Money-Financed Fiscal Programs: A Cautionary Tale[*]

William B. English
Yale University

Christopher J. Erceg
Federal Reserve Board

David Lopez-Salido
Federal Reserve Board

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Abstract

A number of prominent economists and policymakers have argued that money-financed fiscal programs (helicopter drops) could be efficacious in boosting output and inflation in economies facing persistent economic weakness, very low inflation, and significant fiscal strains. We employ a fairly conventional macroeconomic model to explore the possible effects of such policies. While we do find that money-financed fiscal programs, if communicated successfully and seen as credible by the public, could provide significant stimulus, we underscore the risks that would be associated with such a program. These risks include persistently high inflation if the central bank fully adhered to the program; or alternatively, that such a program would be ineffective in providing stimulus if the public doubted the central bank's commitment to such an extreme strategy. We also highlight how more limited forms of monetary and fiscal cooperation – such as a promise by the central bank to be more accommodative than usual in response to fiscal stimulus – may be more credible and easier to communicate, and ultimately more effective in providing economic stimulus. JEL Classification: E52, E58

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1. Introduction

A number of economists and policymakers (e.g., Buiter (2014) and Turner (2015)) have suggested that in a sufficiently dire economic situation, money-financed fiscal programs – sometimes referred to as "helicopter money" – could be used to provide stimulus beyond what can be accomplished with standard monetary policy alone. Such programs involve an increase in government spending or a reduction in taxation, with the fiscal spending financed directly by the central bank.[1] These economists argue that such policies can be effective in stimulating economies suffering inflation that is persistently very low (or negative) and output that is far below potential, even if monetary policy is constrained by the effective lower bound on interest rates and fiscal policy is constrained by high levels of government debt.

Our paper uses a New Keynesian model to examine the possible costs and benefits of coordinated monetary and fiscal policies. While we devote particular attention to money-financed fiscal expansions, we also consider more limited forms of coordination that are consistent with relatively transient departures from the usual central bank reaction function. We discuss the possible effects of such programs and some of the practical considerations that would likely complicate their use.

We begin by considering a "textbook"' money-financed fiscal program that involves an increase in government spending funded by an equal-sized permanent expansion in the stock of currency.[2] A critical feature of such a program is that the central bank commits not to reverse the increase in currency in the future through monetary policy actions, so that the fiscal expansion is financed entirely by the inflation tax. In our benchmark model in which agents fully understand this commitment and regard it as credible, a money-financed program is a powerful tool for boosting output

[1] The term "money-financed fiscal program" is from Bernanke (2016). Sometimes these programs are referred to as "helicopter drops" of money, though we think it is useful to bear in mind that the policies involve a mix of traditional fiscal and monetary policy actions. For recent discussion of such programs, see Turner (2015), Buiter (2014), and Galí (2016). For a critical perspective, see Borio et al (2016) and Cecchetti and Schoenholtz (2016). See Friedman (1969) for the original discussion of "helicopter money."

[2] Since we assume that the central bank can pay interest on reserves, currency is the only non-interest-bearing liability of the central bank.

and inflation. The government spending multiplier is around five *even outside of a liquidity trap*, so that only a small fiscal expansion is required to push a weak economy out of recession and boost inflation to the central bank's target, while also achieving a sizable reduction in the government debt-to-GDP ratio. Moreover, because higher expected inflation tends to raise the policy rate, the zero lower bound is not a constraint on implementation. These results are closely aligned with those reported by Gali (2016), which are derived in a similar framework.

What accounts for these powerful expansionary effects? To answer this question, it is helpful to express the monetary policy rule – which links growth in the money supply (which consists entirely of currency in our model) to fiscal spending – as a reaction function in terms of the policy rate. We show that the reaction function under a money-financed program can be interpreted as a form of flexible price level targeting in which the central bank's policy rate responds to real activity (consumption in our model), as well as to the gap between the price level and its target level. The key twist is that the targeted price level path shifts upward in response to the rise in government spending, with the magnitude of the shift depending on the size and persistence of the government spending hike. Most of the substantial output stimulus from the money-financed program in the baseline model arises from this upward shift in the price level target path, as agents immediately grasp that boosting the price level to its new target will require the central bank to keep real interest rates persistently low.[3] The associated rise in nominal currency demand, in turn, generates enough seigniorage to finance the fiscal expansion. Conversely, under a constant price level target (but still assuming flexible price level targeting), the fiscal expansion would be debt-financed and imply a peak multiplier of less than unity, so that a large fiscal expansion would be required to blunt the effects of recession.

[3] The long-run effects on the price level are determined by the familiar relationship linking real seigniorage revenue to currency growth scaled by the ratio of currency to GDP (see Fischer (1982)). Because currency is a small share of GDP, a fiscal expansion causes a large rise in the price level. While this implication is likely to be robust, the contour of the inflation response – as well as of those of output and debt – will depend on the particular features of our model.

Because a money-financed program involves a dramatic shift in the central bank's normal reaction function, achieving near-term output stimulus from such a program is contingent on the public rapidly understanding the new strategy and regarding it as credible. However, it seems likely that it would be difficult in practice to communicate the new strategy to the public because the resulting period of high inflation would likely be seen as at variance with the objective of low and stable inflation shared by almost all central banks. Moreover, because raising revenue through seigniorage depends on the base of the inflation tax, the magnitude of the effects on inflation would depend the specific features of the currency demand function, and thus be hard to predict. Given these considerations, our sense is that it would be difficult in most circumstances for a central bank to convince the public that it was changing its reaction function in such a substantial way. While a central bank could initially finance the acquisition of government debt by printing money and even promise to hold new debt in perpetuity, the public would be likely to view the monetary expansion as transient, and expect that the central bank would soon revert to its usual reaction function. In practice, this reversion could be achieved by the central bank eventually paying interest on reserves..[4] The economic effects in this case would be similar to under debt-financed fiscal stimulus.[5]

Accordingly, we modify our model to allow for the possibility that agents only gradually come to perceive a shift in the central bank's reaction function following the announcement of a money-financed fiscal program. Specifically, we adopt a Kalman filtering framework in which agents are uncertain whether the increases in the money supply associated with an announced money financed program are only temporary – and thus will be reversed – or whether they reflect permanent increases in money as called for by the program. We show that if the learning process is gradual,

[4] Ireland (2014) shows that with the payment of interest on reserves, the central bank can choose the level of reserve balances essentially independently of its monetary policy stance.

[5] Some authors (e.g., Cechetti and Schoenholtz (2016) and Borio et al (2016)) have interpreted a money-financed program more narrowly along these lines.

the boost to output and inflation may be small or negligible in the near-term, and only become substantial at longer horizons; an implication is that a money-financed program may be much less effective in providing stimulus in a recession than implied by the baseline model. In a similar vein, we also consider an augmented model that allows for price-setting and aggregate demand to be much less forward-looking than in the baseline model that is in the spirit of the recent literature on the forward guidance puzzle (McKay, Nakamura, and Steinsson 2014 and Gabaix 2016). We show that the near-term stimulus to output and inflation from a money-financed program is much smaller in this setting, with the monetary component providing very little boost if the zero lower bound is binding.

Given these considerations, fiscal expansion can enhance the potency of monetary policy substantially if the zero bound is binding; hence, some coordination between monetary and fiscal policy can be desirable. Even so, we argue that more limited forms of monetary and fiscal policy coordination that involve more modest shifts in the monetary policy reaction function than a full money-financed program – such a modest rise in the targeted path for the price level under price level targeting – are likely to be more credible and easier to communicate. [6] Such a commitment by the central bank would tend to make fiscal expansion more attractive, since it would boost the output effects of any given-sized fiscal program, while reducing the upward pressure on the debt-to-GDP ratio compared with the baseline policy. While these implications are qualitatively similar to a money-financed program, we see an incremental shift in monetary policy as more likely to be credible, in part because it poses much less risk of creating outsized and costly increases in inflation.[7] Moreover, especially in difficult economic circumstances in which the central bank cannot signal a change in the reaction function by lowering the policy rate, a coordinated fiscal

[6] Nominal GDP targeting may have broadly similar implications. For a discussion of the possible benefits of nominal GDP targeting coordinated with expansionary fiscal policy, see the comments by Woodford in Reichlin, Turner, and Woodford (2013).

[7] As the price level only increases modestly, only a small fraction of the fiscal expansion is ultimately financed through seigniorage.

program can boost the public's confidence in policymakers' ability to achieve their objectives.[8]

Our paper concludes with some historical examples of money-financed fiscal programs that complement our model results by highlighting key factors which influence the effectiveness of monetary-fiscal cooperation. One well-understood lesson is that monetary financing of the large runups in government debt that accompany major wars can generate high and persistent inflation. In such dire circumstances, the public regards a shift in the monetary policy regime as more likely; and the expectation that the new regime will involve significant debt monetization can induce sharp rises in inflation, while also boosting output. We interpret the U.S. experience during the Civil War and French experience during and after WWI in this vein. Similarly, conditions of economic depression may make it more likely that a money-financed program succeeds in raising inflation and output, as illustrated by Japan in the early 1930s, and by Roosevelt's New Deal shortly thereafter.[9] On the other hand, a central bank that has built a reputation for low and stable inflation may find it difficult to promise even the temporary rise in inflation that would be implied by a money-financed program. We see the challenges that the Bank of Japan has faced in boosting inflation in this light.

This paper is organized as follows: Section 2 presents the benchmark model and calibration, while Section 3 discusses our simulation results. Section 4 considers monetary-fiscal cooperation from a historical perspective, while Section 5 concludes.

2. Benchmark Model

Our benchmark model builds on the workhorse New Keynesian model by incorporating a demand function for money (which consists exclusively of currency). In the next section, we show how a rule for setting currency growth to yield a given amount of seigniorage can be re-interpreted in

[8] It bears emphasizing that even these more limited forms of monetary-fiscal coordination may pose important risks, including to central bank independence (as discussed below). Accordingly, central banks may well opt to provide additional monetary stimulus without explicit coordination with the fiscal authority.

[9] See Romer (2014) for a discussion along these lines of U.S. monetary policy in the Great Depression.

terms of an instrument rule for the policy rate.

2.1. Households

Households derive utility from consumption, c_t, and from their holdings of real money balances, m_t, but experience disutility from the hours they spending working, n_t. The period utility function of households is assumed to take the separable form:

$$u(c_t, n_t, m_t) = \frac{[c_t - \psi_c c^a_{t-1} + \nu_0 \xi_t]^{1-\frac{1}{\sigma}} - 1}{1 - \frac{1}{\sigma}} - \chi_0 \frac{n_t^{1+\chi}}{1+\chi} - \frac{\mu_0}{1+\mu}[\max\{v_t^* - \frac{m_t}{c_t^a}, 0\}]^{1+\mu} \tag{1}$$

where the discount factor $\beta \in (0,1)$, $\sigma \geq 0$, $0 \leq \psi_c < 1$, $\chi \geq 0$, $\chi_0 > 0$, $\mu_0 > 0$, and $\mu > 0$. The subutility function over consumption allows for external habit persistence in consumption, with c^a_{t-1} denoting lagged aggregate consumption, which households take as given in deciding on their own consumption. The consumption taste shock ξ_t is an exogenous AR(1) process with a persistence parameter of ρ_ξ. The final term of equation (1) implies that real balances – expressed as a ratio to aggregate consumption – are valued at the margin until reaching a stochastic bliss point of v_t^*. For simplicity, we assume that the scaling factor is aggregate consumption, c_t^a, which is taken as given by the household; this formulation implies that the consumption Euler equation doesn't depend on the level of real balances, consistent with most empirical analysis.

Households face a budget constraint that may be expressed in real terms as:

$$b_t + m_t + c_t = (1 - \tau_{n,t}) w_t n_t + \frac{1}{1+\pi_t}((1 + i_{t-1}) b_{t-1} + m_{t-1}) + \mathfrak{d}_t - \tau_t \tag{2}$$

The household's after-tax income consists of labor income, $(1 - \tau_{n,t}) w_t n_t$ (where w_t denotes the real wage and $\tau_{n,t}$ is a distortionary labor income tax), dividends, $\mathfrak{d}_t$, from the ownership of firms, minus the lump-sum taxes, τ_t, paid to the government. The household uses this income to purchase consumption goods, increment its real bond holdings, $b_t = \frac{B_t}{P_t}$ (nominal holdings B_t divided by the price level P_t), and accumulate real balances, $m_t = \frac{M_t}{P_t}$. The real return on bonds is $\frac{1+i_{t-1}}{1+\pi_t}$, where

i_{t-1} is the nominal interest rate and $\pi_t = \frac{P_t}{P_{t-1}} - 1$ is the inflation rate; the gross real return on money is simply $(1+\pi_t)^{-1}$.

The household's problem consists of choosing its consumption, labor hours, real balances, and bond holdings to maximize its discounted utility $E_0 \sum_{t=0}^{\infty} \beta^t \ U(c_t, n_t, m_t)$ subject to the budget constraint given by equation (2). The first order conditions imply the usual consumption Euler equation and household labor supply decision, respectively:

$$\lambda_t = \beta E_t \left\{ \frac{1+i_t}{1+\pi_{t+1}} \lambda_{t+1} \right\} \tag{3}$$

$$-\frac{u_{n_t}}{\lambda_t} = w_t(1-\tau_{n,t}), \tag{4}$$

where λ_t is the marginal utility of consumption (which depends partly on lagged consumption). Household money demand can be expressed as:

$$\mu_0 (v_t^* - \frac{m_t}{c_t})^{\mu} = \lambda_t c_t \left(1 - \frac{1}{1+i_t} \right), \qquad \text{if} \qquad i_t > 0 \tag{5}$$

Given the opportunity cost of holding money balances when the (net) interest rate is positive, real money demand (expressed relative to consumption) is less than its satiation level v_t^*. As in Eggertsson and Woodford (2003), the money demand function is continuous at $i_t = 0$ with $\frac{m_t}{c_t} \geq v_t^*$ if $i_t = 0$. This formulation is useful because it allows us substantial flexibility to calibrate the interest semi-elasticity of money demand, as can be seen from the log-linearized form that we work with below:

$$\widetilde{m}_t = \widetilde{c}_t - \phi_c(\widetilde{\lambda}_t + \widetilde{c}_t) - \phi_i \widetilde{i}_t + (\frac{v^*}{v}) v_t^* \quad , \qquad \text{if} \qquad i_t > 0 \tag{6}$$

where $\phi_c = \frac{\frac{v^*}{v}-1}{\mu}$ and $\phi_i = \frac{\frac{v^*}{v}-1}{\mu} \frac{1}{i(1+i)}$. Under log utility over consumption and abstracting from habit, real money balances vary directly with consumption with a unit coefficient (since $\widetilde{\lambda}_t = -\widetilde{c}_t$), and the semi-interest elasticity of money demand varies directly with $\frac{\frac{v^*}{v}-1}{\mu}$.

2.2. Firms and Price-Setting

We assume that there is a single final domestic output good Y_t that is produced from a continuum of differentiated intermediate goods $Y_t(f)$ according to the Dixit-Stiglitz technology $Y_t = \left[\int_0^1 Y_t\left(f\right)^{\frac{1}{1+\theta_p}} df\right]^{1+\theta_p}$ where $\theta_p > 0$. Firms that produce the final output good are perfectly competitive in both product and factor markets, purchasing intermediate goods, $Y_t(f)$, at prices $P_t\left(f\right)$ to minimize the cost of producing Y_t. The demand schedule for each intermediate good derived from this cost-minimization problem is of the form:

$$Y_t\left(f\right) = \left(\frac{P_t(f)}{P_t}\right)^{\frac{-(1+\theta_p)}{\theta_p}} Y_t. \tag{7}$$

where P_t is the aggregate price index (i.e., $P_t = \left[\int_0^1 P_t\left(f\right)^{\frac{-1}{\theta_p}} df\right]^{-\theta_p}$).

Intermediate good f is produced by a monopolistically competitive firm according to a Cobb-Douglas production function:

$$Y_t\left(f\right) = K_t(f)^{\alpha}(Z_t L_t(f))^{1-\alpha}, \tag{8}$$

where Z_t denotes a stationary shock to the aggregate level of productivity. The intermediate goods producers face perfectly competitive factor markets for hiring capital, $K(f)$, (at a real rental price of r_{Kt}) and labor, $L_t(f)$, (at a real wage of $\frac{W_t}{P_t}$). The first-order conditions for the cost-minimizing input choices imply that all intermediate producers have an identical real marginal cost per unit of output $\frac{MC_t}{P_t}$. Real marginal cost can be expressed as the ratio of the real wage to the marginal product of labor:

$$\frac{MC_t}{P_t} = \frac{\frac{W_t}{P_t}}{MPL_t} = \frac{\frac{W_t}{P_t}L_t}{(1-\alpha)K}, \tag{9}$$

noting that the aggregate ratio of labor to capital appears in (9) because all firms choose the same factor proportions, and that the aggregate capital stock is assumed fixed.

Intermediate-goods-producing firms set prices according to Calvo-style staggered contracts, with firm f facing a constant probability, $1-\xi_p$, of being able to re-optimize its price, $P_t(f)$. Each firm that is allowed to reoptimize chooses its price ($P_t^{opt}(f)$) to maximize:

$$\max_{P_t^{opt}(f)} E_t \sum_{j=0}^{\infty} \xi_p^j \psi_{t,t+j} \left[(1+\pi)^j P_t^{opt}(i) - MC_{t+j} \right] Y_{t+j}(i), \tag{10}$$

subject to its demand curve (7), where $\psi_{t,t+j}$ is the stochastic discount factor (i.e. $\beta^j E_t \frac{\lambda_{t+j}}{\lambda_t}$)). The term $(1+\pi)^j$ reflects that the price of firms not able to reset their price is assumed to increase at the steady-state inflation rate of π each period. The first order condition (together with the identity for the evolution of the aggregate price index) yields the standard New Keynesian Phillips Curve.

2.3. Fiscal Policy

It is convenient to consider the fiscal authority (Treasury) and central bank as a single consolidated entity (the "government"). The government finances its purchases of real goods and services, g_t, either through taxation, real seignorage revenue, or by issuing debt. Accordingly, the government's flow budget constraint, which determines the evolution of government debt, b_t, is:

$$b_t = \frac{1+i_{t-1}}{1+\pi_t} b_{t-1} + g_t - \tau_t - \tau_{n,t} w_t n_t - s_t, \tag{11}$$

where s_t is real seignorage revenue, and recalling that τ_t is a lump-sum tax on households and $\tau_{n,t}$ the labor income tax rate. Real seignorage revenue in turn is equal to the new nominal monetary liabilities issued by the government divided by the price level (i.e., the purchasing power of newly issued money):

$$s_t = \frac{M_t - M_{t-1}}{P_t} = m_t - \frac{m_{t-1}}{1+\pi_t} \tag{12}$$

We assume that government spending follows an exogenous AR(1) process of the form:

$$g_t = (1-\rho_g) g_{t-1} + \varepsilon_{gt}. \tag{13}$$

and that the income tax rate τ_n is constant. Thus, lump-sum taxes adjust to satisfy the government budget constraint (11).

2.4. Market Clearing

The aggregate production function is given by:

$$y_t = \widetilde{a}_t k^a n_t^{1-\alpha} \tag{14}$$

where $\widetilde{a}_t$ denotes the level of technology scaled by price dispersion (see Woodford (2003)), and aggregate labor and capital are $n_t = \int_0^1 L_t(f)df$ and $k = \int_0^1 K_t(f)df$, respectively. The aggregate resource constraint is:

$$y_t = c_t + g_t \tag{15}$$

2.5. Monetary Policy

Our benchmark assumption is that monetary policy sets seigniorage revenue to be proportional to the *shock* to government spending on goods and services, i.e., to the deviation of government spending from its steady state level.

$$s_t = \frac{M_t - M_{t-1}}{P_t} = \frac{M_t - M_{t-1}}{M_{t-1}} \frac{M_{t-1}}{P_t} = \left(\frac{g_t - g}{g} \right)^{\phi} \tag{16}$$

We devote considerable attention to the case in which any shock to government spending is fully financed by seigniorage (i.e., $\phi = 1$). However, we also consider cases in which government spending is only partially financed by seigniorage. As we will discuss, this money-based rule can be recast in terms of a reaction function for the policy rate that makes it easier to interpret.

2.6. Log-Linearized Equations

The log-linearized equation characterizing price-setting takes the familiar form of the New Keynesian Phillips curve:

$$\widetilde{\pi}_t \;= \beta \widetilde{\pi}_{t+1|t} + \kappa_{mc}(\varsigma_0 \widetilde{x}_t - \varsigma_1 \psi_C \Delta \widetilde{x}_t). \tag{17}$$

where $\widetilde{x}_t$ is the output gap – the deviation of output from its potential level under flexible prices – and the "speed effect" term $\Delta\widetilde{x}_t$ in the growth rate of the output gap reflects the effects of habit persistence in consumption on labor supply. The parameter κ_{mc} denotes the contemporaneous sensitivity of inflation to real marginal cost, and varies inversely with the mean duration of price contracts. The New Keynesian IS curve is given by:

$$\widetilde{x}_t - \psi_C \widetilde{x}_{t-1} = (\widetilde{x}_{t+1|t} - \widetilde{x}_t) - \sigma(1-\psi_C)(i_t - \pi_{t+1|t} - r_t^*), \tag{18}$$

where r_t^* is the potential or "natural" real rate of interest that would prevail under fully flexible prices. The model is complete with the specification of the (log-linearized) money policy reaction function that we describe below.

2.7. Calibration

We calibrate our model at a quarterly frequency using fairly standard parameter values. The discount factor of $\beta = 0.995$ implies a steady state real interest rate of 2 percent (at an annualized rate). With a steady state inflation rate of 0 percent (i.e., $\pi = 0$), the steady state nominal interest rate is also 2 percent. We set the intertemporal substitution elasticity $\sigma = 0.5$, so that the interest elasticity of aggregate demand is somewhat lower than under log utility.[10] The habit parameter ψ_c is set to 0.8. This value is on the higher side of the range of estimates in the empirical literature, but helps our model generate a fairly plausible path for the government spending multiplier, even if somewhat lower than estimated by e.g., Blanchard and Perotti (2002). The Frisch elasticity of labor supply of $\frac{1}{\chi} = 0.5$ and capital share of $\alpha = 0.3$ are in the typical range specified in the literature. The government share of steady state output is set to 20 percent ($g_y = 0.2$), which is close to the average federal government spending share in U.S. GDP.

The responsiveness of inflation to marginal cost plays a key role in determining how monetary

[10] The scale parameter on the consumption taste shock ν is set to 0.001 (this parameter is set to have a negligible impact on the slope of the IS curve).

policy actions affect output and inflation. We assume $\xi_p = 0.95$, so that the mean duration of price contracts is 20 quarters – implying a very flat Phillips Curve slope that seems consistent with empirical evidence for the United States, at least in recent years. The specification of money demand implies a unitary long-run elasticity with respect to consumption. We impose a short-run interest rate semi-elasticity of money demand equal to 2.5 (when expressed at an annual rate). Given that the share of real balances in consumption is set to 0.4, this implies that a 1 percentage point rise in the (annualized) nominal interest rate would reduce the share of currency to GDP by 1 percentage point.[11] We discuss the monetary policy rule in more detail below.

Finally, we solve the log-linearized model using the AIM algorithm.

3. Effects of a Money-Financed Fiscal Program

We begin by using our model to show how a fairly small money-financed fiscal program could – at least in principle – provide a large boost to output while also reducing the government debt to GDP ratio. Thus, as seen in Figure 1, we consider a rise in government spending that equals only 0.4 percent of GDP in the initial quarter, and which cumulates to 1 percent of GDP; the persistence of the shock is 0.9. Both the design of the scenario and our results are close to those reported in Gali (2016).

The red dashed lines show the effects of the government spending hike under the assumption that monetary policy follows the Taylor (1993) rule. Although output and inflation both rise, the government spending multiplier (not shown) is less than unity, reflecting that the central bank raises both nominal and real interest rates, which crowds out private demand. The spending multiplier averages about 0.8 percent in the first year following the shock, which is closely in line with most empirical estimates of the spending multiplier based on U.S. data prior to the financial

[11] The 40 percent figure reflects quarterly consumption. Currency is roughly 10 percent of annual consumption spending.

crisis (Ramey and Zubairy, forthcoming). The spending hike is almost exclusively debt-financed. The ratio of government debt to GDP rises because the higher government spending generates persistent primary deficits, and because the higher real interest rates raise the cost of financing existing debt. Seigniorage actually falls in the short-run as higher nominal interest rates reduce real money demand, though the eventual rise in the price level translates into a small amount of seigniorage at longer horizons.

Policies that boost debt may be regarded as undesirable or unsustainable, especially in economies with high levels of public debt. Accordingly, our second scenario considers a money-financed fiscal program. In this simulation we assume the same fiscal expansion as before, but also assume a radical shift in monetary policy, under which the central bank commits to raising the demand for nominal currency permanently by the amount required to finance the increase in government spending. (The increase must be in currency, since we assume that interest is paid on reserve balances.) In order to boost currency demand by the required amount, the price level must eventually rise by enough that the public voluntarily demands this additional nominal currency. This change in monetary policy is assumed to be fully understood by the public and completely credible – an assumption to which we will return below.

The blue solid lines in Figure 1 show the results of this money-financed fiscal program in our model. The money-financed program generates a large and persistent rise in the inflation rate. The inflation rate rises by more than 2 percent above baseline, and eventually causes the price level to rise by 10 percent. The large rise in the price level in response to this fairly small increase in government spending reflects that the inflation tax base – the ratio of money balances to nominal GDP – is small, so that the money stock must rise by a substantial amount in percentage terms. Because real interest rates decline markedly, GDP expands by nearly $1\frac{1}{2}$ percent relative to baseline, consistent with an implied spending multiplier of around 5. The money-financed program elicits a large fall in the debt-to-GDP ratio of around 13 percentage points after a decade. While seigniorage revenue rises by the size of the government spending hike by design, most of the improvement in the debt-to-GDP ratio reflects a rise in tax revenues due to the output expansion, and also the depressing effects of low real interest rates on interest expenses and hence outstanding debt.

Results along these lines have led a number of economists to conclude that central bank-Treasury coordination to monetize fiscal spending could be a potent tool to confront cyclical downturns: Only a small dose of fiscal spending is required to provide a powerful boost to GDP and inflation, and such a program would have the collateral benefit of reducing the government debt burden. Support for including monetization in the arsenal of central bank tools has undoubtedly been fueled by the long period in which many central banks have been constrained by the effective lower bound (ELB) on policy rates since the financial crisis. An attractive feature of a money-financed fiscal program in a liquidity trap is that the rise in inflation expectations and aggregate demand it engenders tends to boost the nominal interest rate, and hence can help "lift" central banks off the ELB more quickly.

Figure 2 shows the effects of the same (small) rise in government spending against the backdrop of a deep recession that would pin the policy rate at zero for three years absent the fiscal stimulus. In contrast to our previous results in Figure 1, which are reported in deviations from the steady state baseline, Figure 2 shows the responses in levels, with the baseline generated by a transitory preference shock that increases desired savings. The boost to output and inflation from fiscal stimulus under a standard monetary policy reaction function – the promise to continue following the Taylor rule after liftoff from the ELB – is barely noticeable. The spending multiplier is considerably larger than in normal times because real interest rates fall, which crowds in private demand (c.f., Christiano, Eichenbaum, and Rebelo 2011, and Woodford 2011); even so, a much larger fiscal program would be required to close output and inflation gaps.[12] By contrast, the money-financed program quickly erases most of the output gap, moves inflation above target within two years, and induces some decline in government debt relative to GDP (rather than a sizeable runup). Notably, the nominal interest rate rises from the ELB shortly after the shock, and attains its long-run value within a couple of years.

3.1. Re-interpreting the central bank's reaction function

While the central bank's reaction function under a money-financed program is typically thought of as a money supply rule, it is helpful to express the rule in a more familiar form in terms of the policy rate. In general, the policy reaction function implied by monetary financing depends on the currency demand function. Under the reasonable assumptions about currency demand in our model —that real currency demand varies directly with activity, and inversely with the policy rate—the central bank's reaction function under a money-financed fiscal program can be interpreted as a form of "flexible price-level targeting," in which the policy rate varies with the gap between the price level and its target path, and also with real activity (output or consumption). The crucial twist is that the target price level path varies with the size and persistence of the fiscal expansion, rather than remaining constant or growing at fixed rate (e.g., 2 percent per year).

In this vein, the interest rate reaction function can be derived by noting that the log-linearized form of the monetary policy rule in equation (12) can be expressed:

$$m_y(\Delta\widetilde{m}_t + \widetilde{\pi}_t) = g_y\widetilde{g}_t \tag{19}$$

where m_y is the ratio of real balances to steady-state output, and g_y is the steady-state government expenditure share of output.. Thus, a money-financed increase in government spending requires some combination of an expansion in real money demand ($\Delta\widetilde{m}_t$) and higher inflation. Substituting

[12] Note that Figure 2 shows the output gap (to keep all responses in levels). The output response is somewhat larger given that higher government spending boosts potential GDP.

the log-linearized money demand function (6) into equation (19) and solving for the policy rate yields:

$$\Delta\widetilde{i}_t = \frac{1}{\phi_i}\left(\widetilde{\pi}_t - \frac{g_y}{m_y}\widetilde{g}_t + \phi_c(\Delta\widetilde{c}_t - (\frac{v^*}{v})\Delta v_t^*)\right) \quad , \text{if} \qquad i_t > 0 \tag{20}$$

where we have abstracted from habit persistence for expositional simplicity. This "super-inertial" reaction function can be written alternatively in terms of the level of the policy rate as:

$$\widetilde{i}_t = \frac{1}{\phi_i}\left(\widetilde{p}_t - \widetilde{p}_t^* + \phi_c(\widetilde{c}_t - (\frac{v^*}{v})v_t^*)\right) \quad , \text{if} \qquad i_t > 0 \tag{21}$$

where the price level target, $\widetilde{p}_t^*$, evolves according to:

$$\widetilde{p}_t^* = \widetilde{p}_{t-1}^* + \frac{g_y}{m_y}\widetilde{g}_t \tag{22}$$

Abstracting from $\widetilde{p}_t^*$, the interest rate reaction function (21) can be interpreted as consistent with a form of flexible price level targeting, with consumption rather than output the relevant activity measure. The key difference is that a money-financed fiscal expansion raises $\widetilde{p}_t^*$, which can be regarded as tantamount to a time-varying price level target that varies with the size and persistence of the government spending expansion.

This framework provides a useful way to help understand why a money-financed fiscal expansion generates a much larger rise in output and inflation than under the Taylor rule. Figure 3 provides a decomposition along these lines. In particular, this figure reports exactly the same responses to a government spending shock as in Figure 1 under both the Taylor rule (dashed red) and money-financed program (solid blue). However, Figure 3 also shows the effects of the government spending hike in the case that monetary policy adopted flexible price-level targeting – consistent with the reaction function in equation (21) – but leaving the price level target path $\widetilde{p}_t^*$ unchanged (the green dash-dotted lines). The striking feature of the figure is that the shift to flexible price level targeting alone induces only a slightly bigger output response (the multiplier in the first year is only about 10 percent larger). Thus, the vastly larger multiplier under the money-financed program occurs because agents regard it as implying a large upward shift in the price level target path over time (the black dotted line in the upper right panel shows the target path $\widetilde{p}_t^*$).

Given that agents immediately recognize this shift in the target price level path, it is unsurprising that there are large expansionary effects on output. The central bank must lower the trajectory for the real interest rate in order to raise output by enough to boost the price level toward this new target path, and hence generate the seigniorage needed to finance the fiscal expansion. Figure 3 illustrates how most of the decline in the real interest rate under a money-financed program is due to the upward shift in the price-level target path (the difference between the solid blue and green dash-dotted lines in the middle left panel). The strong expansion of output and inflation causes the nominal interest rate to rise (as was seen in Figure 2).

3.1.1. Role of Money Demand

Equation (21) underscores how the effects on output of a money-financed fiscal expansion depend critically on the specific features of money demand. The price level target path would rise more than in Figure 3 if real money demand was a smaller share of output – as the base for the inflation tax would be smaller – and conversely, rise more if money demand was larger. Thus, as seen in Figure 4, while our baseline calibration of money demand implies that the price level rises about 10 percent relative to baseline under the benchmark case, the price level would rise 20 percent under a calibration in which money demand were only half as large, and the effects on output and interest rates would be commensurately larger.

3.1.2. Monetary Financing and the Phillips Curve Slope

The slope of the Phillips Curve plays an important role in determining how the rise in nominal money demand associated with a money-financed fiscal program is distributed between output and inflation. Under our benchmark calibration with a low Phillips Curve slope, a large and relatively persistent output expansion is required in order to boost the price level to its new target path. However, if inflation was more responsive to output, a smaller and more transient output expansion could achieve the same rise in nominal demand, so that a given-sized money-financed fiscal expansion would imply less GDP stimulus. The red dashed lines in Figure 5 illustrate the implications of the same rise in government spending under a steeper Phillips Curve slope corresponding to a Calvo parameter of $\xi_p = 0.8$, rather than $\xi_p = 0.95$ as in our benchmark calibration. Output peaks at a little over 1 percent above baseline under this alternative calibration, while the peak rise in inflation is nearly twice as large. The shorter duration of the output expansion translates into a less persistent improvement in the primary budget balance, and, accordingly, the government debt-to-GDP ratio also declines by less.

As we will discuss more below, when considering historical episodes, the prospect of a relatively muted inflation response to a money-financed program is likely to be greater when the central bank is perceived as allowing a one-time shift in its price level target, perhaps in response to extraordinary circumstances such as a major war or depression. Conversely, repeated efforts to monetize fiscal deficits would seem likely to engender a much larger inflation response – and correspondingly, less persistent effects on real interest rates and GDP – as agents would likely react by re-setting prices more frequently, and possibly by adjusting upward their views about longer-term inflation.

3.2. The Effects of Imperfect Credibility

We next consider two forms of departure from the baseline model that have the effect of damping the substantial near-term stimulus that arises from the perceived shift in the target price level path under monetary financing. In this subsection, we assume that agents must learn about the new reaction function, and in particular, about the shift in the target price level path. Indeed, given that monetary financing involves a dramatic shift in the policy reaction function, it seems likely that the private sector would either fail to understand what the new policy regime entailed, or regard the central bank's commitment to the new regime as somewhat tenuous. We try to capture this uncertainty in our model by assuming that agents model must solve a signal extraction problem: They see the central bank printing money, but must decide whether the money stock hike presages monetization of the new government spending, or will be reversed.[13]

To set up the signal extraction problem formally, we begin by recalling that under full monetary financing, money growth is determined according to:

$$M_t = M_{t-1} + \frac{g_y}{m_y}\widetilde{g}_t \tag{23}$$

We now consider the possibility that only some component of the new government spending $\widetilde{g}_t^{mf}$ is financed by money creation, while the remainder is financed by issuing debt $\widetilde{g}_t^{df}$ (thus, $\widetilde{g}_t = \widetilde{g}_t^{mf} + \widetilde{g}_t^{df}$). Moreover, we assume that the money stock may also be buffeted by other shocks, so that money growth is given by:

$$M_t = M_{t-1} + \frac{g_y}{m_y}(\widetilde{g}_t^{mf} + \Delta e_{Tt}) \tag{24}$$

The money-financed component $\widetilde{g}_t^{mf}$ is itself linked to an underlying shock e_{gt} via the linear relation $\widetilde{g}_t^{mf} = \psi u_{gt}$ where u_{gt} has the same persistence as the actual government spending shock g_t:

$$u_{gt} = (1 - \rho_G)u_{gt-1} + e_{gt} \tag{25}$$

where the innovations e_{gt} and e_{Tt} are assumed to be N(0,1), and uncorrelated with the innovation to government spending ε_{gt} in expression (13).

This framework provides a stylized way of analyzing how a money-financed program might play out under different assumptions about the information available to agents. Broadly speaking, agents

[13] In our simple model, a reversal would require the central bank to scale back currency in circulation and substitute interest-bearing debt. In practice the central bank could finance the fiscal expansion initially by expanding the monetary base – and thus depart temporarily from its normal reaction function – but later pay interest on those reserves (consistent with a return to its usual reaction function).

would typically expect fiscal spending to be debt-financed: This is captured by our assumptions that the money-finance innovation e_{gt} is uncorrelated with the fiscal innovation, and that the scaling parameter ψ is very small. Hence if the authorities did opt to finance the higher government spending by printing money, this would be reflected in an extremely large rise in u_{gt} (given that ψ is small). Under full information, agents would observe the shock u_{gt} directly, and accordingly, immediately change their views about the long-run money stock and price level, recognizing that the money shock would have to rise enough to finance the new government spending. By contrast, under imperfect information, we assume that agents only see the actual money stock M_t , but cannot distinguish the money-financed component u_{gt} from random variation in the money stock that is captured by e_{Tt}. Hence, they must solve a signal extraction problem to infer these components based on their incoming observations about M_t. Specifically, they use the Kalman filter with the observation equation given by:

$$M_t = H' z_t = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} M_t \\ u_{gt} \\ e_{Tt} \end{bmatrix} \quad , \tag{26}$$

and where the underlying state vector z_t in turn is perceived to follow a first-order vector autoregression:

$$\begin{bmatrix} M_t \\ u_{gt} \\ e_{Tt} \end{bmatrix} = \begin{bmatrix} 1 & \psi(1-\rho_G) & -1 \\ 0 & 1-\rho_G & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} M_{t-1} \\ u_{gt-1} \\ e_{Tt-1} \end{bmatrix} + \begin{bmatrix} \psi & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} e_{gt} \\ e_{Tt} \end{bmatrix} \tag{27}$$

Figure 6 shows the implications of imperfect credibility for output, inflation, and government debt. While agents are assumed to have a complete understanding of how government spending will evolve (it is the same shock as in Figure 1), they believe initially that it will be largely debt-financed. The speed at which agents update their views about the state – and critically, about the persistent shock u_{gt} that determines the extent of monetary financing – depends on the Kalman gain, which in turn depends on the size of the parameter ψ. Specifically, the parameters of the Kalman filter are set so that agents initially believe that only a small fraction of the increase in spending will be monetized, and accordingly, initially expect most of the rise in money to be reversed. However, as agents are surprised by ongoing increases in the money stock (middle right panel), they come to expect that more of the government spending hike will be monetized.

Output and inflation rise much more gradually in this simulation than in Figure 1,with the peak impact on output and inflation occurring 6-7 years after the policy is implemented. Thus, to the extent that the policy aims to support the economy in a recession, the stimulus is less “well-timed” than under the extreme assumption of full information.

3.3. Less Forward-Looking Behavior

A recent literature, including McKay, Nakamura, and Steinsson (2014) and Gabaix (2016) has highlighted how the standard New Keynesian model implies that monetary policy actions expected to be taken in the distant future can have extremely powerful near-term effects - in fact, even larger than if the same actions were taken today. This potent effect of future policy changes has been dubbed the “forward guidance puzzle,” and reflects the highly forward-looking behavior of both output and inflation in the baseline New Keynesian model. In this section, we consider the effects of introducing less forward-looking behavior into both the aggregate demand and price-setting equations in the spirit of Gabaix (2016). Our specification has the appeal of encompassing both the baseline New Keynesian model and a purely ”backward-looking” adapative expectations model as special cases. In this context, when aggregate demand and inflation are less forward-looking, we show that money-financed programs tend to generate much less *near-term* stimulus, much like in models in which agents follow the sort of learning mechanism we have described above. While it is helpful, for analytical reasons, to treat learning and less forward-looking behavior as distinct mechanisms – as we do here – it is worth emphasizing that both features would be likely to play an important role in affecting how a money-financed program would play out in practice.

As noted by Gabaix (2016), the general form of our augmented model appears very similar to the baseline New Keynesian model, with the key difference a diminshed effect of the future evolution of economic variables in both the Phillips curve and IS equation. Thus, relative to expressions (17) and (18), the Phillips becomes:

$$\widetilde{\pi}_t - \iota_P \widetilde{\pi}_{t-1} = \beta \delta_\pi (\widetilde{\pi}_{t+1|t} - \iota_P \widetilde{\pi}_t) + \kappa_{mc}(\varsigma_0 \widetilde{x}_t - \varsigma_1 \psi_C \Delta \widetilde{x}_t) \tag{28}$$

while the IS curve is now:

$$\widetilde{x}_t - \psi_C \widetilde{x}_{t-1} = \delta_x (\widetilde{x}_{t+1|t} - \widetilde{x}_t) - \sigma(1-\psi_C)(i_t - \pi_{t+1|t} - r_t^*), \tag{29}$$

where the new parameters δ_π and δ_x represent the discount factors (or attention parameters) for both price-setters and households, respectively.[14] The baseline New Keynesian model is a special case when $\delta_\pi = \delta_x = 1$. At the opposite extreme, the model is consistent with an older generation of Keynesian models with adaptive expectations and an accelerationist Phillips Curve when $\delta_\pi = \delta_x = 0$ and $\iota_P = 1$. In this latter case, the backward-looking nature of the model eliminates any effect that forward guidance regarding the future path of nominal interest rates may have on current output and inflation.

We now illustrate how the monetary stimulus from a money-financed fiscal program has a much weaker effect than in the baseline model. To do so, we adopt a calibration in which we set $\delta_x = 0.9$, $\delta_\pi = 0.25$, and we keep $\iota_P = 0$. This parameterization gives monetary policy much less scope to affect current inflation and output through influencing inflation expections. This latter feature seems consistent with research indicating that even relatively large-scale fiscal interventions such as the U.S. ARRA program of 2009 had small effects on inflation expectations (Dupor 2013), as well as with the recent experience of a number of industrial economies. In particular, these economies – most notably, Japan – have experienced very low inflation despite the expectation that

[14] Note that the natural real interest rate – here denoted $r^*_{\delta t}$ – differs slightly from the orginal in expression (18) given that future shocks are discounted by $0 < \delta_x < 1$.

the employment rate would remain at a historically high level.

Figure 7 illustrates the effects of a money-financed fiscal program in this model variant with less forward-looking behavior. The money financed program provides considerable stimulus, albeit smaller initially than in the baseline model. However, the key difference is that nominal interest rates must fall progressively – and by a very large amount – to elicit these expansionary effects. Because inflation doesn't respond much to the expectation of persistently strong future demand, the low real rates required to boost the price level to its higher target path $\widetilde{p}_t^*$ must be achieved by keeping the nominal rate very low.

Given the zero lower bound on policy rates, the low nominal interest rates required under a money-financed program would pose obvious implementation challenges in the event policy rates were already low beforehand, as would be likely in a recession. In this vein, Figure 8 shows the effects of a shock to the target path $\widetilde{p}_t^*$ – the monetary component of a money-financed fiscal program – against the backdrop of a severe recession that would pin the policy rate at zero for over two years absent the program.[15] For computational reasons associated with the zero lower bound, we consider a program one-quarter as large as previously, which implies that the target price level path $\widetilde{p}_t^*$ eventually rises about 2.5 percent above baseline. As shown by the red dashed lines, this program would still deliver considerable stimulus if the zero bound constraint was not enforced (against the backdrop of the same-sized recession). By contrast, with a binding zero bound (the solid blue lines), the program hardly provides any stimulus to output or inflation, reflecting both that monetary policy is unable to reduce nominal (and real) interest rates and the vastly diminished power of forward guidance.

[15] The figure presents the results as deviations from the recession baseline for visual clarity (otherwise, the stimulus from monetary easing would be obscured by the recession-induced sharp decline in output and inflation). The figure also report results only over the first three years when the effects on monetary transmission due to the zero lower bound are most evident.

3.4. More Limited Forms of Monetary-Fiscal Cooperation

Our alternative specifications with some combination of less forward-looking behavior and learning highlight conditions under which monetary policy may – of itself – have somewhat limited ability to provide near-term stimulus; this contrasts sharply with the baseline model in which monetary policy of itself exerts very powerful effects, so that fiscal policy isn't really needed. To the extent that the former case is more plausible – and notwithstanding a myriad of open questions about the degree to which expectations are forward-looking, and the speed of learning – expansionary fiscal policy may play a key role in giving monetary policy more traction to boost aggregate demand. In particular, fiscal expansion may boost aggregate demand and the path of interest rates enough that monetary policy can take reinforcing steps by following a somewhat more accommodative reaction function than previously anticipated. In other words, some degree of monetary and fiscal cooperation can help boost the efficacy of monetary policy.

We next illustrate this point in the model with less forward-looking behavior. Against the backdrop of a deep recession induced liquidity trap – similar to Figure 8 – monetary expansion (here a rise in the target path $\widetilde{p}_t^*$) of itself provides very little stimulus (the blue lines) given the more limited power of forward guidance in this model. The red dashed lines show (partial) effects of the same monetary expansion against the backdrop of a large fiscal expansion.[16] The fiscal expansion boosts the path of policy rates enough to give monetary policy scope to depress bond yields both through reducing policy rates and through forward guidance. This monetary expansion raises output about 0.3 percent and also boosts inflation, in contrast to the very small rise that occurs without fiscal expansion.

The monetary policy expansion is clearly much more effective in the near-term with fiscal ex-

[16] Our simulation here assumes that the policy reaction function is specified in terms of targeting nominal income rather than consumption. The latter would give government spending expansions little traction to affect interest rates (since higher government spending tends to crowd out private consumption). Our general point that fiscal actions would boost interest rates across a wide range of reaction functions – and even under flexible consumer price targeting in a more general model with rule of thumb households – remains quite robust.

pansion, even if somewhat less potent than in normal times. But importantly, additional monetary expansion – say the commitment to raise $\widetilde{p}_t^*$ by 4 percent rather than 2 percent – would provide very little additional near-term stimulus *unless accompanied by more fiscal expansion.* The extra stimulus from a larger monetary expansion (without more fiscal) would be felt mainly in the form of a large rise in inflation and output long after the recession had faded into history.

It also bears emphasizing how a limited commitment on the side of monetary policy – here to raise the price level target – seems preferable to making a commitment to monetize a given amount of fiscal spending. The former would provide much more clarity about how the commitment would likely affect inflation (e.g., 1/2 percent above target on average over several years), even if leaving uncertain the amount of seigniorage to be raised by the monetary action. By contrast, monetization of even a small amount of fiscal spending (or debt) would have very unpredictable effects on inflation and the long-run price level even in the benign case that long-run inflation expectations remained anchored near the central bank's target.

4. Monetary-Fiscal Cooperation: Some Historical Examples

Although the importance of central bank independence for the achievement of low and stable inflation has been emphasized by monetary economists in recent decades, monetary-fiscal cooperation similar to that discussed in this paper has been common in the past. In particular, there are many historical examples of countries that have used monetary policy to help finance fiscal actions in wartime.[17] In effect, such cooperation allowed for the financing of war expenditures with seigniorage. In many cases, this approach required a temporary suspension of the gold standard. For example, U.S. government during the Civil War issued unbacked paper money – the "greenbacks" – to finance war expenditures that totaled about 10 percent of pre-war GDP.[18] In addition, under

[17] See Rockoff (2014) for a summary of this literature and a discussion of U.S. examples.

[18] Rockoff (2014) reports that total issuance of greenbacks reached nearly $500 million, while Historical Statistics of the United States reports nominal GDP at the start of the war was less than $5 billion (table Ca9-19).

the National Banking Act, newly-chartered national banks issued national bank notes that were backed only by government securities, an implicit monetization of the debt. In total, the nominal money supply increased by about 17 percent of pre-war nominal GDP. Over the same period, federal debt increased by about $2.6 billion, or nearly 60 percent of pre-war GDP.[19] The result of the fiscal and monetary stimulus was a rise in output, as well as an increase in the general level of prices of more than three quarters over the course of the war.[20] However, unlike the situation modeled above, the United States ultimately returned to the gold standard at the pre-war parity in 1879, implying that the increase in the price level was temporary, rather than permanent.

By contrast, French governments after the First World War ultimately allowed the value of the franc to decline by 80 percent before it was de facto repegged to gold in 1926. As discussed in Bordo and Hautcoeur (2003), France had not increased taxes to pay for the war, but had rather depended on borrowing and substantial money growth (which exceeded 60 percent for a time). As a result, at the end of the war, France faced very large challenges, including a debt-to-GDP ratio of more than 180 percent, large ongoing budget deficits, prices that had more than doubled relative to pre-war levels, and a large monetary overhang (which they estimate at 17 percent of GDP). These challenges were reinforced by the war-related decline in GDP, which was about 10 percent below its 1910 level in 1919. Given this difficult situation, Bordo and Hautcoeur (2003) note that a return to the pre-war parity would have been extremely difficult, although they argue that had political agreement on burden sharing been reached earlier, the ultimate devaluation in terms of gold could have been limited to roughly 50 percent. Even in that case, however, the result of the monetary financing of a significant portion of the war effort would have been a permanent doubling of the price level. As it was, prices rose by roughly a factor of five over twelve years.[21]

[19] The federal debt figures are taken from Historical Statistics of the United States, Table Ea584–587.

[20] Output and price data are from Historical Statistics of the United States, Table Ca9-19. Output is available only for the United States as a whole. This measure increased by about 20 percent over the course of the war, with much of the increase presumably in the North.

[21] The permanent increase in prices in France may have helped to support the recovery in output after the war, which rebounded to more than 120 percent of its 1910 level by 1925 despite the wartime damage. By contrast, in the

An intermediate case arose in the United States at the time of the Second World War, when the Federal Reserve cooperated with the Treasury to help with the financing of the war effort. To do so, the Federal Reserve essentially fixed the yields on Treasury securities at low levels, which also limited price volatility that could have adversely affected financial intermediaries. As noted by Chaurushiya and Kuttner (2003), the Federal Reserve purchased a very large fraction of outstanding Treasury bills for a time in order to keep their yields from exceeding 3/8 percent. By contrast, Federal Reserve purchases of longer-term Treasury securities were modest until after the war, when the ceiling on bill rates was increased. By the end of 1945, high-powered money (currency plus banks' reserve balances at the Federal Reserve) had roughly doubled from its pre-war level to approximately $40 billion, while gross federal debt surged from $51 billion in 1940 to more than $260 billion in 1945, reflecting deficits of roughly $50 billion a year from 1943-45.[22] In the face of this extraordinary monetary and fiscal policy, nominal GDP more than doubled, from $101 billion to $223 billion between 1940 and 1945, with real GDP rising more than 70 percent and prices increasing by more than a quarter.[23]

The inflationary effects of the expansionary war-time policies in the United States were blunted by rationing and price controls until after the war. But the withdrawal of the price controls in 1946 led to a sharp further increase in prices, which rose by another third between 1945 and 1948 – a cumulative increase of roughly two-thirds from pre-war levels. To limit the expansionary effects of its interest rate peg and associated securities purchases, the Federal Reserve greatly increased reserve requirements, with the required reserve ratio peaking at 26 percent in the fall of 1948.[24] The recession in 1948-49 eased inflationary pressures until the run-up to the Korean War in 1950.

United Kingdom, the return to the prewar parity was accompanied by weaker growth, with U.K. output in 1925 less than 110 percent of its 1910 level (Bordo and Hautcoeur, 2003, figure 8).

[22] High-powered money figures are taken from the 1940 and 1946 Annual Reports of the Board of Governors of the Federal Reserve System. The Federal Debt figures are taken from Historical Statistics of the United States, Table Ea679–682.

[23] Output and price data are from Historical Statistics of the United States, Table Ca9-19.

[24] Eichengreen and Garber (1991), pp. 183.

Concerns about inflation at that time sparked discussions between the Federal Reserve and the Treasury that led, in turn, to the Accord in March 1951. Even following the Accord, the Federal Reserve took steps to limit the increase in interest rates for a time, although large tax increases were also put in place.

Eichengreen and Garber (1991) provide an interpretation of monetary policy in the pre-Accord period that is broadly consistent with our description of monetary-fiscal cooperation. They suggest that the Federal Reserve's efforts to limit the variation in interest rates during this period can be seen as implying a target range for the price level, in which the effects of strong aggregate demand on real interest rates are countered with monetary accommodation so long as the price level is expected to remain within a desired target range. In this view, the low level of longer-term yields that the Federal Reserve supported was feasible because investors expected the price level to fall back to a lower level over time, providing a higher real return on monetary assets. Thus, so long as the Federal Reserve's price level target was credible, low short-term rates that accommodated the fiscal expansion and allowed prices to increase temporarily were consistent with low nominal longer-term yields. In part this policy mix was effective because investors anticipated that the economy would return to its weak pre-war state after the end of the war. However, with the economy stronger than expected, the Federal Reserve had to tighten policy to maintain the price level target, and the interest rate on bills was increased in the late 1940s, reinforced by the increase in reserve requirements. But as the economy geared up for the Korean war, the Federal Reserve could no longer achieve its price level target without raising interest rates, and the result was the Accord and a move to a tighter monetary policy.

Monetary-fiscal cooperation has also been implemented in periods of economic stress outside of wartime. For example, in the early 1930s, Japan recovered relatively early and rapidly from the Great Depression, reflecting the effects of the Takahashi economic policy. This policy, introduced by finance minister Korekiyo Takahashi staring in late 1931, had three parts: a departure from the gold standard and substantial devaluation of the yen; an increase in government spending with explicit financing of government deficits by the Bank of Japan (BOJ); and more accommodative monetary policy, including reductions in the discount rate and an easing of regulations limiting note issuance (see Shizume, 2009). This combination of policies appeared to be quite effective, with Japanese industrial production rebounding strongly in 1932 and wholesale prices advancing at about a 10 percent pace, on balance, in 1932 and 1933 after declining even more rapidly in 1930 and 1931. This strong macroeconomic impact appears to have reflected in part the effect of the clear change in policy regime on inflation expectations, consistent with our earlier modeling results.[25]

These historical examples make clear that fiscal policy paid for in part with seigniorage revenue can be effective in boosting output and inflation. However, the examples focus on periods of extraordinary fiscal stress caused by wars or depressions, which may help to convince the public that a significant change in policy regime has occurred. That leaves the question of whether such a policy approach could be helpful in less dramatic circumstances.

One case along these lines is policy in the United Kingdom in the 1960s. The Bank of England was not an independent central bank at the time, and so the government could implement monetary-fiscal cooperation.[26] In addition, this policy came at a time when there was no major war and no severe economic crisis, and monetary policy was not constrained by the effective lower bound and inflation was not persistently low. Nonetheless, the government used coordinated policies to provide accommodation based on the judgment that potential output was higher than it appears to have actually been (Nelson and Nikolov 2003). Not surprisingly, the result was not a one-time jump in the price level to accommodate the fiscal expansion, but rather a steady rise in inflation over a period

[25] Shizume (2009), p. 7. Romer (2014) argues that the U.S. departure from the gold standard during the depression had similar effects because it marked a credible change in regime.

[26] See Cairncross (1996) for a discussion of how the Bank of England's limited degree of operational independence during this period affected its policy choices.

of more than a decade. Indeed, even after the price level had increased and there was a devaluation in the late 1960s, the government continued to run an accommodative policy, pushing inflation and inflation expectations higher, As a result, there was a prolonged period of undesirably high inflation that was ultimately brought to a close only by a protracted contraction that was required to re-anchor inflation and inflation expectations. One interpretation of this unfavorable outcome is that monetary-fiscal cooperation can only be used effectively if the central bank has sufficient independence to credibly say that the period of higher inflation will be temporary, resulting in a higher price level, but not persistently higher inflation.

However, the experience in Japan in recent decades suggests that an independent central bank, at least if it is believed to prefer low and stable inflation, may find it difficult to credibly commit to even a temporary period of higher inflation. Japanese prices fell fairly steadily for more than a decade starting in the late 1990s, and the economy expanded only slowly, on balance. A number of efforts to use fiscal and monetary policy proved insufficient to move the economy firmly out of deflation, and put growth on a firmer track. As a consequence, Japanese gross central government debt is now approximately 250 percent of GDP – very high under any interpretation – and inflation remains below target, despite highly accommodative monetary policy that has pushed BOJ assets to over 90 percent of GDP.[27] In response to this difficult policy situation, the Japanese government has implemented a mix of more-accommodative monetary policy and highly accommodative fiscal policy.[28] With regard to monetary policy, the BOJ has cut its short-term policy rate to negative territory, and it has indicated that it will conduct purchases of longer-term government securities in order to keep the yield on 10-year Japanese government bonds near zero.[29] In addition, the Policy Board has indicated that it will maintain the low level of interest rates until inflation runs

[27] See FRED: https://fred.stlouisfed.org/series/GGGDTAJPA188N

[28] In addition to structural policies – see Cabinet Office, Ministry of Finance, and Bank of Japan (2013).

[29] The BOJ has also undertaken purchases of corporate instruments and JREITS and provided low-cost financing for bank loans. See BOJ (2017).

persistently above its 2 percent target rate.[30]

This combination of policies has some attributes like those of the limited forms of monetary-fiscal cooperation we considered above. In particular, the overshoot of the inflation target could lead to a higher price level than would otherwise have been expected given the 2 percent inflation target, and the implied negative real interest rate on longer-term government debt should reduce the pressure on fiscal policymakers and make possible a more accommodative fiscal policy than might otherwise be desirable. Indeed, some commentators have suggested that the highly accommodative monetary policy has allowed for more fiscal expansion, and one has even suggested that the policy mix has the "effect of helicopter money."[31] It will be interesting to see if these announced policies will be effective in finally bringing the long period of slow growth and very low inflation in Japan to an end.

To summarize, the historical cases examined here suggest that to make monetary-fiscal cooperation effective the central bank needs to be able to credibly raise the expected price level, but without losing control of the price level. Control could be maintained by a credible commitment to the gold standard over the medium term, as in the United States during and after the Civil War. Even without a gold standard, the central bank may have sufficient credibility to contain inflation expectations, as in the United States after World War II. In addition, a gold standard or other similar commitment device may help to communicate an intended increase in the price level, making the higher price level credible while at the same time limiting expectations of a further rise in prices once the desired level is achieved. However, to keep price expectations anchored after the devaluation, it is likely important that the devaluation be seen by the public as a very unusual event that will not be repeated any time soon. That sort of expectation is probably easier to convey if

[30] See BOJ (2016).

[31] Kihara (2016) quotes Etsuro Honda as saying that BOJ policy "in a sense, ...has the same effect of helicopter money." Such an assessment seems overstated, however, since the BOJ is not explicitly monetizing government borrowing to finance fiscal policy.

the monetary-fiscal cooperation is undertaken in response to extraordinary circumstances, as was the case in France after World War I and Japan in the 1930s. Finally, without a framework for communicating about the future level of prices, it may be very difficult to generate the desired outcome for one of two reasons. First, as in the United Kingdom in the 1960s, if the central bank is not independent and conditions are not extraordinary, then the change in the price level may not be seen as a one-off policy step, but rather as the start of a policy of permanently higher inflation. Alternatively, as in Japan in recent years, an independent central bank with a track record of low and stable inflation may find it difficult to credibly commit to even a temporary increase in inflation above the levels it is believed to prefer, potentially making the cooperative policy relatively ineffective.

5. Concluding Remarks

The simulations in this paper suggest that a money-financed fiscal expansion, if understood and seen as credible by the public, could provide very substantial stimulus. A commitment to use monetary policy to boost nominal currency holdings by enough to finance the fiscal action would increase the effects of the combined action well beyond those of debt-financed fiscal stimulus alone. In particular, the change in monetary policy would increase the expected future price level, and thus reduce real interest rates substantially. However, as discussed above, policymakers may find the economic effects of such a program to be undesirable because of the large (and unpredictable) effects on inflation, and because it would risk unanchoring longer-term inflation expectations that could require costly actions to rectify.

Moreover, making such a change in monetary policy clear and credible – outside of wartime and depressions – would likely be very difficult, and the macroeconomic effects could well prove to be very limited in practice. If monetary policy is constrained by the effective lower bound on the policy rate, the change in monetary policy could not be signaled by a change in the current policy rate, but rather only by unconventional policy steps, such as asset purchases or providing forward guidance regarding future short-term nominal rates. In addition, the announced change in monetary policy might not be time consistent, and policymakers would likely find it very difficult to constrain future monetary policy decisions. Indeed, with central banks having spent considerable time building their reputations for low and stable inflation, the public would probably anticipate that policymakers would not follow through with the announced change in policy once the economy had recovered sufficiently. Moreover, by increasing uncertainty, the announcement of such a radical change in policy could even boost risk premiums and so be counterproductive. And if the change in monetary policy only became credible gradually, as in our model with learning, then the impact of the new policy on the ecoomy would come later, after the economic recovery was well underway, at which point the higher inflation would not offer any benefit. That possibility could further undermine the credibility of the program, since it would likely heighten time-inconsistency problems.

The credibility of the change in monetary policy might be strengthened if such a change were relatively modest – along the lines of the policies considered in section 3.3 – because it would not require a drastic change in the monetary policy framework, with all of the risks that such a change would entail. Such a limited approach would reduce the effects of the change on inflation and so make the policy less time inconsistent, while still supporting the effects of the fiscal action.

Coordinated changes in monetary and fiscal policy could also help to make the change in monetary policy more credible than it would be on its own. Such a coordinated change could be seen as a signal that the authorities were committed to taking bold action to address a persistently weak economy and were willing to accept the consequences. In addition, expansionary fiscal policy, by stimulating output and inflation, would bring forward the date when monetary policy would have tightened in the absence of the associated change in monetary policy. Thus, the fiscal expansion could help make the change in monetary policy visible to the public sooner, enhancing the credibility of the change. Moreover, government action on the fiscal component of the program would allow the government to signal its agreement with the proposed change in monetary policy and acknowledge the higher inflation that it would imply. That signaling might also include an indication that the government anticipates that higher inflation will help keep the debt-to-income ratio in check, which would provide additional support for the credibility of the coordinated change in monetary policy.

Of course, such steps on the part of the government could call into question the independence of the central bank. Indeed, the central bank could, in the future, be pressed to engage in such coordinated policies in situations when they were not warranted (that is, when output is not persistently low, inflation is not below target, and the policy interest rate is not constrained by its effective lower bound). However, even in the extreme case of a money-financed program, it may be possible to develop approaches that would help preserve monetary policy independence. For example, Bernanke (2016) has suggested a "dual key" approach in which the Federal Reserve would authorize the placement of funds in a special account that the Treasury could use to finance spending. However, the Congress would have to authorize the spending of funds in that account. Thus, both the Federal Reserve and the Congress would have to independently agree that a money-financed fiscal program was desirable before it could be undertaken.

A final issue, which we do not try to address here, is the possible international implications of money-financed fiscal programs. In particular, some recent research suggests that when monetary policy is constrained by the effective lower bound, more accommodative policy in one economy may have adverse implications for other economies through its effects on exchange rates and trade.[32] Thus, implementation of a money-financed fiscal program in one country could hurt its trading partners and potentially lead to the implementation of such programs in those economies as well.

[32] See, for example, Caballero, Farhi, and Gournchas (2016) and Eggertson, Mehtotra, Singh, and Summers (2016) for a discussion of the international implications of monetary policy at the lower bound.

Such an outcome would not be undesirable in some circumstances, but given the possible spillovers, it might be appropriate to consult with policymakers in other jurisdictions before implementing such a program. Doing so could help to avoid disorderly outcomes in foreign exchange markets.

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Figure 1. Rise in Government Spending

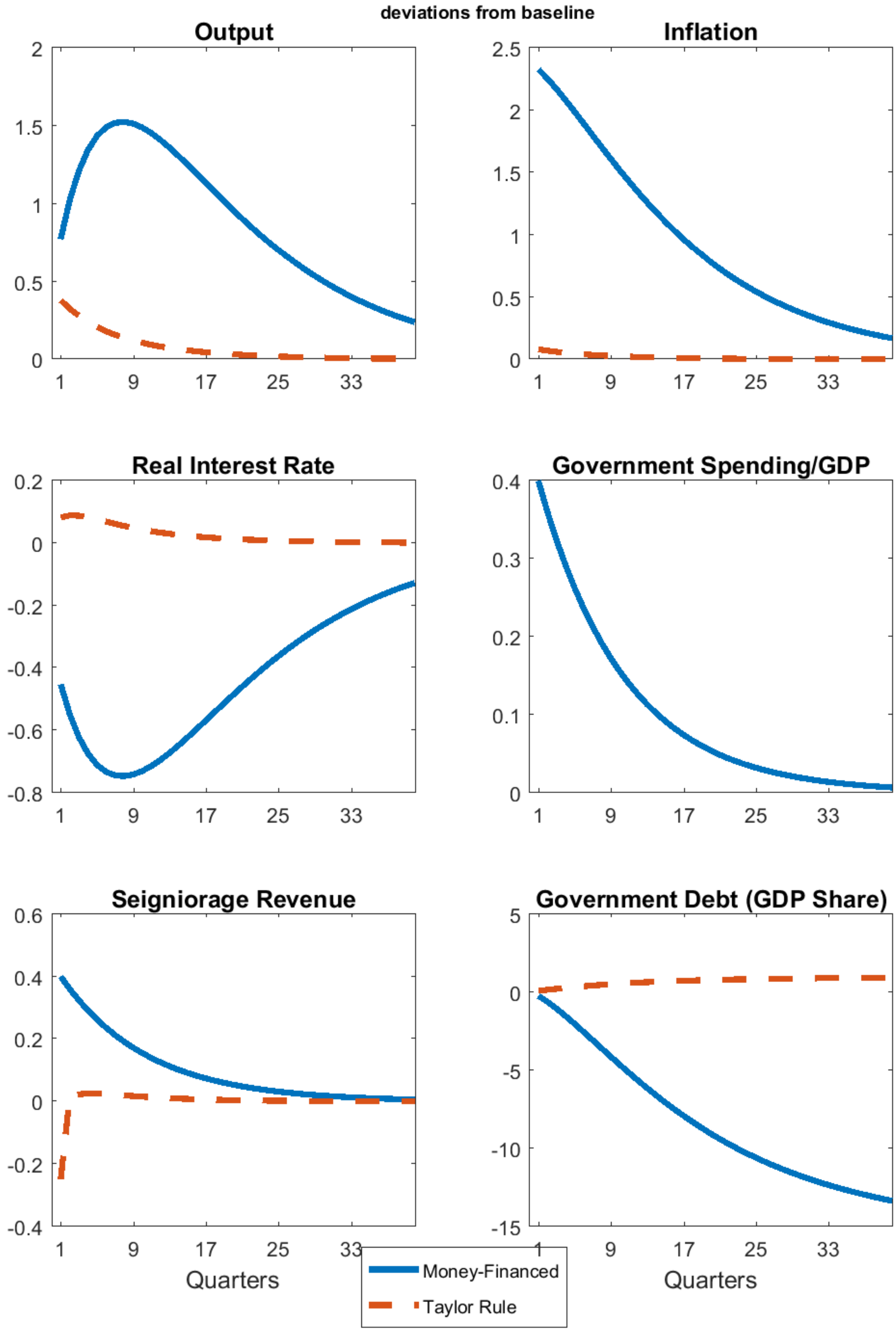

Figure 2: Rise in Government Spending in Liquidity Trap

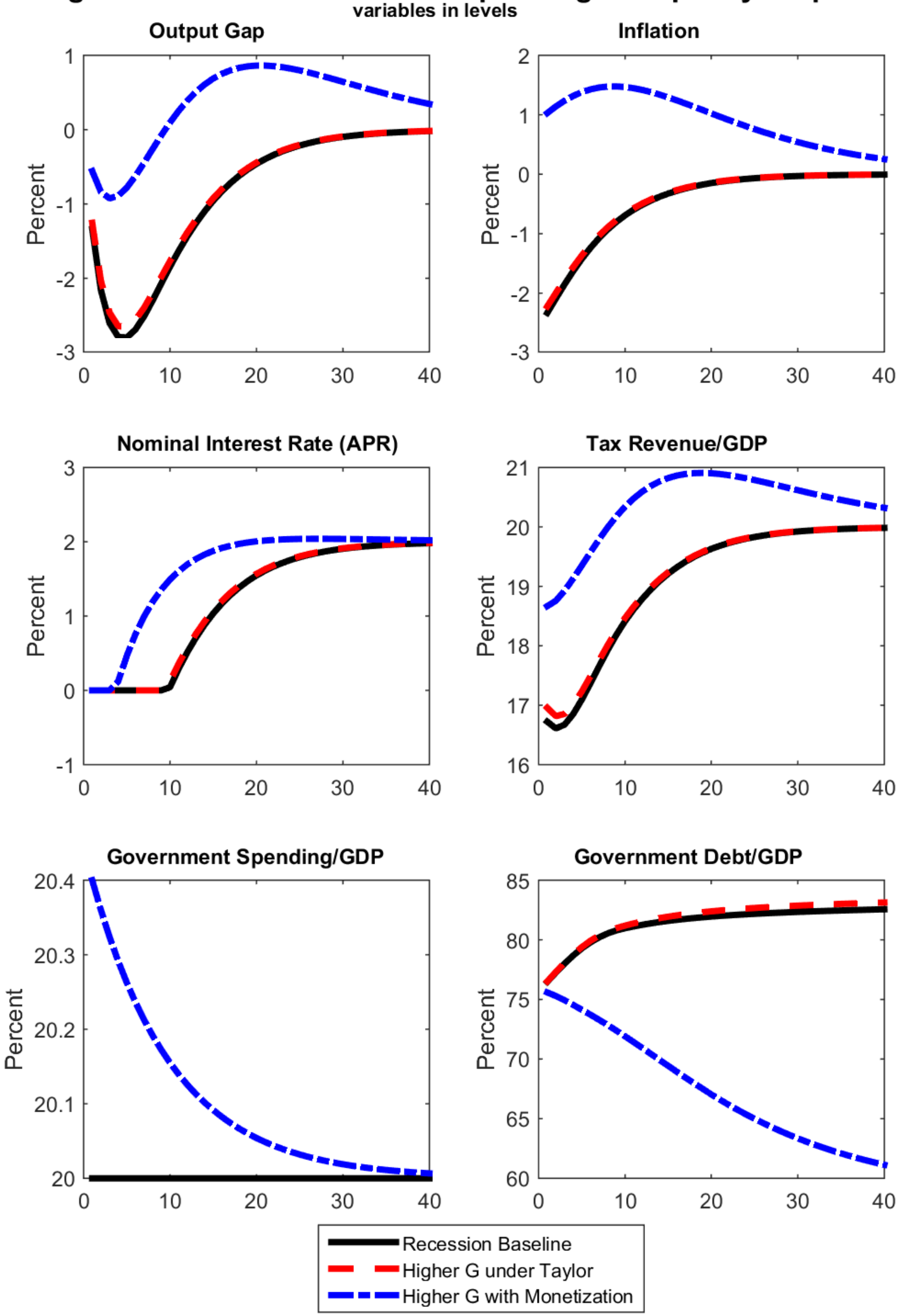

Figure 3. Causes of High Multiplier under Monetization

deviations from baseline

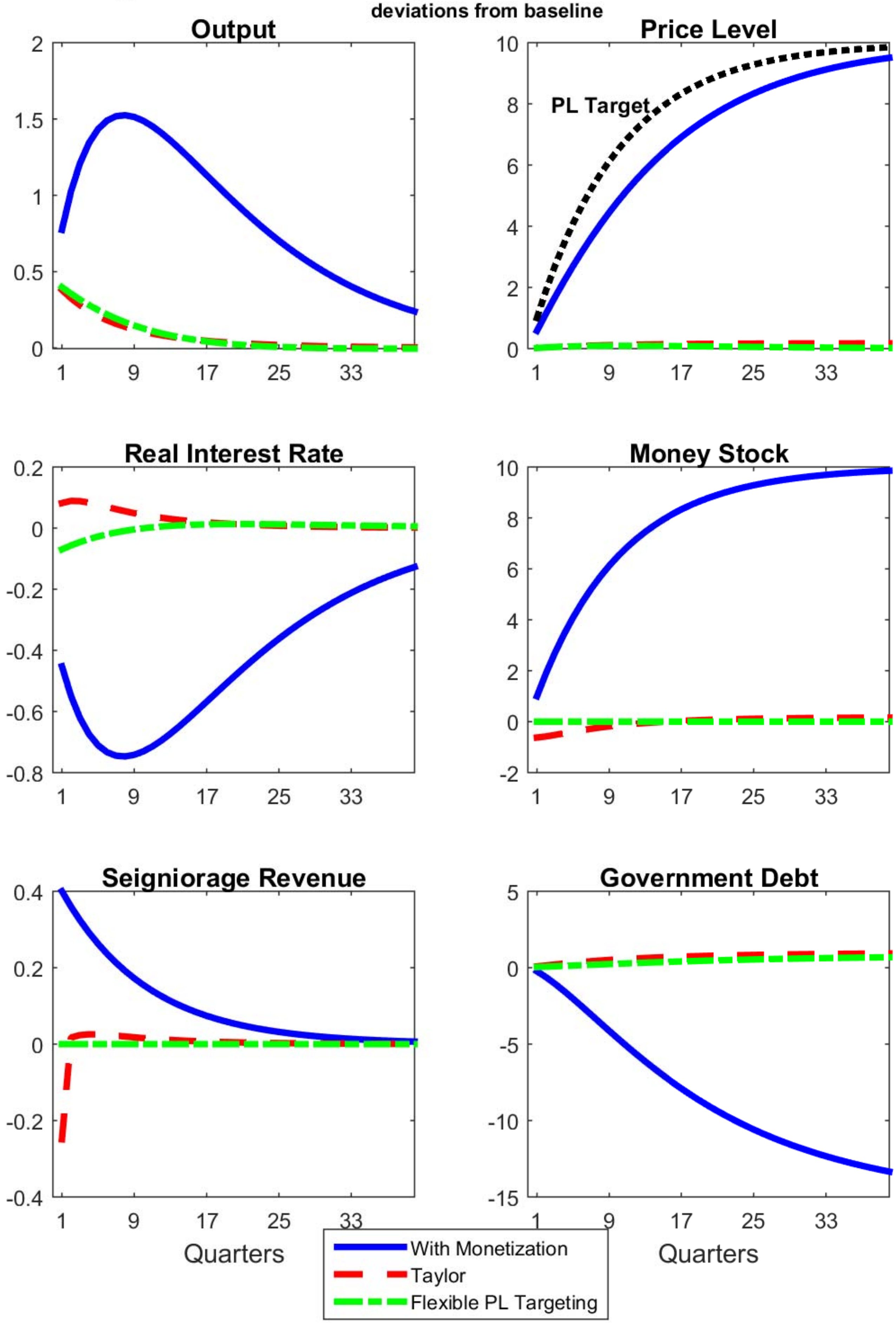

Figure 4. Money-Financed Rise in Govt Spending: Role of Money Demand

deviations from baseline

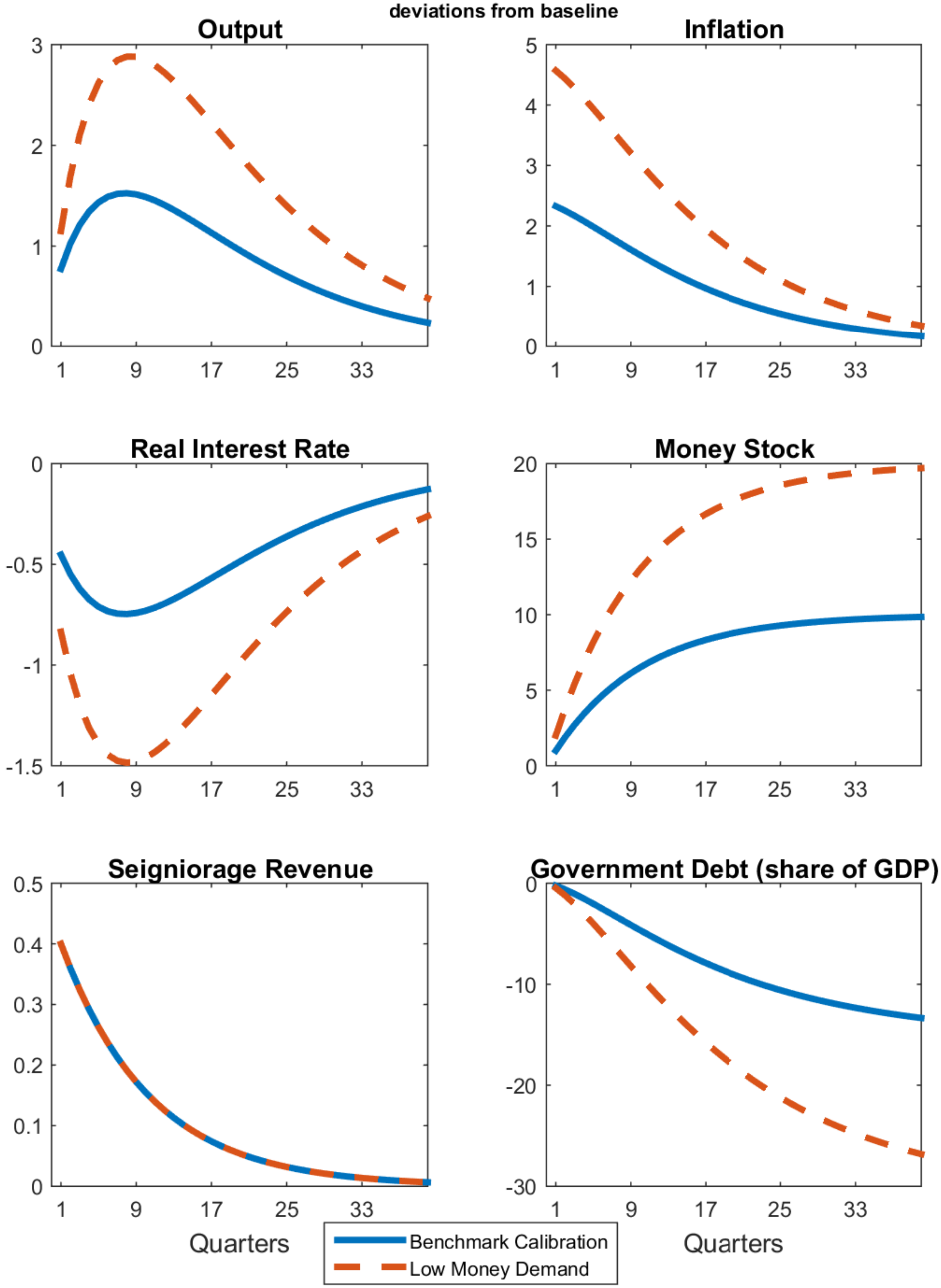

Figure 5. Money-Financed Rise in Govt Spending: Steeper Phillips Curve

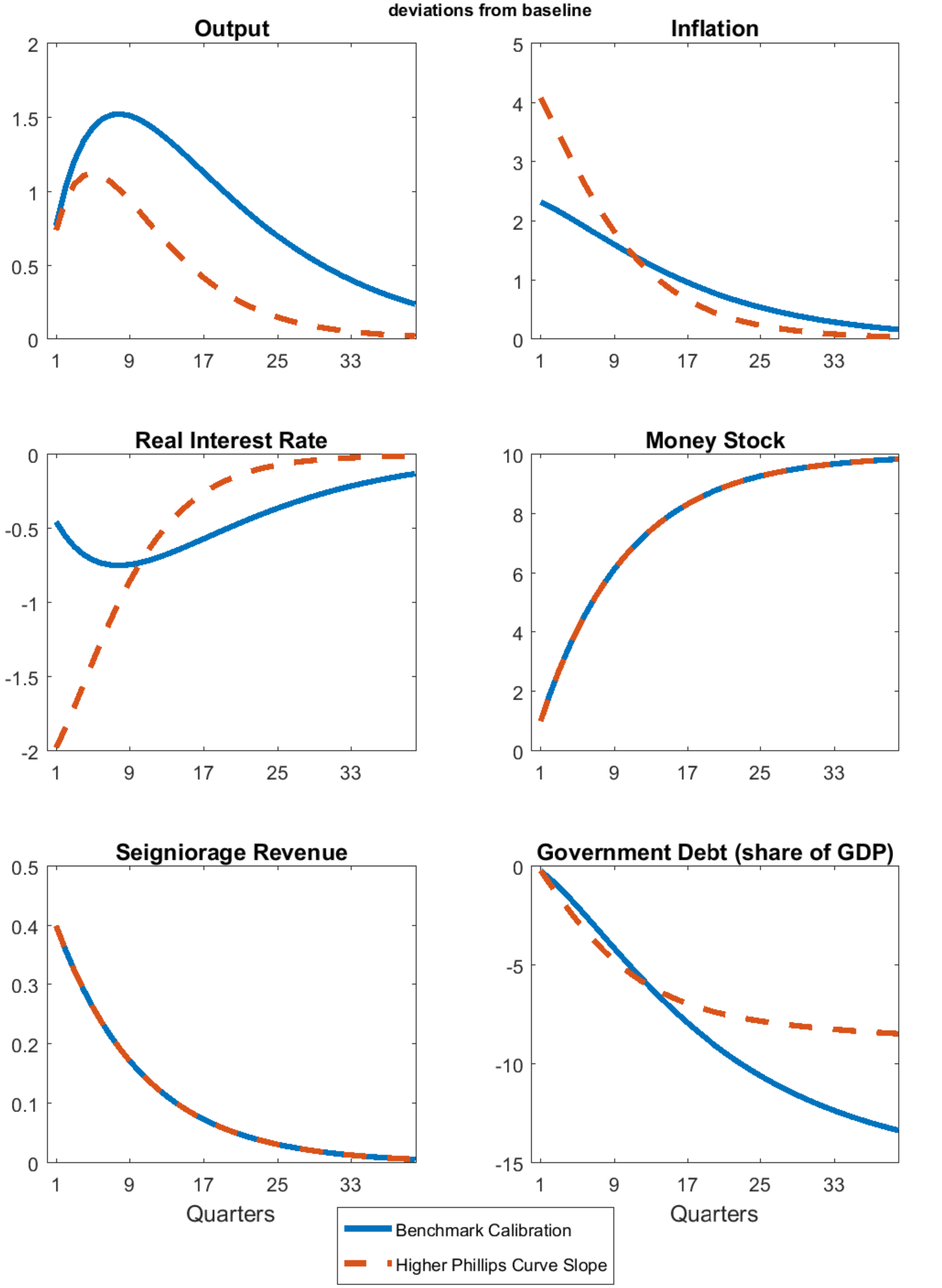

Figure 6. Government Spending with Monetization but Varying Credibility

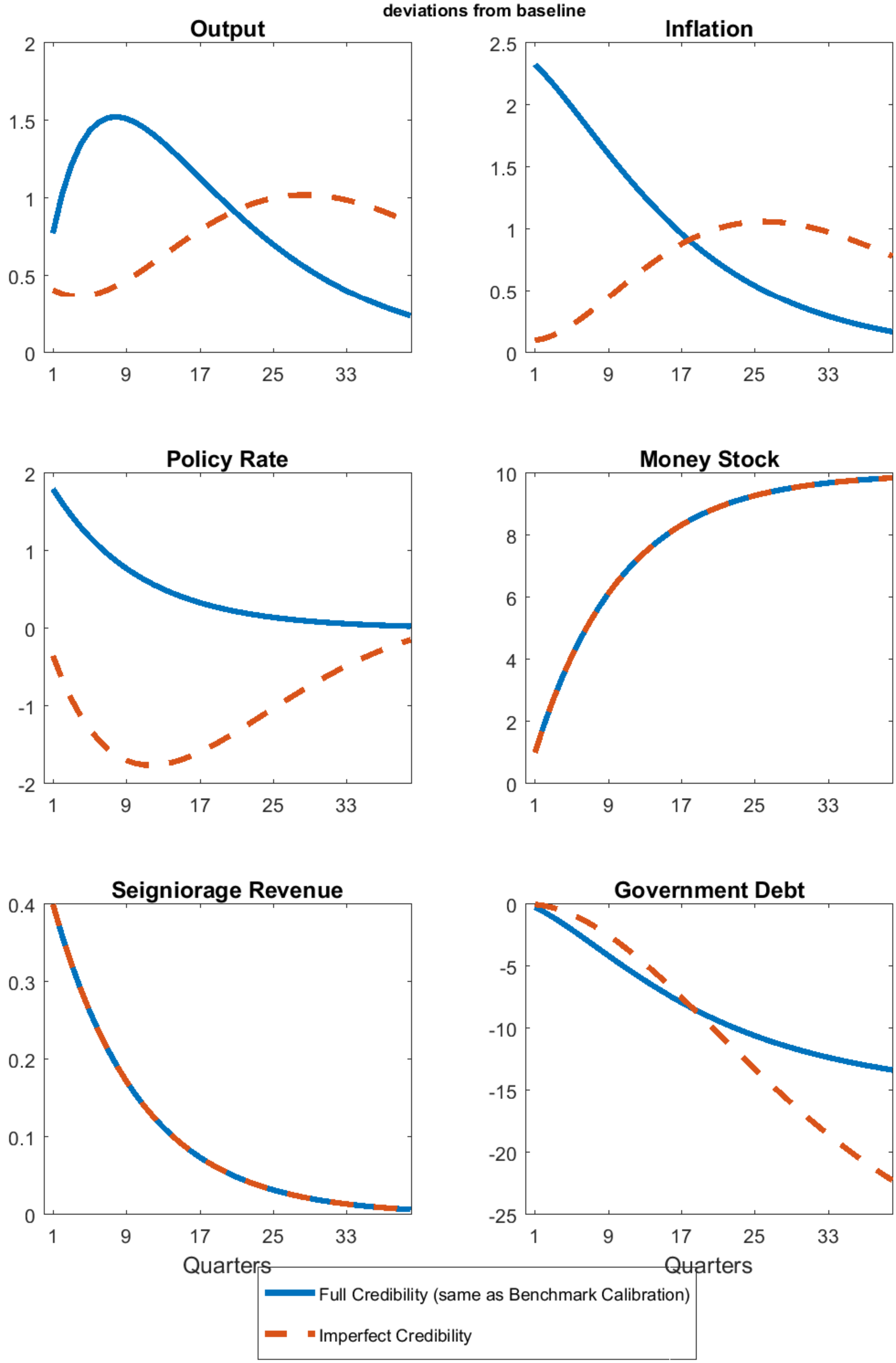

Figure 7. Rise in Government Spending: Less Forward-Looking

deviations from baseline

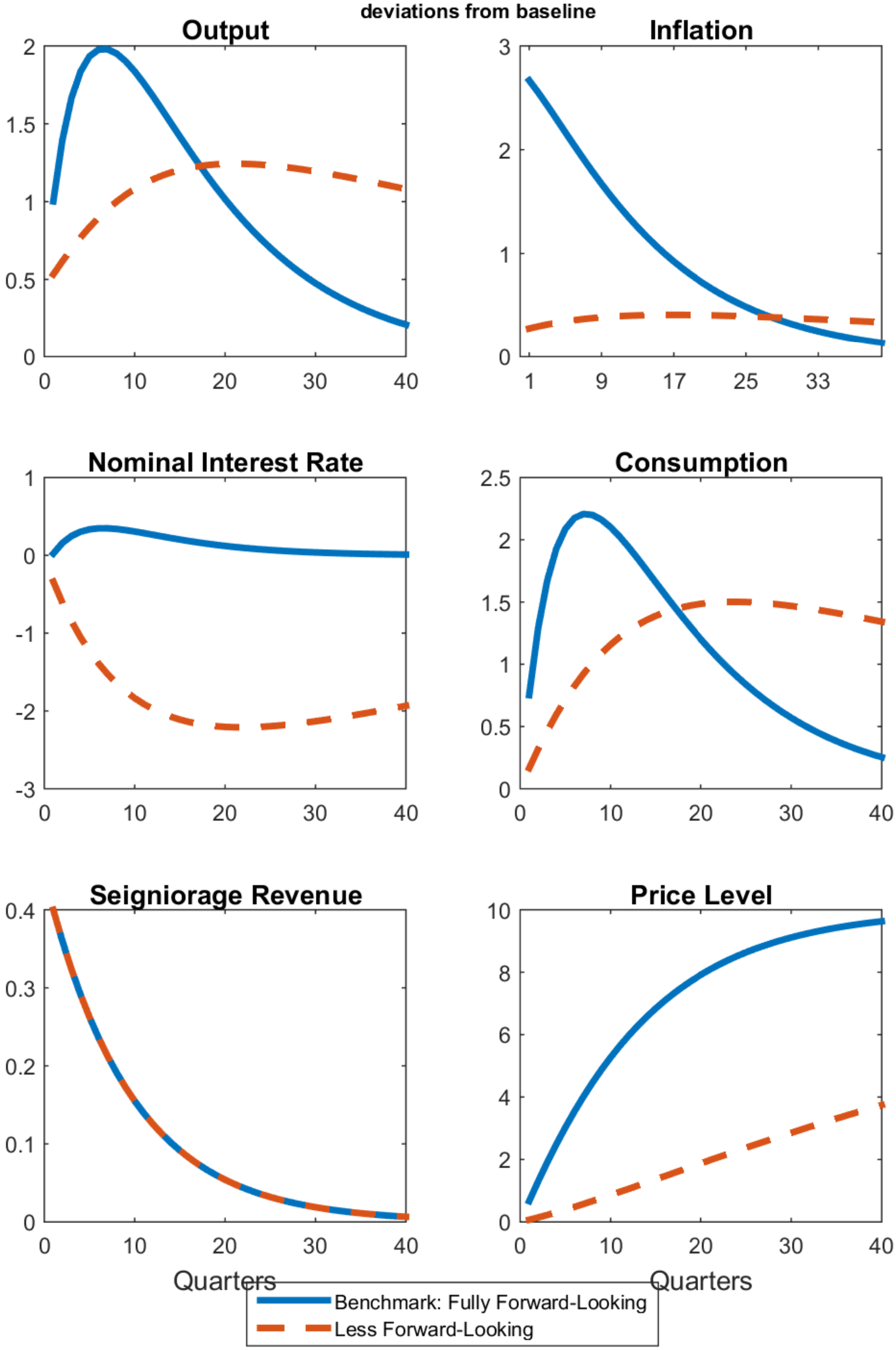

Figure 8. Monetary Expansion with ZLB: Less Forward-Looking

deviations from baseline

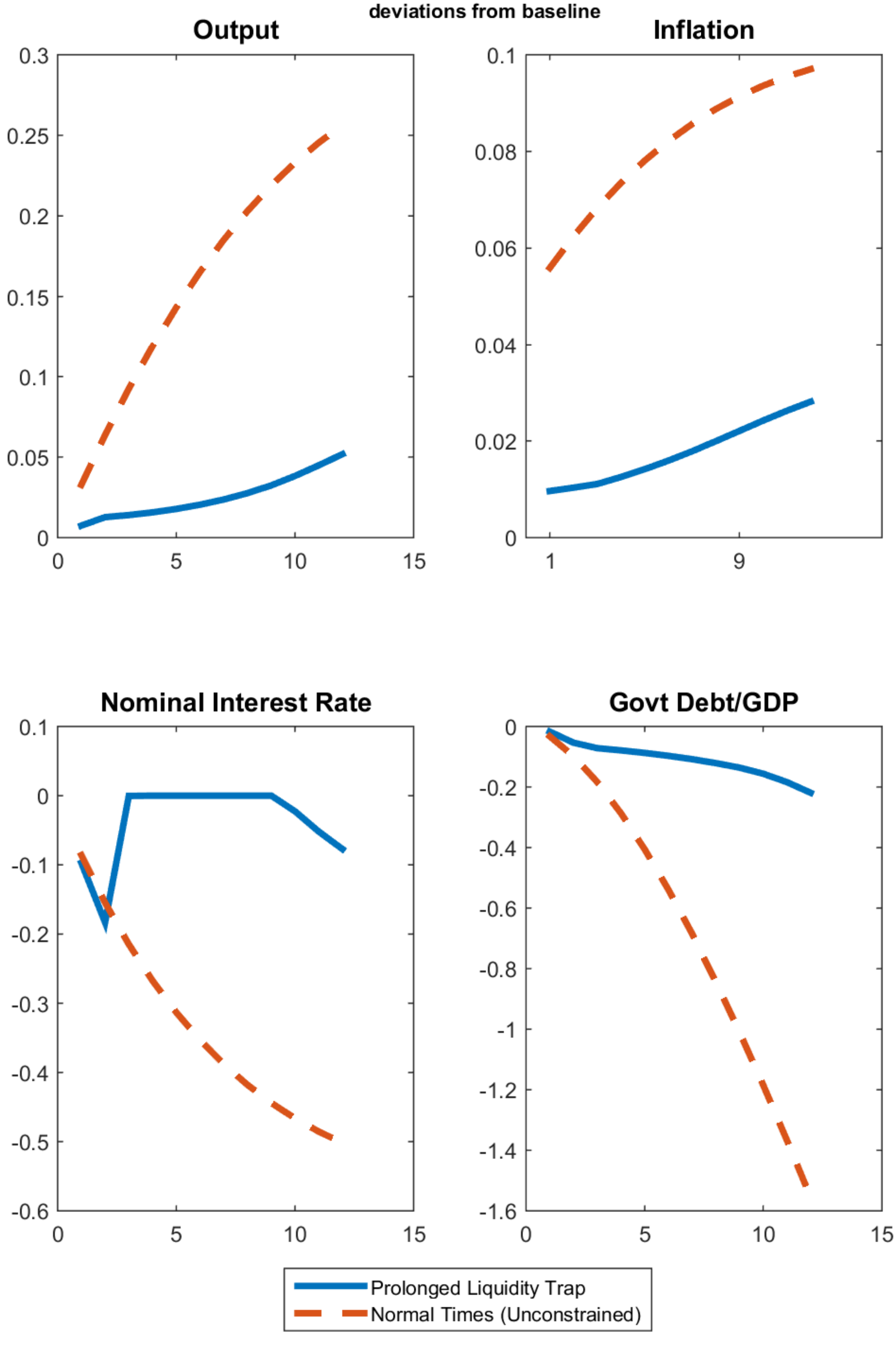

Figure 9. Monetary Expansion in Liquidity Trap