2020b) in their analysis of price-level targeting.

For a stationary equilibrium, the discounted future debt level must converge to zero, implying:[22]

$$\frac{\hat{b}_{t-1}}{b} = \pi_t + \sum_{i=1}^{\infty} \left(\frac{1}{1+\rho} \right)^i \pi_{t+i}. \tag{11}$$

Hence, 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 the basis for the "unpleasant monetarist arithmetic" of Sargent and Wallace (1981).[23] 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.

Case 2. Tax cuts if debt rises. The same qualitative results hold if active fiscal policy involves setting $\psi_\tau < \rho$ and $\psi_g = 0$; now net taxes react to deviations of debt from its steady state, while government purchases remain constant. Importantly, $\psi_\tau < 0$ means that net taxes are *cut* when the debt level rises, an example of "irresponsible" fiscal policy. With spending fixed, the primary surplus then responds to the debt level by the same extent as net taxes do, $\psi_s = \psi_\tau$. Because ψ_τ appears only in the debt accumulation equation, (11) is modified to become:

$$\frac{\hat{b}_{t-1}}{b} \left(\frac{1+\rho-\psi_\tau}{1+\rho} \right) = \pi_t + \sum_{i=1}^{\infty} \left(\frac{1}{1+\rho-\psi_\tau} \right)^i \pi_{t+i}.$$

Now the present discounted value of inflation depends *negatively* on ψ_τ. With $1+\rho-\psi_\tau > 1$, decreasing ψ_τ increases $1+\rho-\psi_\tau$, 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. The higher expected inflation helps to offset the negative demand shock. Hence, in regime F, an active fiscal policy that *cuts* net taxes as the debt level rises, $\psi_\tau < 0$, may help stabilize the economy to a greater extent than a policy that holds all fiscal instruments constant (Case 1).

Case 3. Tax cuts and/or spending hikes if debt rises. A more general example of regime F involves using all available fiscal instruments and setting $\psi_s \equiv \psi_\tau - \psi_g < \rho$; both net taxes and government purchases respond to deviations of debt from its steady state. When both fiscal instruments react to the debt level, (11) becomes:

[22] That is, the last term in (10) must equal zero to satisfy the *no-Ponzi-game condition*, so the government does not run Ponzi schemes by acquiring infinite debt that is never repaid.

[23] A discussion can be found in Walsh (2017) chapter 4.

$$\frac{\hat{b}_{t-1}}{b}\left(\frac{1+\rho-\psi_\tau+\psi_g}{1+\rho}\right)=\pi_t+\sum_{i=1}^{\infty}\left(\frac{1}{1+\rho-\psi_\tau+\psi_g}\right)^i\pi_{t+i}.$$

The present discounted value of inflation depends *positively* on ψ_g. Conditional on any $\pi_t < 0$, a higher ψ_g increases the future inflation that follows a contractionary demand shock to ensure a stationary debt process. Therefore, similarly to cutting net taxes in the face of rising debt levels, an "irresponsible" fiscal policy that *increases* government purchases as debt levels rise, $\psi_g > 0$, may also serve to stabilize the economy.

This case also raises the question of 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 $\hat{r}_t^n \equiv (1-\rho_z)\,z_t - \sigma\,(1-\Gamma)\,E_t\left\{\Delta\hat{g}_{t+1}\right\}$, 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. However, because the debt stock returns to its steady state in a stationary equilibrium, Ψ eventually reverses sign and boosts future demand.[24]

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.

[24] 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 accounting for the fiscal rules. If $\psi_g > 0$, the fact that the government debt initially rises in the face of a negative demand shock implies the 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.

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 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 $\psi_\tau = 0.2$ and $\psi_g = 0$ for PF, implying any increase in the debt-to-GDP ratio above its target is corrected more than a half in one year by future taxes, in the absence of further deficits.[25] We set the debt target $b = 2.4$ which corresponds to 60% of annual GDP. 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.[26]

[25] That is, given $\rho = 0.005$ and $\psi_\tau = 0.2$, the debt condition (7) implies $(1 + \rho - \psi_\tau)^4 \approx 0.42$. For example, a 10% increase in debt above target would lead to higher net taxes (primary surpluses) such that in four quarters debt falls back to only 4.2% above target.

[26] The model outcomes are obtained with Dynare (`https://www.dynare.org`). Specifically, we feed the equilibrium conditions of the model into Dynare. Then, in order to obtain the dynamic responses shown in the figures, we use the perfect-foresight, deterministic simulations algorithm implemented in Dynare 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 in Dynare with the 'extended_path' command. These long simulations are used to compute the variances of inflation, output gaps, and government purchases that determine the welfare losses associated with each policy regime and parameter configuration considered. Replication files are available from the authors upon request.

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 at the ZLB. We examine the implications of permanently adopting a rule-based PM/AF regime that would appear to be "fiscally irresponsible" but serves as an automatic stabilizer that helps to offset aggregate-demand shocks when monetary policy is unable to respond.[27] 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. We also analyze whether the government's long-run debt target matters for the predictions of the model.

4.1 Effects of Regime F and ZLB without Fiscal Response

The various policy scenarios we investigate are summarized in Table 2. Scenario 1 is our benchmark representation of regime M.[28] Monetary policy is active with a response to inflation given by $\phi = 2$. With $\psi_\tau = 0.2$ and $\psi_g = 0$, passive fiscal policy ensures net taxes adjust positively to movements in the level of debt. Given the discount rate $\rho = 0.005$ per quarter, the coefficient on the lagged debt stock in the debt accumulation equation (7) is then smaller than unity, $1 + \rho - \psi_\tau = 0.805$, 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 $\psi_\tau = \psi_g = 0$. Hence, the coefficient on the lagged debt stock in the debt accumulation equation is larger than unity, $1 + \rho = 1.005$, implying an "irresponsible" debt outlook that will endogenously generate movement in expected inflation to

[27] One could envision a policy framework that switches occasionally between a standard AM/PF when away from the ZLB and PM/AF when at the ZLB. However, if agents in the economy anticipate a future return to AM/PF in the steady state, a policy that switches to $\psi_\tau < 0$ when at the ZLB would fail to raise expectations of future inflation and only cause unwarranted volatility in fiscal variables. A policy that switches to $\psi_g > 0$ when at the ZLB would directly affect aggregate demand and inflation, but may fail to temporarily replace monetary policy as the means of controlling inflation. Simulations of the model generally crashed when raising ψ_g moderately at the ZLB, even though the coefficient on the lagged debt stock in the debt accumulation equation (7) was still smaller than unity.

[28] Regime M uses the baseline calibration that we introduced in Section 3.4 and is summarized in Table 1.

ensure debt sustainability.[29]

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 ZLB.[30] 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. As reported in Table 3, without ZLB in the model, the total welfare loss in regime M is less than a quarter of that in scenario 2 (0.31% versus 1.41%). 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 suggest that scenario 2 may deliver improved performance relative to regime M once the ZLB is taken into account. As Figure 2 shows, with the ZLB, 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 0.99%). Instead in scenario 2, the total welfare loss *falls* moderately due to the ZLB (from 1.41% to 1.22%); the reason is that, at the ZLB, monetary policy is effectively constrained and therefore unable to offset the expectations of higher future inflation generated by active fiscal policy to ensure debt sustainability.[31]

[29] In scenario 2, given $\psi_\tau = \psi_g = 0$, the primary surplus is held constant, $\psi_s \equiv \psi_\tau - \psi_g = 0$.

[30] In all the figures, variable are shown in quarterly rates (not annualized); the steady state of the real and nominal interest rate is $\rho = 0.5\%$ per quarter.

[31] In other words, if the ZLB binds, the *weaker* response of monetary policy to inflation in the face of large contractionary demand shocks means that active fiscal policy is *more* effective in stabilizing inflation. For simulations of the

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 Irresponsible Tax Cuts and Spending Hikes

We begin with two examples of "irresponsible" 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 $\psi_\tau = -0.2$ and $\psi_g = 0$, while scenario 4 sets $\psi_\tau = 0$ and $\psi_g = 0.2$. In both cases, the primary surplus is then given by $\hat{s}_t = (\psi_\tau - \psi_g)\,\hat{b}_{t-1} = -0.2\hat{b}_{t-1}$. 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 5. 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.[32] 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 to 3%. 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

model under a passive monetary policy that pegs the nominal interest rate to its steady state, see Section 5.

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

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 3% under the AF rules, while it reaches 15% 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 "irresponsible" 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 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 (0.70% versus 0.99%). 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 24.9% in regime M to only 10.5% 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.[33] Scenario 5 sets $\psi_g = \psi_\tau = 0.2$, 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 3% in scenario 4 and near 6% 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 third (from 0.70% to 0.93%) if net taxes are used to

[33] 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. See footnote 11.

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.

4.3 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 $\psi_g = 0.2$ 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.[34] 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 fifth (from 0.70% to 0.55%) 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 10.5% to 8%).

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

[34] In our analysis, if $\psi_g = 0$, the value of b does not affect the welfare results (it only affects fiscal variables), because policy is unable to influence the natural interest rate and the natural output level. However, this is not the case if $\psi_g \neq 0$, as then the path of debt affects government purchases, the output gap, and inflation.

"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 Irresponsible Policy Responses in Recent Recessions

During both the Great Recession that followed the 2008-09 global financial crisis and the COVID induced recession that began in 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 rose to 80% at the onset of the COVID induced recession (2020Q1).[35] To illustrate the size and composition of the U.S. federal response during these recessions, Figure 6 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.[36] 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, while the bars on the right show the response to the COVID induced recession during 2020.

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 from 2007Q4 to 2009Q2. 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 2020, the fiscal response to COVID was *smaller overall* measured relative to the debt level, the primary surplus fell only by 38% of the rise in debt, given that the debt level in 2020 was much higher than during the Great Recession. The response during COVID was also more equally balanced between increases in purchases (15% of the rise in debt) and cuts in net taxes (23% of the rise in debt) compared to the previous recession.[37]

[35] The Great Recession in the U.S. lasted from December 2007 until June 2009 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.

[36] 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 6, 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.

[37] These fiscal responses do not include the fiscal stimulus package proposed by the Biden administration that, at the time of writing, is underway to be implemented during 2021.

We use these values to calibrate ψ_τ and ψ_g to study the consequences of "irresponsible" fiscal policies during the two recessions. Table 4 summarizes the experiments. In panel A, the Great Recession (GR) scenario sets $\psi_\tau = -0.4$ and $\psi_g = 0.1$, combined with a passive monetary policy described by $\phi = 0.8$. The COVID scenario sets $\psi_\tau = -0.2$ and $\psi_g = 0.2$, maintaining $\phi = 0.8$. We calibrate the debt target b to the debt-to-GDP level in the data at the start of each recession episode; GR sets $b = 35\%$ and COVID sets $b = 80\%$ as a share of annual GDP. With the ZLB, Figure 7 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 $\psi_s = -0.5$, might be expected to be more expansionary than the COVID policy, with $\psi_s = -0.4$. However, the two policies do a similar job in stabilizing inflation and the output gap, with inflation overshooting slightly less under the COVID policy. Large differences appear in the behavior of the fiscal variables themselves. Under the COVID policy, debt rises more and the primary surplus falls 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 4.3). 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.[38]

Imposing the ZLB, Figure 8 shows the responses to a negative demand shock for the COVID policy with $\phi = 0.8$ and with $\phi = 0$.[39] The latter scenario is labeled "COVID no M" to indicate no response of monetary policy to movement in inflation. The impact of the nominal rate peg on inflation

[38] Setting $\phi = 0$ in rule (8) implies the nominal interest rate equals its steady-state value, $i_t = \rho > 0$, for all t.
[39] The COVID responses for $\phi = 0.8$ are the same as those shown in Figure 7.

is large. While inflation rises to 1% when $\phi = 0.8$, it rises to only half that level and returns to zero more quickly when $\phi = 0$. Under the nominal rate peg, the output gap also returns more quickly to zero. Because the nominal interest rate cannot adjust under the peg, the initial fall in inflation raises the real interest rate. The resulting increase in the (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 0.99% 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.[40] 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.

6 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, and 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

[40] This result is consistent with figure 3 of Ascari, Florio and Gobbi (2020b), who report the total loss is decreasing with ϕ in a PM/AF regime. Their fiscal regime corresponds to $\psi_g = \psi_\tau = 0$ in our setting.

commit to a policy rule and has *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 minimized under an active fiscal policy and a nominal interest rate peg.

The model we employ and the policy rules we analyze are highly stylized, but we think the results call into question the exclusive focus on monetary policy as the means of achieving inflation targets and contributing to macroeconomic stability. The fiscal rules we study involve apparently "irresponsible" fiscal actions, 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; it can talk, but it can't act if its policy instrument cannot be reduced. In contrast, the fiscal authority can always act because its instruments are not constrained by the ZLB.

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 the analysis of the actions of 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.

Monetary policy actions also have distributional consequences; in the past, these 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 aren't well known to academics and policymakers, 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.

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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	0.2
ψ_g	Fiscal policy, purchases response to debt	0
b	Debt-to-GDP target	2.4
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	Regime	Implications for a rise in debt
1. Regime M	2	0.2	0	0.6	M	$\hat{\tau}_t$ hike
2. No tax or G	0.8	0	0	0.6	F	No fiscal response
3. Tax	0.8	−0.2	0	0.6	F	$\hat{\tau}_t$ cut, debt financed
4. G	0.8	0	0.2	0.6	F	$\hat{g}_t$ hike, debt financed
5. G balanced	0.8	0.2	0.2	0.6	F	$\hat{g}_t$ and $\hat{\tau}_t$ hike, balanced budget
6. G high b	0.8	0	0.2	2.0	F	$\hat{g}_t$ hike, debt financed

Notes: Under regime M, $\phi > 1$ and $\psi_s \equiv \psi_\tau - \psi_g > \rho$; in regime F, $\phi < 1$ and $\psi_s \equiv \psi_\tau - \psi_g < \rho$, where $\rho = 0.005$ in the model calibration. The debt target b is shown as a share of annual GDP.

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	0.99	0.92	0.07	0.00	24.9
2. No tax or G	1.41	1.31	0.10	0.00	1.22	1.12	0.10	0.00	15.3
3. Tax	0.96	0.89	0.06	0.00	0.79	0.73	0.06	0.00	11.8
4. G	0.83	0.77	0.06	0.00	0.70	0.64	0.06	0.00	10.5
5. G balanced	1.04	0.95	0.09	0.00	0.93	0.84	0.09	0.00	12.8
6. G high b	0.62	0.56	0.06	0.01	0.55	0.48	0.06	0.01	8.0

Notes: $\mathbb{L}$ is the permanent consumption loss from fluctuations. The total loss may differ from the sum of its components due to rounding. Scenario 1 is regime M, all other are regime F.

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

	Policy coefficients					
	ϕ	ψ_τ	ψ_g	b	Regime	Implications for a rise in debt
Panel A: Scenarios with a monetary policy response:						
GR	0.8	−0.4	0.1	0.35	F	$\hat{\tau}_t$ cut and $\hat{g}_t$ hike, debt financed
COVID	0.8	−0.2	0.2	0.80	F	Idem
Panel B: Scenarios without monetary policy response:						
GR no M	0	−0.4	0.1	0.35	F	Idem
COVID no M	0	−0.2	0.2	0.80	F	Idem

Notes: Under regime F, $\phi < 1$ and $\psi_s \equiv \psi_\tau - \psi_g < \rho$, where $\rho = 0.005$ in the model calibration. The debt target b is shown as a share of annual GDP. In panel B, $\phi = 0$ implies the policy rate is pegged to its steady state.

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	1.17	1.12	0.05	0.00	0.92	0.87	0.05	0.00	14.1
COVID	0.99	0.94	0.05	0.00	0.79	0.75	0.05	0.00	12.2
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	0.15	0.03	0.00	0.19	0.15	0.03	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 A, $\phi = 0.8$. Instead in panel B, $\phi = 0$ implies the policy rate is pegged to its steady state and therefore the ZLB has no effects.

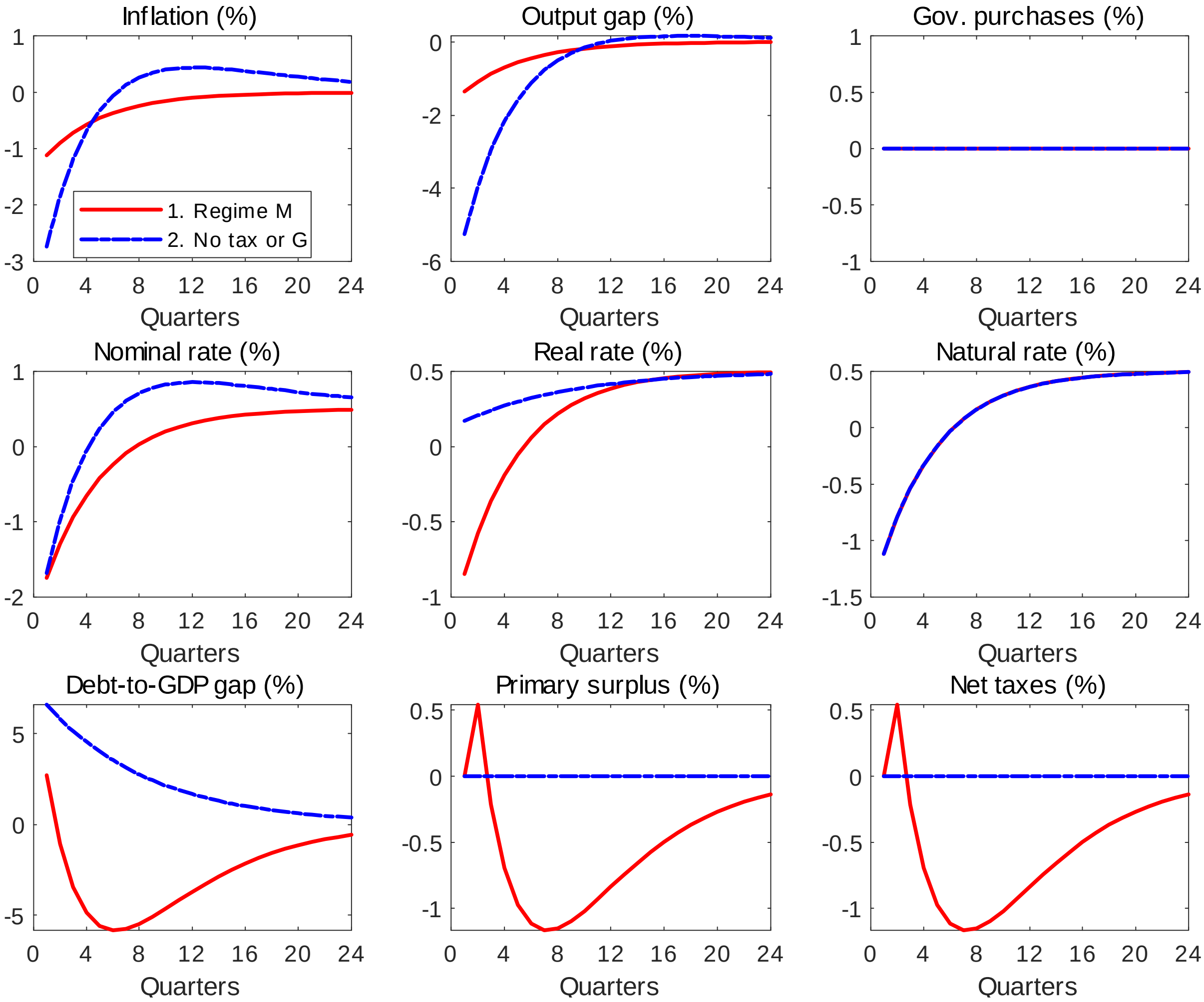

Figure 1: Dynamic effects of regime F (no tax or G) without ZLB. Responses to $-3sd$ demand shock.

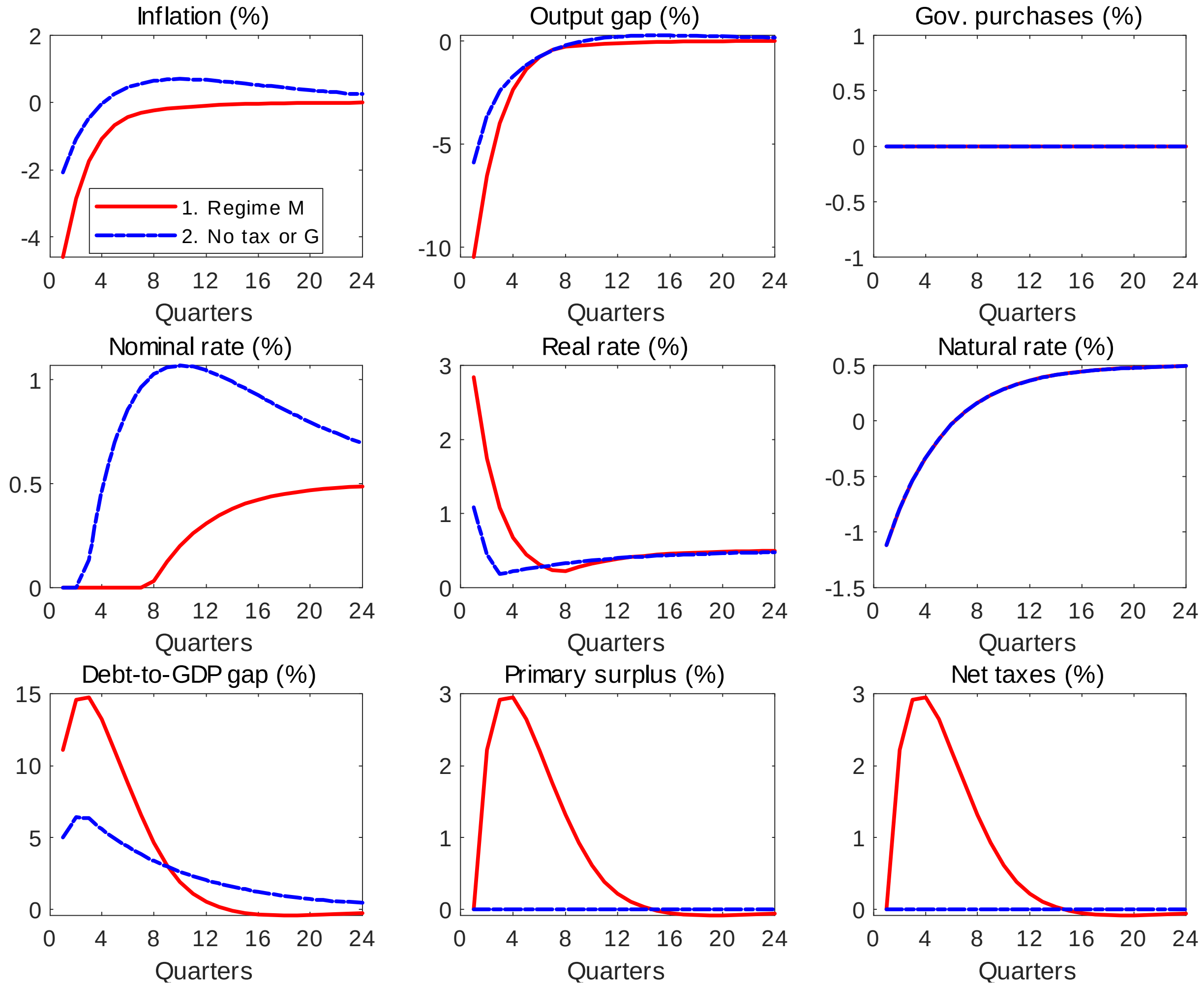

Figure 2: Dynamic effects of regime F (no tax or G) with ZLB. Responses to $-3sd$ demand shock.

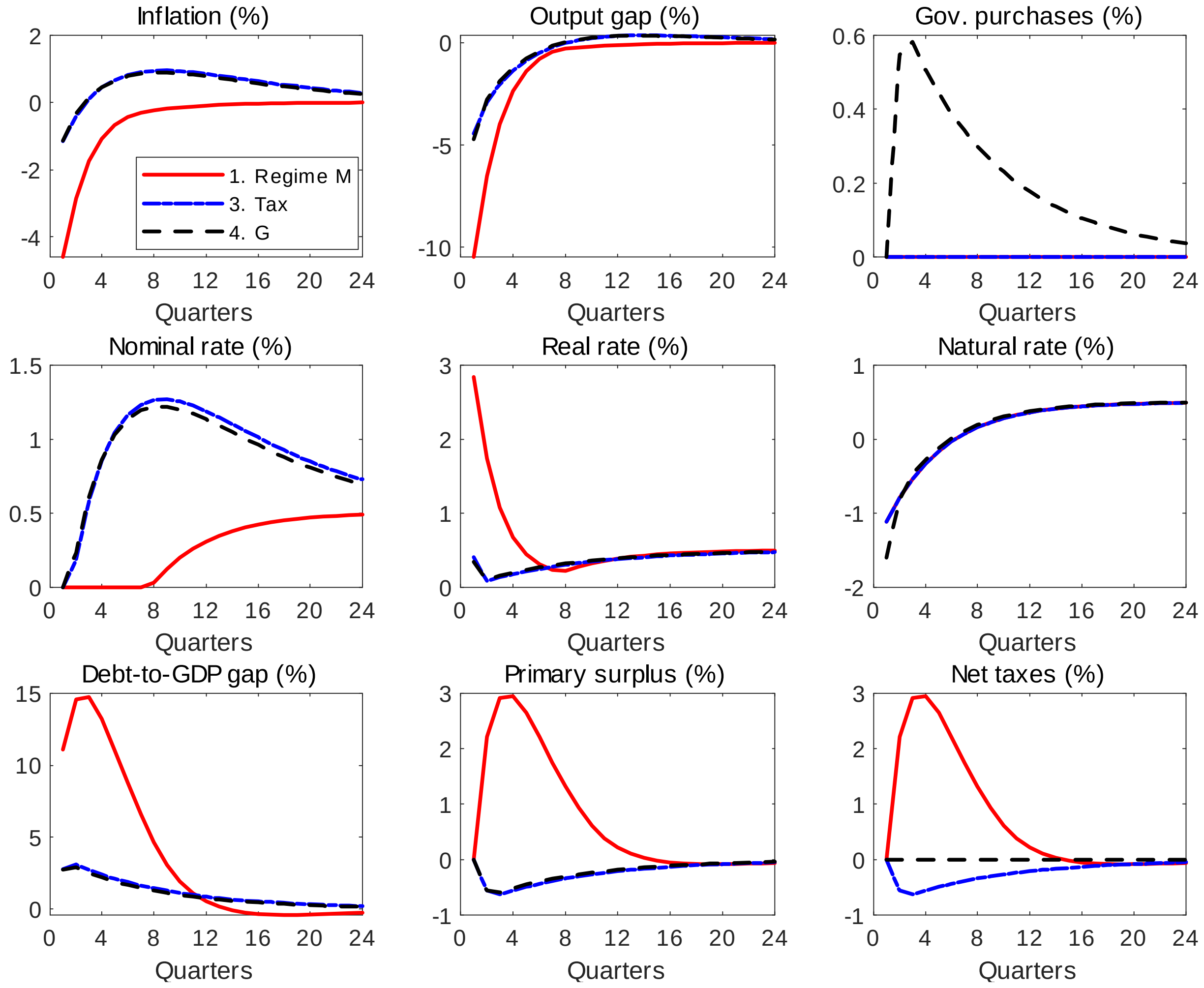

Figure 3: Dynamic effects of a tax cut or G hike with ZLB. Responses to $-3sd$ demand shock.

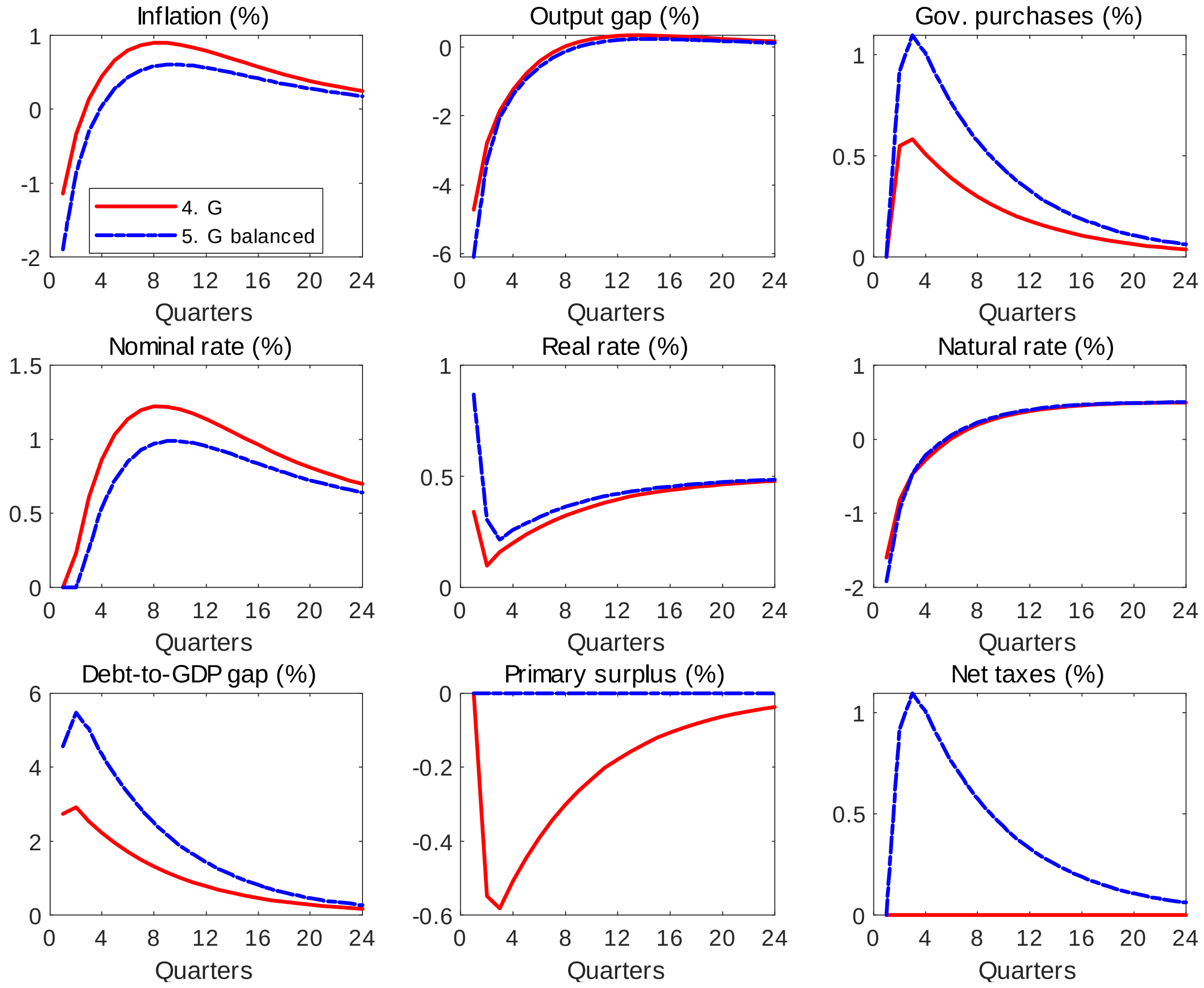

Figure 4: Dynamic effects of G under balanced budget with ZLB. Responses to $-3sd$ demand shock.

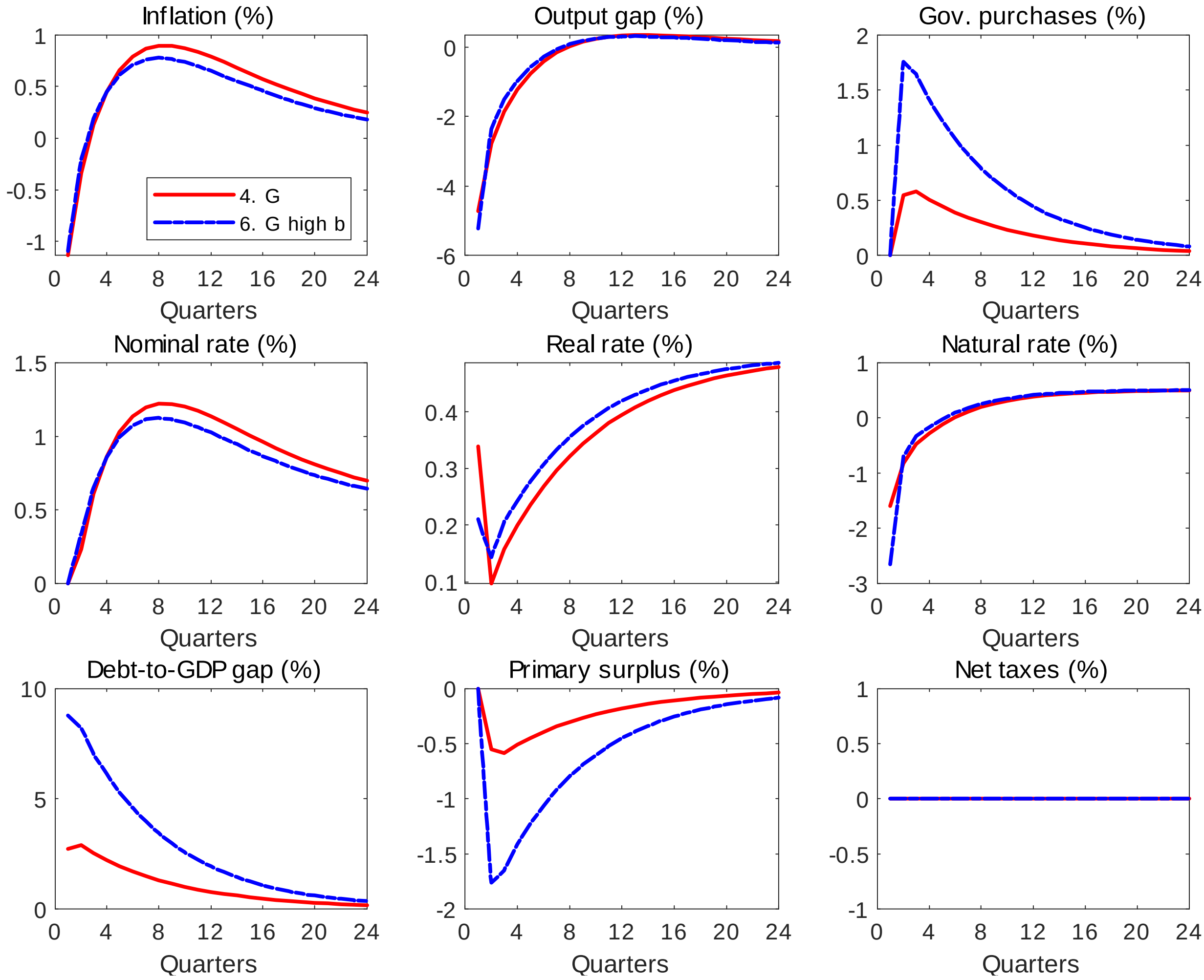

Figure 5: Dynamic effects of G and higher debt target with ZLB. Responses to $-3sd$ demand shock.

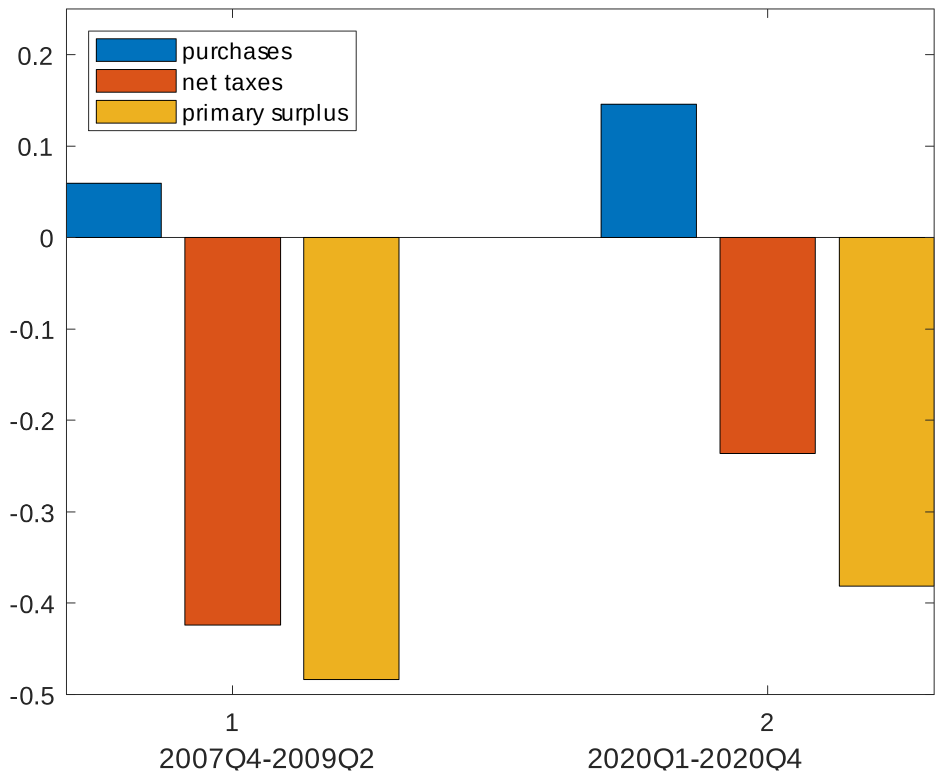

Figure 6: Composition of U.S. federal responses during Great Recession (1) and COVID (2). Each bar is the change in category divided by change in debt held by the public. Data source: FRED.

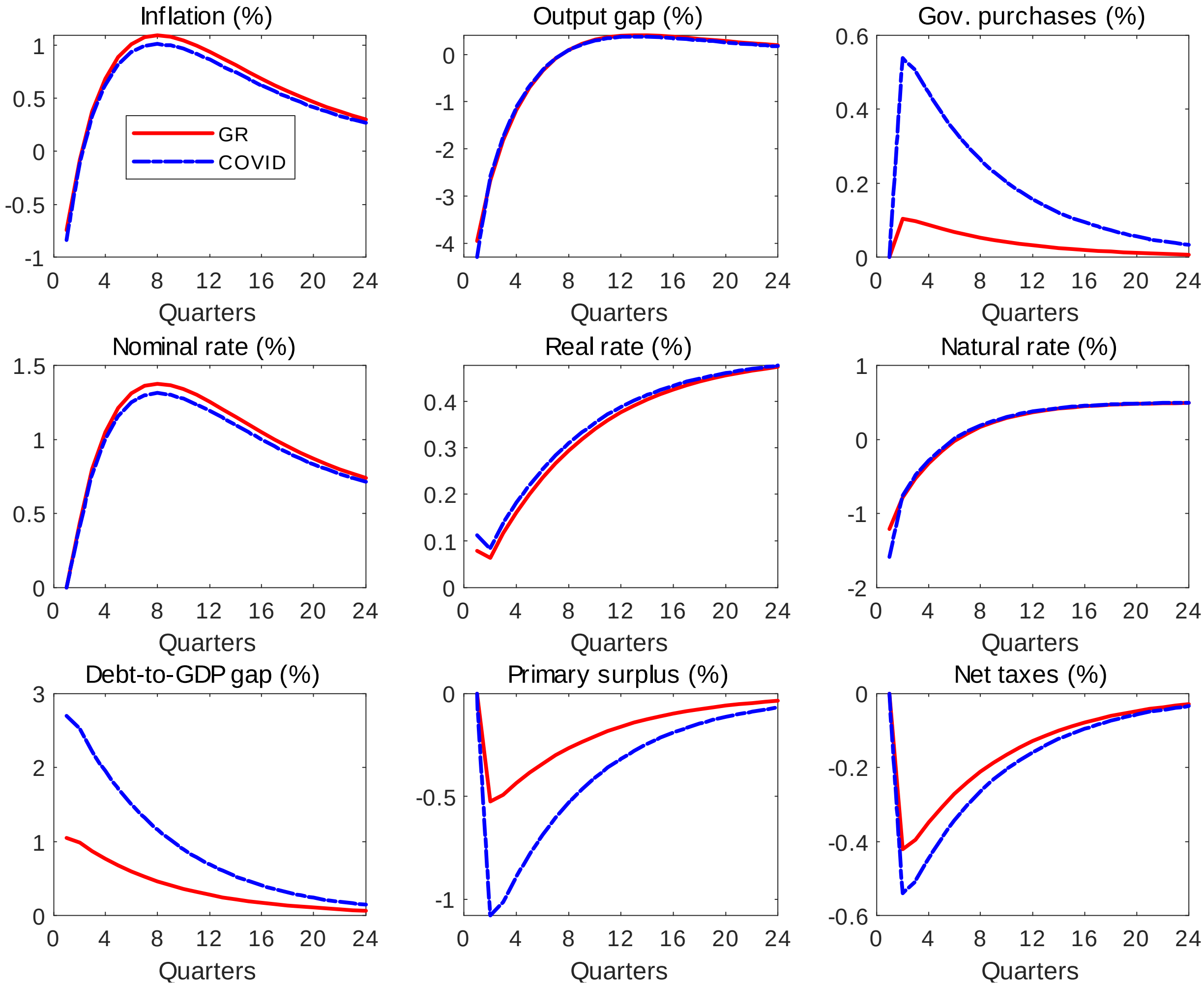

Figure 7: Dynamic effects of irresponsible fiscal stimulus as during the Great Recession and COVID facing the ZLB. Responses to $-3sd$ demand shock.

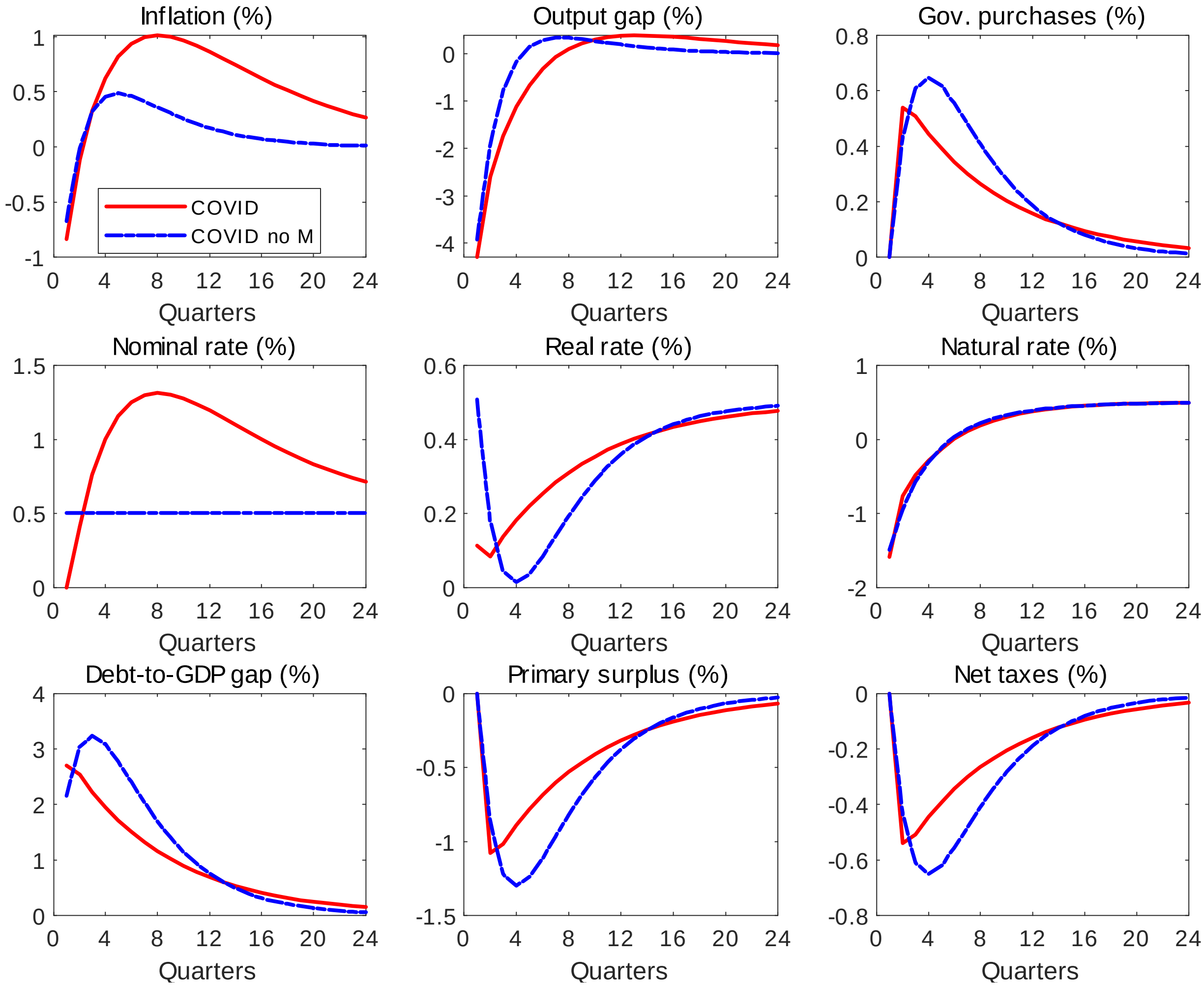

Figure 8: Dynamic effects of irresponsible fiscal stimulus as during COVID facing the ZLB, with and without a monetary policy response. Responses to $-3sd$ demand shock.