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FISCAL ACTIVISM AND THE ZERO NOMINAL INTEREST RATE BOUND

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Abstract

I show that the zero nominal interest rate bound may render it desirable for society to appoint a fiscally activist policymaker who cares less about the stabilization of government spending relative to inflation and output gap stabilization than the private sector does. I work with a simple New Keynesian model where the government has to decide each period afresh about the optimal level of public consumption and the one-period nominal interest rate. A fiscally activist policymaker uses government spending more aggressively to stabilize inflation and the output gap in a liquidity trap than an authority with preferences identical to those of society as a whole would do. The appointment of an activist policymaker corrects for discretionary authorities' disregard of the expectations channel, thereby reducing the welfare costs associated with zero bound events.

Keywords: Monetary policy, Fiscal policy, Discretion, Zero nominal interest rate bound

JEL-Codes: E52, E62, E63

Non-technical summary

According to economic theory, in the absence of policy commitment, the zero nominal interest rate bound can be a severe drag on conventional monetary stabilization policy. Several studies have therefore turned the spotlight on fiscal policy in coping with liquidity traps, showing by means of model-based experiments that the welfare costs associated with zero bound events can be reduced if public spending is used for macroeconomic stabilization. All these studies, however, maintain the assumption that the policymaker has the same preferences as society as a whole. In this paper, I ask whether the presence of the zero lower bound provides a rationale for appointing a policymaker whose preferences differ from those of the private sector. In particular, I focus on the policymaker's attitude towards the use of government purchases as a stabilization tool in the face of zero lower bound events.

The framework used for the analysis is a simple variant of the New Keynesian model which has become the workhorse model in monetary research in the past decade. The model features nominal rigidities and monopolistic competition. Agents are assumed to have rational expectations. Importantly, the model accounts for the fact that nominal interest rates cannot fall below zero. It abstracts, however, from an explicit treatment of unconventional monetary policy measures. Each period, the policymaker chooses the level of the nominal interest rate and government spending, which is assumed to be financed by lump-sum taxes. The policymaker's objective function is derived from society's preferences but I allow the weight put on the stabilization of public spending relative to the stabilization of inflation and the output gap in the policy objective to differ from the one implied by households' preferences. I show that welfare in the model can be improved if the appointed policymaker takes a more activist stance towards the use of expansionary fiscal policy in a liquidity trap, i.e. if he puts less weight on the stabilization of government purchases around target than the private agents do.

Away from the zero bound it is optimal for a discretionary policymaker to rely solely on monetary stabilization policy, irrespective of whether he puts the same weight on government spending stabilization as society does or not. If, however, the policymaker is confronted with a large shortfall in aggregate demand that forces him to lower the nominal interest rate to zero, then the optimal policy mix prescribes the implementation of a transitory government spending stimulus. Fiscal policy is transmitted to the economy through two interrelated channels. First, a transitory government spending stimulus at the zero bound raises current aggregate demand and thereby reduces contemporaneous deflationary pressures. Second, fiscal policy works through an expectations channel. If the policymaker is allowed to use government spending for stabilization policy, rational forward-looking agents anticipate that government spending will be expanded in those states of the world that are associated with zero nominal interest rates. Since fiscal policy makes the downturn in these states less severe, it unfolds a stabilizing effect on agents' expectations. Higher expected future inflation lowers current real interest rates, thereby further mitigating the fall in the output gap and inflation in a liquidity trap.

Crucially, however, this expectations channel of fiscal policy transmission is ignored by discretionary policymakers in the model. Since discretionary policymakers are unable to make credible commitments regarding future policy actions, they take private sector expectations in their decision problem as given. The underestimation of the relative gains from expansionary fiscal policy at zero nominal interest rates results in a subdued willingness of benevolent discretionary policymakers to use government consumption as a stabilization tool. In this environment, the appointment of a discretionary policymaker who cares less about stabilizing government purchases than society as a whole allows to correct for the disregard of the expectations channel. Specifically, due to the lower relative weight put on the stabilization of public consumption, this policymaker is willing to raise government spending more aggressively in times of zero nominal interest rates than a policymaker whose preferences are identical to those of society.

1 Introduction

In the absence of policy commitment, the zero nominal interest rate bound can be a severe drag on monetary stabilization policy. Once the policy rate hits the lower bound, standard nominal interest rate policy becomes unable to stabilize output and inflation against economic turmoil. Several studies have therefore turned the spotlight on fiscal policy in coping with liquidity traps, showing that the welfare costs associated with zero bound events can be reduced if public spending is used for macroeconomic stabilization.[1] All these studies, however, maintain the assumption that the policymaker has the same preferences as society as a whole. In this paper, I ask whether the presence of the zero lower bound provides a rationale for appointing a policymaker whose preferences differ from those of the private sector.

Previous work on policy preferences and stabilization outcomes has emphasized the desirability of inflation-conservative central bankers along the lines of Rogoff (1985), see Clarida, Galí and Gertler (1999) and Adam and Billi (2008).[2] Here, instead, the focus is on the policymaker's attitude towards the use of government purchases as a stabilization tool in the face of zero lower bound events. I use a stylized New Keynesian model where the only source of uncertainty is a stochastic natural real rate of interest. The discretionary policymaker controls the one-period nominal interest rate and the level of government spending. Households value private consumption as well as the provision of public goods and dislike labor. The policymaker's preferences are similar to those of society as a whole, but the weight that he puts on the stabilization of public consumption relative to the stabilization of inflation and the output gap may differ from the one implied by households' preferences.

I show that discretionary policymakers should take an 'activist' stance towards the use of fiscal stabilization policy in a liquidity trap, i.e. welfare can be improved if a policymaker takes office who puts less weight on the stabilization of government purchases than society as a whole. The best-performing activist policymaker replicates the stabilization outcomes that could be obtained under commitment to an optimized feedback rule for government spending. The logic behind these results is rooted in discretionary policymakers' failure to take full account of how their policy decisions transmit to the economy.

Away from the zero bound it is optimal for a benevolent discretionary policymaker to rely solely on monetary stabilization policy. If, however, the policymaker is confronted with a large shortfall in aggregate demand that forces him to lower the nominal interest rate to

[1]See Werning (2012), Nakata (2013) and Schmidt (2013), as discussed below.

[2]More precisely, Rogoff (1985) proposes the appointment of a weight-conservative central banker, i.e. a policymaker who puts less weight on output gap stabilization relative to inflation stabilization than society. For a discussion of other forms of inflation conservatism see Svensson (1997).

zero, then the optimal policy mix prescribes the implementation of a transitory government spending stimulus. Fiscal policy is transmitted to the economy through two interrelated channels. First, a transitory government spending stimulus at the zero bound raises current aggregate demand and thereby reduces contemporaneous deflationary pressures. Second, fiscal policy works through an expectations channel. If the discretionary policymaker is allowed to use government spending for stabilization policy, rational forward-looking agents anticipate that government spending will be expanded in those states of the world that are associated with zero nominal interest rates. Since fiscal policy makes the downturn in these states less severe, it unfolds a stabilizing effect on agents' expectations. Higher expected future inflation lowers current real interest rates, thereby further mitigating the fall in the output gap and inflation in a liquidity trap.

Crucially, however, this expectations channel of fiscal policy transmission is not taken into account by discretionary policymakers when choosing the optimal amount of government spending. They solve a sequence of static optimization problems taking private sector expectations as given. The underestimation of the relative gains from expansionary fiscal policy at zero nominal interest rates results in a subdued willingness of benevolent discretionary policymakers to use government consumption as a stabilization tool. In this environment, the appointment of a discretionary policymaker who cares less about stabilizing government purchases than society as a whole allows to correct for the disregard of the expectations channel. Due to the lower relative weight put on the stabilization of public consumption, this policymaker is willing to raise government spending more aggressively in times of zero nominal interest rates. Using a numerical example, I show that when zero bound episodes are expected to be persistent, the welfare gains from fiscal activism can become quite large.

The paper is most closely related to work by Nakata (2013) and Schmidt (2013) that studies optimal time-consistent monetary and fiscal policy in the presence of the zero lower bound.[3] Werning (2012) considers the case where monetary policy acts under discretion whereas fiscal policy is able to make credible commitments. In contrast to the current paper, all these studies assume that the policymaker exhibits the same preferences as society as a whole. The paper is also related to but distinct from a broad literature on fiscal multipliers that studies the effect of an exogenous change in the fiscal instrument on GDP when monetary policy is constrained by the zero bound, see e.g. Christiano, Eichenbaum and Rebelo (2011), Eggertsson (2011), Woodford (2011) and Denes, Eggertsson and Gilbukh (2013). Finally, the paper builds on earlier research that has documented the severity of the welfare costs associated with the zero lower bound under discretionary monetary policy absent any additional policy

[3]See also Cook and Devereux (2013) for a characterization of optimal discretionary monetary and fiscal policy in a two-country model.

instruments, see Eggertsson and Woodford (2003), Jung, Teranishi and Watanabe (2005), Adam and Billi (2007) and Nakov (2008).
The remainder of the paper is organized as follows. Section 2 introduces the model and the discretionary policy regime. Section 3 presents analytical results on the desirability of fiscal activism based on a discrete state variant of the model. Section 4 presents numerical results for a less restrictive continuous state variant of the model. Finally, Section 5 concludes.

2 The model

The economy is represented by a standard monetary business cycle model with nominal price rigidities and monopolistic competition in the goods market. A detailed description can be found in Woodford (2003). The representative household consumes a composite private consumption good, supplies labor to the production sector in a competitive labor market and enjoys the provision of a composite public good by the government. Utility is separable in all three arguments as in Woodford (2011) and both composite goods are compiled based on the same aggregation technology.[4] Firms employ industry-specific labor and use a constant-return-to-scale technology to produce differentiated goods that can be used for private or public consumption. Nominal rigidities enter the model in the form of staggered price-setting as in Calvo (1983). The policymaker acts under discretion and possesses two policy instruments, the one-period, riskless nominal interest rate and government consumption, which is financed by lump-sum taxes.[5] Time is discrete and indexed by t.

2.1 The private sector

Private sector behavior can be summarized by a standard New Keynesian Phillips curve and a dynamic IS curve

$$\pi_t = \kappa \left(Y_t - \Gamma G_t\right) + \beta E_t \pi_{t+1} \tag{1}$$

$$Y_t = G_t + E_t Y_{t+1} - E_t G_{t+1} - \frac{1}{\sigma}\left(i_t - E_t \pi_{t+1} - r_t\right), \tag{2}$$

where π_t denotes the gross inflation rate between period $t-1$ and t, Y_t represents output, G_t represents government spending as a share of steady state output, i_t is the nominal interest rate between period t and $t+1$, and r_t denotes the natural real rate of interest, which is

[4] Amano and Wirjanto (1998) provide empirical evidence for the U.S. in favor of additive separability in private and public consumption.

[5] For an analysis of discretionary stabilization policy at the zero bound when the timing of government deficits matters see Eggertsson (2006) and Burgert and Schmidt (2013).

observed by all agents at the beginning of period t. In the discrete state variant of the model considered first, the natural rate is assumed to follow a two state Markov process, as defined below. In the continuous state model analyzed in Section 4 the natural rate follows a stationary autoregressive process. Except for the interest rates, all variables are expressed in percentage deviations from the deterministic, non-distorted steady state with the gross inflation rate set equal to one.[6] The parameter $\beta \in (0,1)$ denotes the subjective discount factor and $\sigma > 0$ denotes the elasticity of the marginal utility of private consumption with respect to total output. The parameters κ and Γ are functions of the structural parameters

$$\kappa = \frac{(1-\alpha)(1-\alpha\beta)}{\alpha(1+\eta\theta)}(\sigma+\eta), \quad \Gamma = \frac{\sigma}{\sigma+\eta},$$

where $\alpha \in (0,1)$ denotes the share of firms that cannot reoptimize their price in a given period, $\eta > 0$ denotes the inverse of the elasticity of labor supply, and $\theta > 1$ is the price elasticity of demand for differentiated goods.

2.2 Social welfare

Society's preferences are represented by a linear-quadratic approximation to household welfare

$$E_t \sum_{j=0}^{\infty} \beta^j \frac{1}{2} \left[\pi_{t+j}^2 + \lambda\left(Y_{t+j} - \Gamma G_{t+j}\right)^2 + \lambda_G G_{t+j}^2\right],$$

where the term $Y_t - \Gamma G_t$ represents the output gap.[7] In addition to the two common terms related to inflation and the output gap, government spending enters the objective function, reflecting households' preferences for the provision of public goods and the fact that private consumption has been substituted out using the goods market clearing condition. The relative weights λ, λ_G are functions of the structural parameters

$$\lambda = \frac{\kappa}{\theta}, \quad \lambda_G = \lambda\Gamma\left(1 - \Gamma + \frac{\nu}{\sigma}\right),$$

where ν denotes the elasticity of the marginal utility of public consumption with respect to total output.

[6]The steady state distortions arising from monopolistic competition are offset by an appropriate wage subsidy.

[7]See Schmidt (2013) for the details of the derivation.

2.3 Policy

The policymaker's preferences are similar to those of society as a whole, but he may attach a different weight to the stabilization of public consumption, $\tilde{\lambda}_G > 0$. Each period t, the discretionary policymaker chooses inflation, output, government spending and the nominal interest rate to minimize his objective function subject to the zero nominal interest rate bound and the behavioral constraints, taking agents' expectations as given.[8] In particular, since the model features no endogenous state variable, the policymaker solves a sequence of static optimization problems

$$\begin{aligned}
&\min_{\{\pi_t, Y_t, G_t, i_t\}} \frac{1}{2}\left[\pi_t^2 + \lambda\left(Y_t - \Gamma G_t\right)^2 + \tilde{\lambda}_G G_t^2\right] \\
&\text{subject to} \\
&i_t \geq 0, \\
&\text{Equations (1) - (2),} \\
&r_t \text{ given,} \\
&\{\pi_{t+j}, Y_{t+j}, G_{t+j}, i_{t+j} \geq 0\} \text{ given for } j \geq 1.
\end{aligned}$$

The optimality conditions are

$$(1-\Gamma)\left[\kappa\pi_t + \lambda\left(Y_t - \Gamma G_t\right)\right] + \tilde{\lambda}_G G_t = 0 \tag{3}$$

$$i_t\left(\kappa\pi_t + \lambda\left(Y_t - \Gamma G_t\right)\right) = 0 \tag{4}$$

$$i_t \geq 0 \tag{5}$$

$$\kappa\pi_t + \lambda\left(Y_t - \Gamma G_t\right) \leq 0, \tag{6}$$

as well as the New Keynesian Phillips curve (1) and the consumption Euler equation (2). The next proposition states when and how the discretionary policymaker should use government spending for macroeconomic stabilization.

Proposition 1 *Whenever the zero nominal interest rate bound is binding, the optimal discretionary policy mix prescribes the implementation of a transitory government spending stimulus, $G_t > 0$. Otherwise, government spending is not used as a stabilization tool, $G_t = 0$.*

Proof See Appendix.

[8] Note that while the exposition of the policy problem relies on a single policymaker who controls both policy instruments, results do not change if one reformulates the problem in terms of two separate policymakers, a monetary authority and a fiscal authority.

Notice that the above proposition holds for all $\tilde{\lambda}_G > 0$, independently of whether the policymaker's weight on government spending stabilization equals society's weight λ_G or not.

2.4 Shock process and equilibrium

I first consider a rather simple law of motion for the natural real rate r_t that facilitates the derivation of a closed-form solution. Specifically, following Eggertsson and Woodford (2003), assume that the natural real rate shock equals either $r = \frac{1}{\beta} - 1$ or $r_L < 0$. In the initial period 0, $r_0 = r_L$. Each period thereafter, the natural rate shock irreversibly returns to r with constant probability $0 < 1-\mu < 1$. Once $r_t = r$, all uncertainty is resolved. The closed-form solution then consists of static short-run and long-run policy functions. Throughout the analysis I assume that the following condition holds.

Assumption 1 $(1-\mu)(1-\beta\mu) > \frac{\kappa}{\sigma}\mu.$

Assumption 1 ensures that the propositions below are valid.[9] Given parameter values for β, κ and σ it defines an upper bound on μ. Denote the stochastic period in which the natural real rate jumps back to r by T. The denotation 'long run' then refers to all periods $t \geq T$, and 'short run' refers to all periods $0 \leq t < T$.

Proposition 2 *In the long run, for all $t \geq T$, there is a unique bounded rational expectations equilibrium with positive interest rates satisfying $\pi_t, Y_t, G_t = 0$ and $i_t = r$.*

Proof See Appendix.

Given the characterization of the long-run equilibrium, the short-run equilibrium has the following properties.

Proposition 3 *In the short run, for all $0 \leq t < T$, there is a unique bounded rational expectations equilibrium with $\pi_t = \pi_L, Y_t = Y_L, G_t = G_L$ and $i_t = 0$, where*

$$\pi_L = \omega_\pi r_L < 0 \tag{7}$$

$$Y_L = \omega_Y r_L \tag{8}$$

$$G_L = \omega_G r_L > 0, \tag{9}$$

[9] See also the discussion in Woodford (2011).

and

$$\omega_\pi = \frac{\kappa\tilde{\lambda}_G}{\tilde{\lambda}_G\left((1-\mu)(1-\beta\mu)-\frac{\kappa}{\sigma}\mu\right)+(1-\mu)(1-\Gamma)^2\left((1-\beta\mu)\lambda+\kappa^2\right)}\frac{1}{\sigma}$$

$$\omega_Y = \frac{(1-\beta\mu)\left(\tilde{\lambda}_G-\lambda\Gamma(1-\Gamma)\right)-\kappa^2\Gamma(1-\Gamma)}{\tilde{\lambda}_G\left((1-\mu)(1-\beta\mu)-\frac{\kappa}{\sigma}\mu\right)+(1-\mu)(1-\Gamma)^2\left((1-\beta\mu)\lambda+\kappa^2\right)}\frac{1}{\sigma}$$

$$\omega_G = -\frac{(1-\Gamma)\left((1-\beta\mu)\lambda+\kappa^2\right)}{\tilde{\lambda}_G\left((1-\mu)(1-\beta\mu)-\frac{\kappa}{\sigma}\mu\right)+(1-\mu)(1-\Gamma)^2\left((1-\beta\mu)\lambda+\kappa^2\right)}\frac{1}{\sigma}.$$

Proof See Appendix.

While the short-run response of inflation is unequivocally negative, the sign of the output response depends on the size of $\tilde{\lambda}_G$. For very small values of $\tilde{\lambda}_G$, the reduced-form parameter ω_Y becomes negative, implying that the output response is positive.
Based on the characterization of the short-term equilibrium, we are now equipped to address the central claim of the paper.

3 The desirability of fiscal activism

This section investigates how much relative weight a public authority acting under discretion should put on the stabilization of government spending in its objective function and how this affects the optimal fiscal policy response in a liquidity trap.

3.1 The optimal weight on government spending

Given the assumptions about the shock process, the optimal value for $\tilde{\lambda}_G$, henceforth denoted by $\tilde{\lambda}_G^*$, minimizes

$$\frac{1}{2}\frac{1}{1-\beta\mu}\left[\omega_\pi^2+\lambda\left(\omega_Y-\Gamma\omega_G\right)^2+\lambda_G\omega_G^2\right]r_L^2, \tag{10}$$

where $(\omega_\pi, \omega_Y, \omega_G)$ are defined in Proposition 3. Solving the minimization problem yields the following proposition.

Proposition 4 *Under discretionary policy, welfare can be enhanced by the appointment of a policymaker who puts less weight on the stabilization of public spending than society as a whole $\tilde{\lambda}_G < \lambda_G$. The best-performing policymaker exhibits*

$$\tilde{\lambda}_G^* = \frac{\left((1-\mu)(1-\beta\mu)-\frac{\kappa}{\sigma}\mu\right)\left(\kappa^2+(1-\beta\mu)\lambda\right)}{(1-\mu)(1-\beta\mu)\left(\frac{\kappa^2}{1-\beta\mu}+(1-\beta\mu)\lambda\right)}\lambda_G. \tag{11}$$

Proof The first part follows from the observation that the coefficient on λ_G in (11) is strictly positive and smaller than one. The second part can be derived using standard optimization theory.

The next proposition relates the optimal relative weight on government spending to the policymaker's fiscal policy response at the zero lower bound.

Proposition 5 *In a liquidity trap, the best-performing discretionary policymaker raises government spending by more than a policymaker whose preferences are identical to those of society as a whole*

$$\left|\omega_G\left(\tilde{\lambda}_G^*\right)\right| > \left|\ \omega_G\left(\lambda_G\right)\right| . \tag{12}$$

Proof This follows directly from $\frac{d|\omega_G|}{d\tilde{\lambda}_G} < 0$ and $\tilde{\lambda}_G^* < \lambda_G$.

The notation $\omega_G(\cdot)$ in Proposition 5 underlines that the value of ω_G depends on the relative weight that the policymaker puts on the stabilization of government spending. Furthermore, the analytical expressions for $(\omega_\pi, \omega_Y, \omega_G)$ imply that

$$\omega_\pi\left(\tilde{\lambda}_G^*\right) < \omega_\pi\Big(\ \lambda_G\Big) \ , \quad \omega_Y\left(\tilde{\lambda}_G^*\right) - \Gamma\omega_G\left(\tilde{\lambda}_G^*\right) < \omega_Y\Big(\ \lambda_G\Big) \ - \Gamma\omega_G\Big(\ \lambda_G\Big) \ .$$

Hence, appointing the best-performing activist policymaker instead of a policymaker who exhibits preferences identical to those of society lowers the inflation and the output gap term in the welfare-based loss function (10) and increases the public consumption term. In order to understand why the overall effect of the change in policy preferences is welfare-increasing, reconsider the optimization problem of the discretionary policymaker in Section 2.3. When choosing the optimal amount of government spending in the liquidity trap, the policymaker takes private agents' expectations as given. Hence, he does not properly take into account that agents' anticipation of fiscal policy interventions in those future periods where the natural rate is in the low state unfolds a stabilizing effect on expected future inflation and output. Under forward-looking behavior, higher expected output and inflation in the future feeds back into higher contemporaneous output and inflation. In this regard, discretionary policymakers underrate the relative gains from fiscal stabilization policy when weighing the costs and benefits of a government spending stimulus. The appointment of a policymaker who cares less about the stabilization of public consumption than society as a whole provides a device to correct for discretionary authorities' disregard of the expectations channel. Likewise, if the economy stays only for one period in the low natural rate state and if this is perfectly known by agents, then there is no need to appoint an activist policymaker, $\tilde{\lambda}_G^* \to \lambda_G$ as $\mu \to 0$.

3.2 Comparison to an optimized fiscal rule

How does the fiscally activist discretionary policy regime compare to optimal commitment polices? Since no closed-form solution is available for the optimal plan, I consider a simple class of feedback rules that relates government spending to the natural real rate

$$G_t = \begin{cases} \tau r_t \text{ if } t < T \\ 0 \text{ if } t \geq T, \end{cases} \tag{13}$$

where τ is a parameter.

Proposition 6 *Suppose, the policymaker could commit to fiscal policy rule (13). Monetary policy is conducted under discretion. Then it is optimal to set* $\tau = \omega_G \left(\tilde{\lambda}_G^* \right)$.

Proof See Appendix.

The proposition implies that the activist discretionary policymaker replicates the stabilization performance of the optimized government spending rule. Unlike the fiscal rule, however, the appointment of the activist policymaker does not require any form of policy commitment.

3.3 Numerical example

To give a numerical example, I employ the parameter values estimated by Denes, Eggertsson and Gilbukh (2013) to match U.S. data in the Great Recession period as summarized in Table 1.[10] The period length is one quarter. Under the best-performing fiscally activist regime

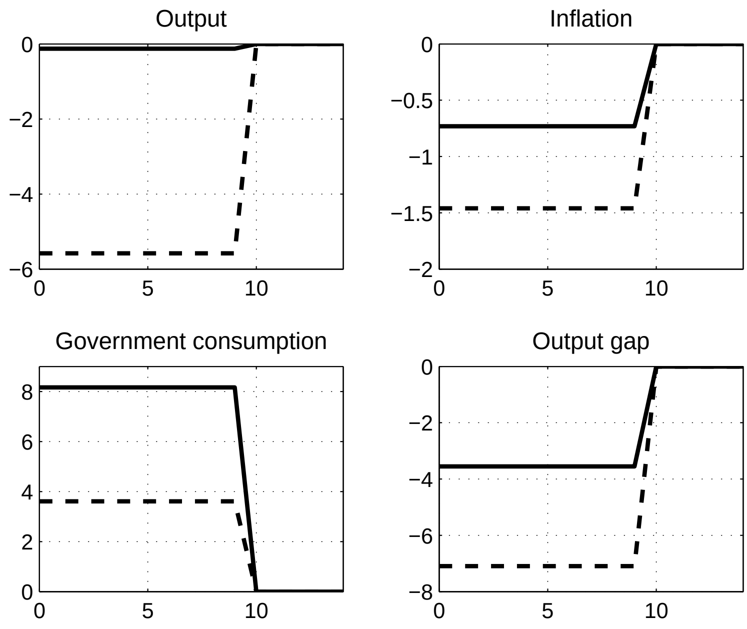
Table 1: Calibration of the two state model

β	0.997	η	1.69	α	0.784
σ	1.22	G/Y	0.2	μ	0.857
ν	4.88	θ	13.23	r_L	-0.0129

($\tilde{\lambda}_G = \tilde{\lambda}_G^* = 0.0002$) the welfare loss is 36% lower than under the regime where policy preferences are identical to those of society as a whole ($\tilde{\lambda}_G = \lambda_G = 0.0011$), henceforth referred to as the benchmark regime.[11] Figure 1 shows impulse responses for the activist regime (solid line) and for the benchmark regime (dashed line), when $T = 10$. The activist policymaker

[10] I have to calibrate two additional parameters not estimated by Denes, Eggertsson and Gilbukh (2013). The steady state ratio of government spending to total output is set equal to 0.2 and the elasticity of the marginal utility of public consumption with respect to output is set such that the intertemporal elasticity of substitution in public consumption equals the intertemporal elasticity of substitution in private consumption

Figure 1: Impulse responses



Note: The figure displays impulse responses to the natural real rate shock for $T = 10$. The solid line represents the fiscally activist regime ($\tilde{\lambda}_G = \tilde{\lambda}_G^*$). The dashed line represents the benchmark regime where the policymaker exhibits the same preferences as the society as a whole ($\tilde{\lambda}_G = \lambda_G$). The inflation rate and the nominal interest rate are expressed in annualized terms.

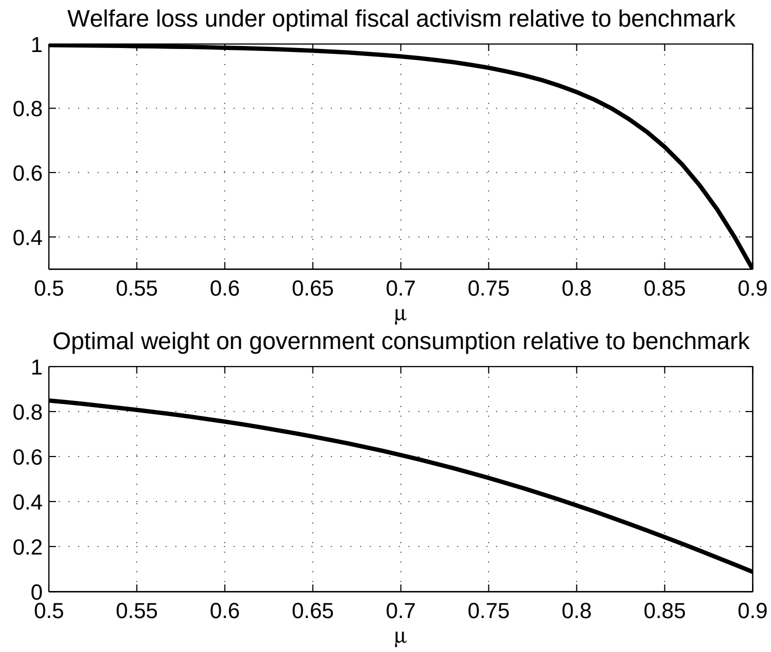
implements a government spending stimulus that is twice as big as the one implemented under the benchmark regime. As a consequence, the fall in the output gap, the inflation rate and in particular in output is much more muted. Once the natural real rate jumps to the absorbing state r, the nominal interest rate becomes positive and all target variables are perfectly stabilized under both policy regimes.

Figure 2 documents the sensitivity of the numerical results with respect to the choice of μ, the conditional probability to stay in the low natural rate state. The upper panel shows the welfare gains from the appointment of the best-performing activist policymaker for alternative values of μ by plotting the ratio of the welfare loss under the activist regime and the benchmark regime. For low values of μ, the welfare performances of both regimes are quite similar. If, on the other hand, the low natural rate state is expected to be relatively persistent than the welfare gains from fiscal activism increase dramatically. The lower panel of Figure 2 shows the corresponding ratio of $\tilde{\lambda}_G^*$ to λ_G. If the low natural rate state is expected to be relatively persistent the best-performing policymaker puts much less relative weight

as in Woodford (2011).

[11] Under a discretionary policy regime that does not use government spending as a stabilization tool at all the unconditional welfare loss is 79% higher than under the benchmark regime.

Figure 2: Welfare and optimal degree of activism



Note: The upper panel displays the ratio of the welfare loss under the fiscally activist regime ($\tilde{\lambda}_G = \tilde{\lambda}_G^*$) to the welfare loss under the benchmark regime ($\tilde{\lambda}_G = \lambda_G$) for alternative values of μ. The lower panel displays the ratio of the weight that the fiscally activist policymaker puts on government consumption stabilization to society's weight.

on the stabilization of public consumption than society as a whole.

4 A continuous state model

This section shows that the desirability of fiscal activism prevails also in a more general stochastic setup and presents some additional results. Specifically, I now assume that the natural real rate r_t follows a stationary autoregressive process

$$r_t = \rho_r r_{t-1} + (1 - \rho_r)\, r + \epsilon_t^r,$$

where ϵ_t^r is an i.i.d N(0,σ_r^2) innovation. In this model, the zero nominal interest rate bound is an occasionally binding constraint and uncertainty will never be fully resolved. The parameterization follows Adam and Billi (2007) and is summarized in Table 2.[12] The rational expectations equilibrium under optimal discretionary monetary and fiscal policy is characterized by policy functions $\pi(r_t)$, $Y(r_t)$, $G(r_t)$ and $i(r_t)$. I use a projection method with

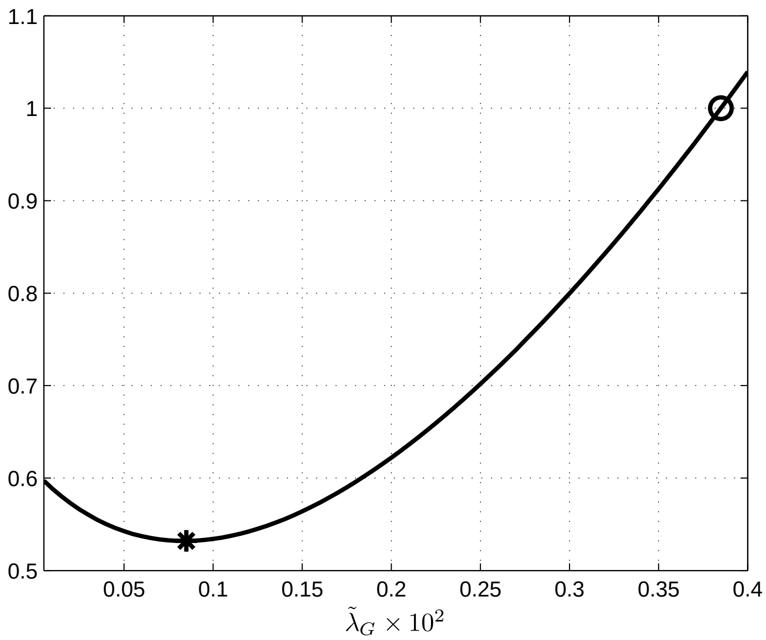
[12] I choose a slightly higher value for the subjective discount factor β commensurate with a steady state real interest rate of 3% in annualized terms.

Table 2: Calibration of the continuous state model

β	0.9926	η	0.47	G/Y	0.2
σ	1/6.25	θ	7.66	ρ_r	0.8
ν	1/1.56	α	0.66	σ_r	0.244/100

finite elements to solve the model numerically.[13] To quantify the welfare implications of alternative policy regimes that differ in terms of parameter $\tilde{\lambda}_G$, I calculate for each candidate the average discounted welfare loss across 2000 simulations with a length of 1000 periods each. Figure 3 plots the social loss for alternative $\tilde{\lambda}_G$ normalized by the loss in the benchmark regime $\tilde{\lambda}_G = \lambda_G$. The latter is denoted by a circle. Clearly, there exist $\tilde{\lambda}_G < \lambda_G$ that

Figure 3: Welfare loss relative to benchmark for alternative $\tilde{\lambda}_G$



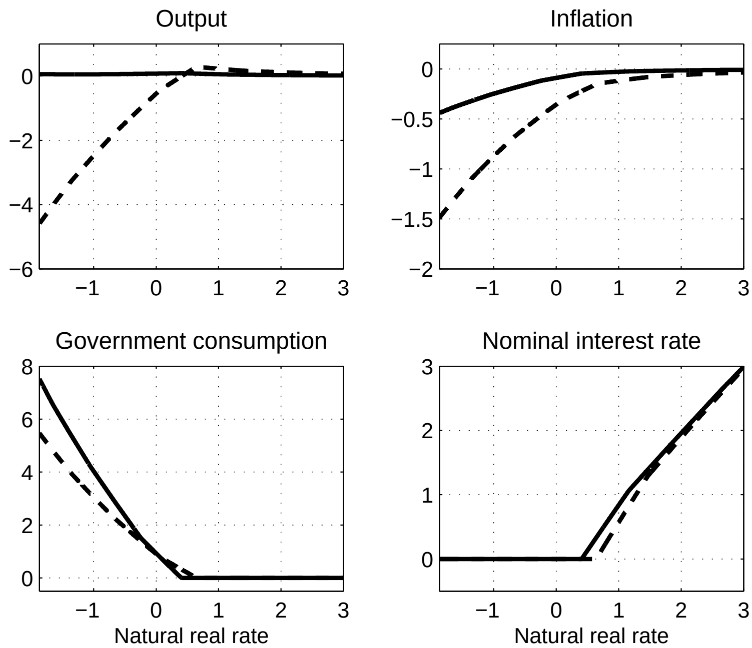
Note: The figure displays the welfare loss for alternative values of $\tilde{\lambda}_G$ normalized by the welfare loss in the benchmark regime $\tilde{\lambda}_G = \lambda_G$. The latter regime is denoted by a circle. The best-performing regime is denoted by an asterisk.

are associated with smaller welfare losses. The best-performing policymaker, denoted by an asterisk, reduces the welfare loss by 47%.

Figure 4 compares the equilibrium responses of output, inflation, government spending and the nominal interest rate to the natural real rate of interest for the benchmark regime and for the activist regime. For low realizations of the natural real rate, the zero lower bound

[13] See Schmidt (2013) for a detailed description of the numerical algorithm.

Figure 4: Equilibrium responses



Note: The figure displays equilibrium responses to the natural real rate of interest. The solid line represents the fiscally activist regime ($\tilde{\lambda}_G = \tilde{\lambda}_G^*$). The dashed line represents the benchmark regime where the policymaker exhibits the same preferences as society as a whole ($\tilde{\lambda}_G = \lambda_G$). Interest rates and the inflation rate are expressed in annualized terms.

becomes binding and both policymakers implement a government spending stimulus. In the benchmark case, zero lower bound episodes are associated with deflation and a decline in output. The activist policymaker implements a more aggressive fiscal policy response, resulting in less deflation and output close to target.

Unlike in the two state model, appointing an activist policymaker improves not only stabilization outcomes when nominal rates are zero but also in states associated with low positive nominal interest rates. Moreover, fiscal activism decreases the frequency of zero bound events, from 7% under the benchmark regime to 5% under the activist regime. This is because in the continuous state model, agents take into account that the economy might be caught in a liquidity trap in the future even if the current one-period nominal interest rate is strictly positive. Since for a given large negative demand shock inflation and the output gap drop less under the activist regime than under the benchmark regime, inflation expectations under the former regime will be closer to target in all states of the world, which unfolds a stabilizing effect on current private sector decisions about allocations and prices in all states.

5 Conclusion

I study optimal time-consistent monetary and fiscal policy in the presence of the zero lower bound on nominal interest rates. Using a stochastic monetary business cycle model I show that the public spending stimulus implemented by a benevolent discretionary policymaker in a liquidity trap - while desirable - is too tame. The key point to notice is that discretionary policymakers by nature take private sector expectations as given, ignoring that agents account for the systematic component of policymakers' reaction function when forming expectations. Specifically, the private sector's anticipation of an expansionary fiscal policy response in those future states of the world that are associated with zero nominal interest rates unfolds a stabilizing effect on agents' inflation expectations.

Is there a way to overcome the shortcoming of insufficient stimulus? In this paper, I have shown that an appropriate degree of fiscal activism can be restored if a policymaker is appointed who cares less about the stabilization of public spending relative to the stabilization of inflation and the output gap than society as a whole. Whenever the zero bound becomes binding, the activist policymaker uses fiscal policy more aggressively to counteract the downturn than a policymaker whose preferences are identical to those of the private sector would do. If zero lower bound episodes are expected to be persistent, the quantitative gains from fiscal activism can become large.

A Appendix

Proof of Proposition 1

The consolidated first-order conditions of the discretionary policymaker's optimization problem read

$$(1-\Gamma)\left[\kappa\pi_t + \lambda\left(Y_t - \Gamma G_t\right)\right] + \tilde{\lambda}_G G_t = 0 \tag{A.1}$$

$$i_t\left(\kappa\pi_t + \lambda\left(Y_t - \Gamma G_t\right)\right) = 0 \tag{A.2}$$

$$i_t \geq 0 \tag{A.3}$$

$$\kappa\pi_t + \lambda\left(Y_t - \Gamma G_t\right) \leq 0, \tag{A.4}$$

as well as the New Keynesian Phillips curve and the consumption Euler equation. If the zero lower bound on the nominal interest rate is binding, condition (A.4) becomes a strict inequality $\kappa\pi_t + \lambda(Y_t - \Gamma G_t) < 0$. Rewriting condition (A.1)

$$G_t = -\frac{1-\Gamma}{\tilde{\lambda}_G} \underbrace{\left[\kappa\pi_t + \lambda(Y_t - \Gamma G_t)\right]}_{<0},$$

where $1-\Gamma, \tilde{\lambda}_G > 0$, and hence $G_t > 0$.

If the zero lower bound on the nominal interest rate is not binding, condition (A.4) holds with equality. In order for conditions (A.1) and (A.4) to hold simultaneously, the government spending gap has to be zero, $G_t = 0$.

Proof of Proposition 2

Suppose, $i_t > 0$ for all $t \geq T$. From Proposition 1 we then know that $G_t = 0$. Hence, the remaining equilibrium conditions for periods $t \geq T$ can be simplified to

$$\pi_t = \beta E_t \pi_{t+1} + \kappa Y_t \quad (A.5)$$

$$Y_t = E_t Y_{t+1} - \frac{1}{\sigma}(i_t - E_t\pi_{t+1} - r) \quad (A.6)$$

$$Y_t = -\frac{\kappa}{\lambda}\pi_t. \quad (A.7)$$

Substitute (A.7) into (A.5)

$$\pi_t = \frac{\lambda\beta}{\kappa^2 + \lambda} E_t \pi_{t+1}. \quad (A.8)$$

Since inflation is a free endogenous variable, it follows from $0 < \frac{\lambda\beta}{\kappa^2+\lambda} < 1$ that there exists a unique rational expectations equilibrium. It is now straightforward to verify that the policy functions are given by the expressions stated in Proposition 2.

Proof of Proposition 3

Using the results from Proposition 2, it holds

$$E_t(\pi_t | t < T) = \mu E_t^L \pi_{t+1}^L, \quad (A.9)$$

where E_t^L denotes the expectations operator conditional on the natural rate shock in period t being in state L, i.e. $t < T$, and π_{t+1}^L is the inflation rate in period $t+1$ conditional on $t+1 < T$. Using similar notation for Y_t, G_t and i_t, given $t < T$, we can rewrite the optimality conditions as

$$\begin{aligned}
\pi_t^L &= \kappa\left(Y_t^L-\Gamma G_t^L\right)+\beta\mu E_t^L\pi_{t+1}^L && \text{(A.10)}\\
Y_t^L &= \mu E_t^L Y_{t+1}^L+G_t^L-\mu E_t^L G_{t+1}^L-\frac{1}{\sigma}\left(i_t^L-\mu E_t^L\pi_{t+1}^L-r_L\right) && \text{(A.11)}\\
i_t^L &= 0 && \text{(A.12)}\\
G_t^L &= -\frac{1-\Gamma}{\tilde{\lambda}_G}\left[\kappa\pi_t^L+\lambda\left(Y_t^L-\Gamma G_t^L\right)\right] && \text{(A.13)}\\
0 &> \kappa\pi_t^L+\lambda\left(Y_t^L-\Gamma G_t^L\right), && \text{(A.14)}
\end{aligned}$$

where I have made use of the fact that $i_t > 0$ is not a solution for $r_t = r_L < 0$, which is straightforward to verify. I first show that a unique bounded rational expectations equilibrium exists in the short run and then derive the closed-form expressions for the policy functions.

Existence of a unique equilibrium

Case I: $\tilde{\lambda}_G \neq \lambda\Gamma(1-\Gamma)$.
Substitute (A.12) and (A.13) into (A.10) and (A.11). We then obtain a system of two equations with two unknowns

$$Az_t^L = BE_t^L z_{t+1}^L + Cr_L, \tag{A.15}$$

where $z_t^L = \left[\pi_t^L, Y_t^L\right]'$ and

$$A = \begin{pmatrix} 1-\frac{\kappa^2\Gamma(1-\Gamma)}{\tilde{\lambda}_G-\lambda\Gamma(1-\Gamma)} & -\kappa\left(1+\frac{\lambda\Gamma(1-\Gamma)}{\tilde{\lambda}_G-\lambda\Gamma(1-\Gamma)}\right) \\ \frac{\kappa(1-\Gamma)}{\tilde{\lambda}_G-\lambda\Gamma(1-\Gamma)} & 1+\frac{\lambda(1-\Gamma)}{\tilde{\lambda}_G-\lambda\Gamma(1-\Gamma)} \end{pmatrix},$$

$$B = \begin{pmatrix} \beta\mu & 0 \\ \left(\frac{1}{\sigma}+\frac{\kappa(1-\Gamma)}{\tilde{\lambda}_G-\lambda\Gamma(1-\Gamma)}\right)\mu & \left(1+\frac{\lambda(1-\Gamma)}{\tilde{\lambda}_G-\lambda\Gamma(1-\Gamma)}\right)\mu \end{pmatrix}.$$

The form of matrix C is omitted since it is not required for what follows. Define $\Omega \equiv B^{-1}A$. Since z_t^L consists of two free endogenous variables, the system (A.15) has a unique bounded solution if and only if Ω exhibits two eigenvalues outside the unit circle. The characteristic polynomial of Ω is given by $P(\delta) = \delta^2 - \phi_1 \delta + \phi_0$, where

$$\begin{aligned}
\phi_0 &= \frac{\tilde{\lambda}_G + (1-\Gamma)^2 (\lambda + \kappa^2)}{\left(\tilde{\lambda}_G + (1-\Gamma)^2 \lambda\right) \beta \mu^2} \\
\phi_1 &= \frac{(1+\beta)\left(\tilde{\lambda}_G + (1-\Gamma)^2 \lambda\right) + \frac{\kappa}{\sigma}\tilde{\lambda}_G + (1-\Gamma)^2 \kappa^2}{\left(\tilde{\lambda}_G + (1-\Gamma)^2 \lambda\right) \beta \mu}.
\end{aligned}$$

Then,

$$\begin{aligned}
P(1) &= \frac{\tilde{\lambda}_G \left((1-\mu)(1-\beta\mu) - \frac{\kappa}{\sigma}\mu\right) + (1-\Gamma)^2 (1-\mu)\left((1-\beta\mu)\lambda + \kappa^2\right)}{\left(\tilde{\lambda}_G + (1-\Gamma)^2 \lambda\right) \beta \mu^2} \\
P(-1) &= \frac{\tilde{\lambda}_G \left((1+\mu)(1+\beta\mu) + \frac{\kappa}{\sigma}\mu\right) + (1-\Gamma)^2 (1+\mu)\left((1+\beta\mu)\lambda + \kappa^2\right)}{\left(\tilde{\lambda}_G + (1-\Gamma)^2 \lambda\right) \beta \mu^2}.
\end{aligned}$$

Note that under Assumption 1 $P(1) > 0$ and $P(-1) > 0$. Continuity implies that the characteristic equation has an even number of roots inside the unit circle. Suppose, both eigenvalues would lie inside the unit circle. Then, $|det(\Omega)| < 1$. However, $det(\Omega) = \phi_0 > 1$. Hence, Ω has two eigenvalues outside the unit circle and the system (A.15) has a unique bounded solution.

Case II: $\tilde{\lambda}_G = \lambda\Gamma(1-\Gamma)$.
Then, equation (A.13) reduces to $\kappa\pi_t^L + \lambda Y_t^L = 0$. Substituting this expression and (A.12) into (A.10) and (A.11), we again obtain a system of two equations with two unknowns, where now $z_t^L = \left[\pi_t^L, G_t^L\right]'$ and

$$A = \begin{pmatrix} 1 + \frac{\kappa^2}{\lambda} & \kappa\Gamma \\ \frac{\kappa}{\lambda} & 1 \end{pmatrix}, \qquad B = \begin{pmatrix} \beta\mu & 0 \\ \left(\frac{\kappa}{\lambda} - \frac{1}{\sigma}\right)\mu & \mu \end{pmatrix}.$$

Define $\Omega \equiv B^{-1}A$. Since z_t^L consists of two free endogenous variables, the system has a unique bounded solution if and only if Ω exhibits two eigenvalues outside the unit circle. The characteristic polynomial of Ω is given by $P(\delta) = \delta^2 - \phi_1\delta + \phi_0$, where

$$\begin{aligned}
\phi_0 &= \frac{1}{\beta\mu^2}\left(1 + \frac{(1-\Gamma)\kappa^2}{\lambda}\right) \\
\phi_1 &= \frac{\left(1 + \beta + \frac{\kappa}{\sigma}\Gamma\right)\lambda + (1-\Gamma)\kappa^2}{\lambda\beta\mu}.
\end{aligned}$$

Then,

$$P(1) = \frac{(1-\mu)(1-\beta\mu) - \Gamma\frac{\kappa}{\sigma}\mu + (1-\mu)(1-\Gamma)\frac{\kappa^2}{\lambda}}{\beta\mu^2}$$
$$P(-1) = \frac{(1+\mu)(1+\beta\mu) + \Gamma\frac{\kappa}{\sigma}\mu + (1+\mu)(1-\Gamma)\frac{\kappa^2}{\lambda}}{\beta\mu^2}.$$

Note that under Assumption 1 $P(1) > 0$ and $P(-1) > 0$. Continuity implies that the characteristic equation has an even number of roots inside the unit circle. Suppose, both eigenvalues would lie inside the unit circle. Then, $|det(\Omega)| < 1$. However, $det(\Omega) = \phi_0 > 1$. Hence, Ω has two eigenvalues outside the unit circle and there exists a unique bounded solution.

Closed-form solution

The closed-form solution can be derived using the method of undetermined coefficients. The minimum-state-variable solution has the form

$$\pi_t = \omega_\pi r_L$$
$$Y_t = \omega_Y r_L$$
$$G_t = \omega_G r_L,$$

where $(\omega_\pi, \omega_Y, \omega_G)$ are the coefficients to be determined. Substituting this guess into equations (A.10) to (A.13), one obtains

$$\omega_\pi = \frac{\kappa\tilde{\lambda}_G}{\tilde{\lambda}_G\left((1-\mu)(1-\beta\mu) - \frac{\kappa}{\sigma}\mu\right) + (1-\mu)(1-\Gamma)^2\left((1-\beta\mu)\lambda + \kappa^2\right)}\frac{1}{\sigma}$$
$$\omega_Y = \frac{(1-\beta\mu)\left(\tilde{\lambda}_G - \lambda\Gamma(1-\Gamma)\right) - \kappa^2\Gamma(1-\Gamma)}{\tilde{\lambda}_G\left((1-\mu)(1-\beta\mu) - \frac{\kappa}{\sigma}\mu\right) + (1-\mu)(1-\Gamma)^2\left((1-\beta\mu)\lambda + \kappa^2\right)}\frac{1}{\sigma}$$
$$\omega_G = -\frac{(1-\Gamma)\left((1-\beta\mu)\lambda + \kappa^2\right)}{\tilde{\lambda}_G\left((1-\mu)(1-\beta\mu) - \frac{\kappa}{\sigma}\mu\right) + (1-\mu)(1-\Gamma)^2\left((1-\beta\mu)\lambda + \kappa^2\right)}\frac{1}{\sigma}.$$

Proof of Proposition 6

Suppose, the policymaker could commit to a simple forward-looking rule for government spending of the form $G_t = \tau r_t$ for $t < T$ and $G_t = 0$ for all $t \geq T$, whereas monetary policy is conducted under discretion. The short-run equilibrium conditions then read

$$\begin{aligned}
G_t^L &= \tau r_L && \text{(A.16)}\\
\pi_t^L &= \kappa\left(Y_t^L - \Gamma G_t^L\right) + \beta\mu E_t^L \pi_{t+1}^L && \text{(A.17)}\\
Y_t^L &= \mu E_t^L Y_{t+1}^L + G_t^L - \mu E_t^L G_{t+1}^L - \frac{1}{\sigma}\left(i_t^L - \mu E_t^L \pi_{t+1}^L - r_L\right) && \text{(A.18)}\\
0 &= i_t^L\left(\kappa\pi_t^L + \lambda\left(Y_t^L - \Gamma G_t^L\right)\right) && \text{(A.19)}\\
0 &\leq i_t^L && \text{(A.20)}\\
0 &\geq \kappa\pi_t^L + \lambda\left(Y_t^L - \Gamma G_t^L\right). && \text{(A.21)}
\end{aligned}$$

First, suppose that $i_t^L = 0$. Substituting government spending rule (A.16) into (A.17) and (A.18), and focusing on the minimum-state-variable solution, we obtain

$$\begin{aligned}
\pi_t^L &= \frac{\frac{\kappa}{\sigma} + (1-\mu)(1-\Gamma)\kappa\tau}{(1-\mu)(1-\beta\mu) - \frac{\kappa}{\sigma}\mu} r_L && \text{(A.22)}\\
Y_t^L &= \frac{\frac{1}{\sigma}(1-\beta\mu) + \left((1-\mu)(1-\beta\mu) - \Gamma\frac{\kappa}{\sigma}\mu\right)\tau}{(1-\mu)(1-\beta\mu) - \frac{\kappa}{\sigma}\mu} r_L. && \text{(A.23)}
\end{aligned}$$

Substituting the solution functions into the welfare-based loss function (10) and using standard optimization theory, the optimal value for τ satisfies

$$\tau^* = -\frac{(1-\mu)(1-\Gamma)\left(\kappa^2 + \lambda(1-\beta\mu)^2\right)}{((1-\mu)(1-\Gamma))^2\left(\kappa^2 + \lambda(1-\beta\mu)^2\right) + \left((1-\mu)(1-\beta\mu) - \frac{\kappa}{\sigma}\mu\right)^2 \lambda_G}\frac{1}{\sigma}.$$

It is then easy to verify that $\tau^* = \omega_G\left(\tilde{\lambda}_G^*\right)$.

To complete the proof, it is shown that any τ that implies $i_t^L > 0$ is not optimal. Suppose, to the contrary, that $i_t^L > 0$. Substituting the government spending rule into (A.17), (A.18) and (A.21), which has to hold with equality, one obtains

$$\begin{aligned}
\pi_t^L &= 0 && \text{(A.24)}\\
Y_t^L &= \Gamma\tau r_L. && \text{(A.25)}
\end{aligned}$$

From (A.18) then follows that $i_t^L > 0$ if and only if $\tau < -\frac{1}{(1-\mu)(1-\Gamma)}\frac{1}{\sigma} < \tau^*$.

Finally, using the welfare-based loss function (10) it is straightforward to verify that the welfare loss for $\tau < -\frac{1}{(1-\mu)(1-\Gamma)}\frac{1}{\sigma}$ exceeds the welfare loss for $\tau = \tau^*$.

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