Is monetary financing a valuable alternative to debt financing in response to fiscal stimuli?

Marco Lorusso[*] Francesco Ravazzolo[†] Claudia Udroiu[‡]

April 20, 2024

Abstract

The unprecedented increase in US sovereign debt has gained attention among policymakers. In this paper, we investigate the use of money supply issued by the central bank to support expansionary fiscal interventions. To do so, we develop and estimate a New Keynesian model using US data for the sample period 1960Q1 - 2019Q4. Then, we conduct a quantitative counterfactual analysis to assess the effects of a fiscal stimulus that does not result in an increase in public debt, as it is financed by money supply. Our impulse response analysis indicates that both increases in monetary-financed government spending and monetary-financed transfers have positive economic effects on private consumption and investment, as well as output. However, the expansionary impact of monetary-financed fiscal shocks comes at a cost: an increase in inflation. Additionally, we divide the sample into two sub-periods and find that the impact of a monetary-financed fiscal stimulus stays positive, but its magnitude varies according to the estimation sub-period. Lastly, we observe that as the debt-to-GDP ratio increases, the positive effects of a monetary-financed fiscal stimulus diminish.

Keywords: Fiscal Policy, Monetary Policy, Bayesian Estimation

JEL Codes: C11, E32, E52, E62

[*]University of Perugia, Newcastle University Business School
[†]Free University of Bozen-Bolzano, BI Norwegian Business School
[‡]Free University of Bozen-Bolzano

1 Introduction

After the Global Financial Crisis (GFC), central banks worldwide have undertaken various measures to boost economic activity. This included reducing interest rates to historically low levels and implementing policies aimed at facilitating lending procedures, both to businesses and financial institutions. One of these monetary policy tools is Quantitative Easing (QE), which involves substantial investments through asset-purchasing programs to inject liquidity into the financial system and support the economy. Concurrently, governments have implemented significant fiscal stimulus packages with increases in government spending, tax cuts and an increase in lump-sum transfers to boost aggregate demand. However, these fiscal measures have left major economies, particularly the United States, with record-high levels of public debt. High levels of public debt and public debt-to-GDP have raised growing concern among scholars and policy-makers about negative effects on the economy.[1] Furthermore, while QE helps mitigating the adverse effects of a crisis, it does not prevent a further increase in public debt. An alternative way to enhance liquidity and support economies while also maintaining control over the level of public debt is through the financing of fiscal programs via the issuance of money supply. This paper contributes to the growing interest in fiscal sustainability and specifically, in the financing of fiscal stimuli, in that it provides additional quantitative evidence on the economic impact of monetary-financed fiscal stimuli (Reichlin et al., 2013; Giavazzi and Tabellini, 2014; English et al., 2017; Di Giorgio and Traficante, 2018; Galí, 2020a; Punzo and Rossi, 2023).

Figures 1, 2a and 2b show the evolution of percent changes in US government spending and government transfers from the previous year during the NBER recessions from 1960Q1 until 2019Q4.[2] In particular, graphs on the left part of Figure 1 report the evolution of government spending in relation to the evolution of public debt measured two periods later.

[1]For example, Checherita-Westphal and Rother (2012) find a non-linear relationship between public debt-to-GDP and economic growth in the Euro Area. The authors find a turning point after which the level of public debt has a negative impact on economic growth at 90-100% of GDP. Cecchetti et al. (2011) conduct an analysis about the effects of public debt on economic growth on 18 OECD countries. They find that the threshold beyond which the level of public debt has negative implications on the economy is equal to 85% of GDP.

[2]The recession dates can be found at: https://www.nber.org/research/data/us-business-cycle-expansions-and-contractions.

Graphs on the right part of the figure show the relationship between government spending and money supply. Figure 2a and 2b show the same comparison for the evolution of transfers. We only choose periods of fiscal stimuli (increases in government spending and/or government transfers) during the recessionary time.[3] The graphs show that during all recessions when there was an increase in government spending or transfers, that fiscal stimulus exhibited a similar trend to the evolution of public debt. A notable exception is the 1960 recession, a period previously described in literature as a regime of passive monetary and active fiscal policy (Leeper, 1991; Davig et al., 2006; Davig and Leeper, 2011; Bianchi and Melosi, 2019; Ascari et al., 2023). These graphs show that during recessionary periods, US fiscal stimuli have been financed through an increase in public debt. On the other hand, in all cases, except for the 1960 recession, the fiscal stimulus and the money supply do not exhibit any evident co-movement, suggesting no relationship between them. In response to these episodes, several works (Reichlin et al., 2013; Turner, 2013, 2015, 2017; Giavazzi and Tabellini, 2014; Galí, 2020a) have asked whether the US central bank could have expanded its monetary policy toolkit to include monetary finance (i.e., the financing of government spending and transfers via money creation) rather than increasing public debt.

In this paper, we aim to answer this question by proposing and estimating a medium-scale New Keynesian model in the spirit of Del Negro et al. (2007), Smets and Wouters (2007), Christiano et al. (2011). Our model includes nominal and real rigidities as well as several demand and supply disturbances to the economy. Among the exogenous shocks, we consider a government spending shock and a government transfers shock. We estimate our model with Bayesian techniques for the sample period 1960Q1 - 2019Q4 using US macroeconomic aggregate data. Then, we proceed with a counterfactual analysis that employs the estimated parameters obtained with our model. To conduct this analysis, we extend the same model to incorporate a "monetary-financing" component. Within this framework, the central bank accommodates fiscal policy and shifts its emphasis from setting the interest rate to controlling the money supply. This framework is similar to the one proposed by Galí (2020a), in which

[3] During the 1970, 1981 and 1990 recessions only changes in transfers exhibited an upward trend, while the same was true for government spending during the 2001 recession. During all other periods, both fiscal stimuli experienced an increase. Finally, we exclude the 1980 recession, spanning from 1980Q1 until 1980Q3, as neither fiscal stimulus was implemented during this period.

the money supply is determined endogenously and used to finance fiscal stimuli.

Although we follow the framework in Galí (2020a), our analysis differs in three main aspects through which we contribute to the literature. Firstly, our model is estimated over the period 1960Q1 - 2019Q4. Secondly, we estimate the model for two sub-periods, from 1960Q1 to 1979Q2 and from 1984Q1 to 2007Q2. We select these time samples following Ascari et al. (2023) to distinguish between periods characterized as fiscally-led and monetary-led. Lastly, we conduct a counterfactual analysis to examine the quantitative impact of a monetary-financed fiscal stimulus on macroeconomic aggregates, compared to a debt-financed fiscal stimulus.

Through our impulse response analysis, we find that this alternative strategy has expansionary effects on the economy. In particular, monetary-financed fiscal stimuli make a positive contribution to consumption and investment, while the level of public debt is maintained unchanged. Moreover, the estimations for the sub-periods reveal that during the period from 1984Q1 to 2007Q2, a monetary-financed fiscal stimulus would have had a greater positive impact on the economy compared to the sub-period from 1960Q1 to 1979Q2. As an additional analysis, we focus on the relevance of the level of public debt-to-GDP and its implications for the economic impact of fiscal stimuli. Our analysis indicates that while the effect of monetary-financed fiscal stimuli on the economy remains positive, the magnitude of the impact diminishes as the level of public debt-to-GDP increases.

Our results show that, as expected, the expansionary impact of a monetary-financed fiscal stimulus comes at a cost, which is an amplified increase in inflation compared to the scenario in which the fiscal stimulus is debt-financed. Monetary-financing has raised concerns regarding the potential consequences of hyperinflation (Sargent and Wallace, 1973). However, given the increased credibility and independence of central banks in developed countries, Cukierman (2020) argues that the risk of hyperinflation may be of lesser concern nowadays. Indeed, past instances of hyperinflation resulting from the monetization of public spending occurred during periods when central banks and governments were not separate entities. English et al. (2017) explain that in case of a monetary-financed program, the central bank can still maintain its independence. An example is given by the "dual key" approach suggested by Bernanke (2016). In this case, the Federal Reserve would authorize the placement of funds in an account that the Treasury could use to finance spending. However, the Congress would have to authorize the use of those funds. This dual approach would ensure that the central bank maintains its independence.

The remainder of the paper is structured as follows. Section 2 presents a literature review on public debt, the interactions between monetary policy and fiscal policy, and monetary-financing. Section 3 describes the theoretical model. Section 4 discusses the estimation results. Section 5 shows simulation results for a comparison of a scenario in which a fiscal stimulus is debt-financed and a scenario in which a fiscal stimulus is monetary-financed. Section 6 provides robustness analyses. Section 7 concludes.

2 Literature review

Our paper contributes to various strands of literature. One is the literature about the adverse consequences of high levels of public debt. Within this body of literature, some studies focus on the analysis of fiscal multipliers. For instance, Ilzetzki et al. (2013) find that in countries with levels of public debt-to-GDP higher than 60%, fiscal multipliers are smaller compared to countries with lower debt-to-GDP ratios, and tend to become negative in the long-run. Huidrom et al. (2020) show that the magnitude of the fiscal multiplier is influenced by the level of public debt. The authors explore two channels through which this occurs: the Ricardian equivalence channel and the interest rate channel. Other papers analyse the negative implications of high levels of public debt on GDP growth and identify thresholds of debt-to-GDP ratios beyond which public debt affects the economy negatively (Checherita-Westphal and Rother, 2012; Cecchetti et al., 2011).

Our paper also contributes to the literature that focuses on the financing components of public debt. Hall and Sargent (2011) show that the decrease in debt-to-GDP from 1945 until 2009 was mainly driven by economic growth, followed by primary surpluses and inflation. Das (2021) disentangles fiscal financing components distinguishing between fiscally-led and monetary-led policy regimes. The author identifies inflation, the growth rate and the primary surplus/deficit as significant factors affecting debt-to-GDP ratios during the fiscally-led regime.

Our paper contributes to the literature about the interactions between monetary policy and fiscal policy. Notably, seminal studies by Sargent et al. (1981), Leeper (1991), Sims (1994), Schmitt-Grohé and Uribe (2000) and Davig and Leeper (2011), among others, investigate the implications of the fiscal-monetary policy mix on various macroeconomic aggregates. Furthermore, Mertens and Ravn (2014) and Bianchi et al. (2020) examine the collaborative nature of monetary and fiscal policies as an effective tool for mitigating the adverse effects of both economic and non-economic shocks.

Given the relevance of high levels of public debt, another strand of literature explores the use of money supply as a fiscal financing alternative and analyses its impact on the economy.

The concept of a "monetary-financed fiscal stimulus" has gained growing consensus among scholars, particularly due to its positive impact on the economy.[4] Benigno and Nisticò (2022) highlight the ongoing debate among academics and policymakers, suggesting that cooperation between governments and central banks could lead to effective measures to mitigate the adverse consequences of unexpected crises. In a VoxEU article, Giavazzi and Tabellini (2014) propose a cooperative policy measure to address the lack of aggregate demand in the EU. The policy measure involves implementing a tax cut financed by the issuance of long-term government debt, that would be purchased by the central bank. The central bank would refrain from neutralizing the increased liquidity injected into the market, and the interest on debt would be paid to the central bank's shareholders as seigniorage. Galí (2020b) proposes to focus on the account the government holds at the central bank. Under this proposal, the central bank would transfer funds to the government's account to finance a emergency fiscal programs. However, the use of monetary-financing should typically be reserved for extreme circumstances when public debt levels are already high. Bernanke (2016) suggests the establishment of a new government account at the central bank, exclusively for emergency situations.

In all cases, when the central bank engages in monetary financing of the public debt, the money supply increases permanently.[5] Bernanke (2003) emphasizes the importance of making

[4]Bernanke (2003) and Buiter (2014) refer to the monetary-financed lump-sum transfers to households financed by newly printed money using Milton Friedman's terminology "Helicopter money".

[5]It is worth noting that this distinguishes monetary financing from QE, which has only a temporary impact on the monetary base.

sure that "much or all of the increase in the money stock is viewed as permanent" (Bernanke, 2003, p.7). The use of money supply to finance a fiscal stimulus through a permanent increase in the monetary base makes it possible to address the issue of Ricardian equivalence that undermines the efficiency of fiscal stimuli. Woodford (2012) and Turner (2015) demonstrate that during times of aggregate demand disruptions, monetary financing would stimulate aggregate demand to a greater extent compared to debt financing. Punzo and Rossi (2023) analyse the redistribution channel of a monetary-financed fiscal stimulus in a two-agent framework. They find positive effects on the economy, but an increase in the consumption gap between the two types of agents. Finally, Okano and Eguchi (2023) find even more positive effects of a monetary-financed fiscal stimulus in a small open economy framework experiencing a liquidity trap, compared to a closed economy.

Giavazzi and Tabellini (2014) and Turner (2015) explain that monetary financing can be criticized from a political point of view. They argue that the use of this policy may be misleading and lead to its excessive and unwarranted utilization. Turner (2015) further argues that the monetary-financing policy is desirable under all circumstances, and the only obstacle lies in addressing limitations from a policy perspective. Once these limitations are overcome, the monetary-financing policy can become the optimal approach to stimulate aggregate demand when needed.

Our quantitative analysis contributes to the existing literature on monetary-financed fiscal stimuli, specifically in the context of US data. By conducting an analysis of the use of money supply to finance fiscal stimuli, we provide insights into the potential implications and outcomes of such a policy approach.

3 Theoretical model

In this section, we present the theoretical model. The structure of the model is in line with standard medium-scale new Keynesian models (see, for example, Smets and Wouters, 2007; Christiano et al., 2005; Del Negro and Schorfheide, 2008; Leeper et al., 2017).

The economy is populated by a continuum of households that provide labour and capital services to intermediate firms and obtain dividends from them. The representative household makes consumption decisions as well as capital accumulation decisions. We assume that it trades a riskless one-period government bond. Labour is differentiated across households, so that there is some monopoly power over wages that results in an explicit wage equation and allows for the introduction of Calvo sticky nominal wages. The representative household receives lump-sum transfers from the government.

Moreover, we include monopolistically competitive intermediate firms. These firms hire labour and rent capital from households, produce intermediate goods and set prices à la Calvo. The final good, which is then sold to households, is produced and packed by a final good firm. Additionally, we assume partial indexation of prices and wages to past inflation rates.

We consider a central bank that sets its policy rate following a Taylor-type interest-rate rule (Taylor, 1993). Moreover, the central bank supplies the money demanded by the household to support the desired nominal interest rate.

Since the focus of our work is on the alternative ways of fiscal stimuli financing, we consider two scenarios. In the traditional debt-financed scenario, the expansionary fiscal policy is financed through the issuance of government bonds. In the monetary-financed scenario, an increase in government spending or transfers is financed through a rise in money supply. We estimate the model under the debt-financed scenario, and with the estimated parameter values we run a simulation of the model under the monetary-financed scenario. This allows us to provide a counterfactual analysis of a monetary-financed fiscal stimulus and compare the impulse response functions derived from both scenarios.

3.1 Households

The utility of the representative household depends positively on consumption and real money balances, whereas it depends negatively on labour supply. The objective function for household $j \in [0,1]$ is given by:

$$\max_{C_t(j), \frac{M_t(j)}{P_t}, L_t(j)} \mathbb{E}_t \Bigg\{ \sum_{t=0}^{\infty} \beta^t b_t \Bigg[\Bigg(ln\left(C_t(j) - hC_{t-1}(j)\right) + \frac{\chi_t}{1-\nu_m} \left(\frac{M_t(j)}{P_t} \right)^{1-\nu_m} \Bigg) - \frac{L_t(j)^{1+\nu_l}}{1+\nu_l} \Bigg] \Bigg\} \tag{1}$$

where C_t, $\frac{M_t}{P_t}$, L_t represent consumption, real money balances and labour, respectively. β_t is the discount factor, b_t represents an intertemporal preference shock to the household's utility function and h is a parameter that measures the degree of external habit formation in consumption. Moreover, χ_t is a preference shifter that affects the marginal utility of money holdings. We assume that b_t and χ_t follow the exogenous processes:

$$ln\, b_t = \rho_b\, ln\, b_{t-1} + \sigma_b\, \epsilon_{b,t}, \text{with}\, \epsilon_{b,t} \sim N(0,1) \tag{2}$$

$$ln\, \chi_t = \rho_m\, ln\, \chi_{t-1} + \sigma_m\, \epsilon_{m,t}, \text{with}\, \epsilon_{m,t} \sim N(0,1) \tag{3}$$

Following Del Negro and Schorfheide (2008) and Punzo and Rossi (2023), we assume that consumption and real money balances enter the household's objective function in a separable way.

The nominal budget constraint faced by the representative household is given by:

$$\begin{aligned} &P_tC_t(j) + P_tI_t(j) + B_t(j) + M_t(j) \\ &\leq R_{t-1}B_{t-1}(j) + M_{t-1}(j) + R_t^k K_{t-1}(j) + W_tL_t(j) + P_tD_t + P_tT_t(j) \end{aligned} \tag{4}$$

where P_t indicates the price level, B_t denote government bonds, while R_t is the gross nominal return of government bonds. I_t represents the private investment and K_t are units of capital. W_t denotes the wage rate earned by the household, R_t^k is the rental rate and D_t are the firm's dividends that the household receive. We also assume that households receive transfers T_t from the government.

The equation for capital accumulation is given by:

$$K_t(j) = (1-\delta)\,K_{t-1}(j) + \mu_t\left(1 - S\left(\frac{I_t(j)}{I_{t-1}(j)}\right)\right) I_t(j) \tag{5}$$

where $S(\cdot)$ is a function that represents the investment adjustment costs, with $S''(\cdot) > 0$, while δ is the depreciation rate of capital. Finally, μ_t represents an exogenous process to investment, and evolves as:

$$ln\,\mu_t = \rho_\mu ln\,\mu_{t-1} + \sigma_\mu\,\epsilon_{\mu,t}, \text{with}\,\epsilon_{\mu,t} \sim N(0,1) \tag{6}$$

Additionally, each household supplies $L(j)$, a differentiated form of labour, to labour packers. Labour packers are perfectly competitive firms that hire labour from the households and combine it into labour services, L_t. These labour services are then offered to the intermediate firms.

3.2 Final good firms

Final good firms operate in a perfectly competitive market and produce a homogeneous good, Y_t. These firms buy $Y_t(i)$, that are goods produced by intermediate firms and pack and sell Y_t to households. The aggregation technology of the final good firm is given by:

$$Y_t = \left[\int_0^1 Y_t(i)^{\frac{1}{1+\lambda_t^p}}\,di\right]^{1+\lambda_t^p} \tag{7}$$

where λ_t^p is a markup shock following the process:

$$ln\,\lambda_t^p = \rho_\pi\,ln\,\lambda_{t-1}^p + \sigma_\pi\,\epsilon_{\lambda^p,t}, \text{with}\,\epsilon_{\lambda^p,t} \sim N(0,1) \tag{8}$$

The cost minimization problem yields the downward-sloping demand for each intermediate input:

$$Y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\frac{1+\lambda_t^p}{\lambda_t^p}} Y_t \tag{9}$$

where $P_t(i)$ is the price of the intermediate good, while P_t indicates the price of the final good. Perfect competition in the final good sector implies that P_t is given by:

$$P_t = \left[\int_0^1 P_t(i)^{-\frac{1}{\lambda_t^p}} \, di\right]^{-\lambda_t^p} \tag{10}$$

3.3 Intermediate good firms

Each intermediate good is produced by an intermediate good firm (i) that combines capital, K_t and labour, L_t through the following technology:

$$Y_t(i) = A_t^{1-\alpha} K_t(i)^\alpha L_t(i)^{1-\alpha} \tag{11}$$

where A_t indicates an exogenous component to total factor productivity following the process:

$$ln\, A_t = \rho_z \, ln\, A_{t-1} + \sigma_z \epsilon_{z,t}, \; \epsilon_{z,t} \sim N(0,1)$$

All firms face the same prices for their labour and capital inputs. Therefore, profit maximization implies that the capital-to-labour ratio is the same for all firms:

$$\frac{K_t(i)}{L_t(i)} = \frac{\alpha}{1-\alpha} \frac{W_t}{R_t^k} \tag{12}$$

We also assume that intermediate good firms adjust their prices in a sticky way, due to staggered prices à la Calvo. Finally, we allow for partial indexation to the past inflation rate.

3.4 Monetary policy

As mentioned above, the monetary authority sets up the nominal interest rate R_t following a Taylor-type interest-rate rule (Taylor, 1993). As in Del Negro et al. (2007) this implies that the policy rate is adjusted according to changes in inflation and output.

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\phi_r} \left[\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi} \left(\frac{Y_t}{Y}\right)^{\phi_y}\right]^{1-\phi_r} e^{\lambda_t^r} \tag{13}$$

where R is the steady-state nominal interest rate, π is the steady-state inflation, and Y represents steady-state inflation. ϕ_π is the weight of inflation on the interest rate, ϕ_y is the weight of output on the interest rate, while ϕ_r captures the degree of interest rate smoothing. Finally, λ_t^r is a monetary policy shock and it is assumed to follow the exogenous process:

$$ln\,\lambda_t^r = \rho_r\, ln\,\lambda_{t-1}^r + \sigma_r \epsilon_{r,t},\ \epsilon_{r,t} \sim N(0,1)$$

3.5 Fiscal policy

The government budget constraint is given by:

$$P_t G_t + P_t T_t + R_{t-1} B_{t-1} = B_t + \Delta M_t \tag{14}$$

where G_t represents government spending and $\Delta M_t = M_t - M_{t-1}$.

Transfers follow a fiscal rule, that we build following Leeper et al. (2010). The fiscal rule is the following:

$$\frac{T_t}{T} = \left(\frac{B_{t-1}}{B}\right)^{-\psi_{bt}} \left(\frac{Y_t}{Y}\right)^{-\psi_{yt}} e^{t_t} \tag{15}$$

where T represents the steady-state level of transfers, B is the steady state level of public debt, ψ_{bt} is the transfers' response to public debt in $t-1$, ψ_{yt} is the transfers response to the level of output, and t_t is a stochastic component to transfers and it is assumed to follow the process:

$$ln\,t_t = \rho_t\, ln\,t_{t-1} + \sigma_t \epsilon_{t^*,t},\ \epsilon_{t^*,t} \sim N(0,1) \tag{16}$$

The government spending shock follows the exogenous process:

$$ln\,g_t = \rho_g\, ln\,g_{t-1} + \sigma_g \epsilon_{g,t},\ \epsilon_{g,t} \sim N(0,1) \tag{17}$$

We estimate our model with the fiscal policy block as outlined above. In Section 5 we will use the obtained estimated parameters to calibrate a modified version of the model, in which the increase in transfers and government spending are monetary-financed. This will be the monetary-financed scenario.

3.6 Market equilibrium

The final goods market is in equilibrium if the firms' production equals the demand of the household for consumption, investment and government spending.

$$Y_t = C_t + I_t + G_t \tag{18}$$

4 Estimation results

In this section, we describe the data and the estimation technique used to estimate the theoretical model. We then discuss how we estimate the endogenous parameters and the exogenous processes related to the structural shocks. Finally, we present the main estimation results.

4.1 Data and estimation technique

We use quarterly data for nine time series publicly available on the Economic Data website of the Federal Reserve Bank of St. Louis over the sample period 1960Q1 - 2019Q4.[6]

The observed variables are real output, real private consumption, real private investment, real wage, inflation, the shadow rate, real government spending, real government transfers and money supply. Accordingly, the model features nine shocks for nine observed variables. Following Leeper et al. (2010) and Pfeifer (2014), we detrend the logarithm of each real variable separately,[7] while we demean the inflation rate and nominal interest rate.[8]

[6]We exclude the period starting from 2019Q4 from the dataset due to the substantial volatility and uncertainty it introduced to macroeconomic aggregates. Ng (2021), among others discuss the unique nature of COVID data. To avoid introducing additional complexity/features to the model, we restrict the sample to 2019Q4.

[7]In particular, we use the HP filter with a smoothing parameter equal to 1,600.

[8]Some studies (see, for example, Greenwood et al., 1997, Greenwood et al., 2000, Altig et al., 2011, Schmitt-Grohé and Uribe, 2012) have estimated DSGE models including one or two common stochastic trends. This strategy is feasible when the number of trends is limited to one or two, but it becomes non-trivial in the presence of a larger number of trends. In this regard, Leeper et al. (2010) argued that, in models analysing fiscal policy, the number of trends is often larger than two because several fiscal variables display their own trends. Moreover, some of these variables, such as transfers, show upward trends, and this requires specific modelling assumptions in order to guarantee fiscal sustainability. Indeed, online Appendix G shows that the fiscal series included in our analysis clearly display different trends in the sample period considered. Accordingly, as an estimation strategy, we prefer to follow the treatment of observed variables used by Leeper et al. (2010).

The measurement equations for the observables matching the model variables is:

$$
\begin{aligned}
\text{Output} &= 100 \times y_t \\
\text{Consumption} &= 100 \times c_t \\
\text{Investment} &= 100 \times i_t \\
\text{Real wage} &= 100 \times w_t \\
\text{Inflation} &= 100 \times \pi_t \\
\text{Shadow rate} &= 100 \times r_t \\
\text{Government spending} &= 100 \times g_t \\
\text{Transfers} &= 100 \times t_t \\
\text{Money supply} &= 100 \times m_t
\end{aligned}
$$

where the left-hand side of the equation is the observable variable and the right hand side represents the log-linearized model variable scaled by 100. For a detailed description of data construction, please see online Appendix C.

We employ Bayesian estimation techniques, which enable us to specify prior probability distributions for model parameters and subsequently combine these with likelihood functions derived from the data. This method is well-suited for our analysis, as we can draw upon extensive literature on DSGE modelling to inform our choice of priors. We employ Monte Carlo Markov Chain (MCMC) methods and the Metropolis Hastings (MH) algorithm. The model is estimated using 3,000,000 draws from posterior distributions. We run two parallel chains in the MCMC MH algorithm, and the acceptance rate for each of the chains is approximately 24%.[9]

4.2 Fixed parameters and prior distributions

Table 1 describes calibrated values for the fixed parameters. We fix the household's discount factor to 0.99 to match a 4% annual real interest rate. We obtain an average annual inflation rate that closely matches the one in our sample, equal to approximately 4%. The

[9] All our estimations are done with Dynare (http://www.dynare.org/).

labour share in our production function is calibrated to be 0.33 and the capital depreciation rate is set at 0.025 as in Del Negro et al. (2007) and Bianchi et al. (2023). Finally, we follow Leeper et al. (2017) and Bianchi et al. (2023) and calibrate both steady state markup values for wages and prices equal to 0.14. We follow Galí (2015) to calibrate the inverse elasticity of substitution between money and consumption, and set this parameter equal to 1. The shares of government spending and transfers on output, and the steady-state inverse velocity of money supply are set equal to our sample averages. We finally calibrate the share of public debt-to-GDP to 60%, as in Galí (2020b).

Table 2 shows priors and posteriors for the endogenous parameters. Consumption habits and investment adjustment costs are set as in Smets and Wouters (2007). Taylor rule parameters ϕ_r, ϕ_π and ϕ_y, as well as wage and price stickiness parameters ζ_w and ζ_p, wage and price indexation parameters, ι_w and ι_p, and the priors for fiscal policy parameters, ψ_{bt} and ψ_{yt} are in line with Bianchi et al. (2023). Table 3 reports all priors for the exogenous processes. The prior values for persistence parameters align with Leeper et al. (2010), while those for the standard errors are set following Smets and Wouters (2007).

4.3 Posterior estimates

The last three columns of Tables 2 and 3 show the posterior mean estimates and their related 10 percent and 90 percent credible sets.

Identification tests based on Qu and Tkachenko (2012) and Iskrev (2010) show that the Jacobian matrices of the first two moments and the spectral density have full rank. According to these tests, the parameters are all identified. Moreover, trace plots for each of the estimated parameters display no trend, implying that the Metropolis Hastings algorithm converges to a stable distribution.

Table 2 reports posterior estimates for the endogenous parameters that are mostly in line with literature, except for the wage indexation and the price indexation parameters, which are estimated to be lower than previous studies, such as Smets and Wouters (2007) and Del Negro et al. (2007). As it becomes evident from Table 3, we obtain higher standard errors for shocks to more volatile aggregates, such as inflation, investment, and money supply, than for other variables. The table shows that the autoregressive processes for the shocks that appear to be most persistent are money supply and monetary policy. Graphs for prior and posterior distributions, together with other estimation output can be found in online Appendix D.

5 Effects of monetary-financed fiscal stimuli

In this section, we analyse two scenarios in which the government and the central bank collaborate to implement expansionary fiscal policies through fiscal stimuli. Two types of fiscal stimuli are analysed: an increase in government transfers to households and an increase in government spending. We divide the analysis for each of the fiscal stimuli into two scenarios. The first scenario, called the debt-financed scenario, involves the central bank implementing a monetary policy strategy based on inflation targeting. In this scenario, the central bank controls the policy rate. In the second scenario, called the monetary-financed scenario, the central bank gives up control of the policy rate and focuses on the determination of money supply. The second scenario is obtained by modifying the theoretical model to include a "monetary-financing" specification, as described below. First we estimate the model under the debt-financed scenario,[10], and then we simulate the model under the monetary-financed scenario. We finally compare the impact of the two fiscal stimuli under the two distinct scenarii. To calibrate both models for the comparison, we use the estimated parameters derived from the estimation conducted under the debt-financed scenario.

In the debt-financed scenario, the model features a Taylor rule, as described by equation (13). In the alternative scenario, where the fiscal stimulus is financed by the money supply, the fiscal authority implements fiscal stimuli, while the central bank adjusts the money supply to maintain the level of the real public debt constant. As in Galí (2020a) and Punzo and Rossi (2023), having constant debt implies that the deviation of debt from its steady state value must be equal to zero: $b_t = 0$. In this case, the linearized version of equation (14) reads as follows:

$$\Delta m_t = \frac{1}{\chi}\left[\frac{g}{y}g_t + \frac{t}{y}t_t + \frac{b}{y}\frac{r}{\pi}\left(i_{t-1} - \pi_t\right)\right] \tag{19}$$

Equation (19) evolves as a money growth rule, with money growth being endogenously

[10]Estimation results have been described in Section 4.

determined as a result of the interactions between monetary policy an fiscal policy.

Graphs in Figure 3 show the effects of a rise in government spending on the main economic aggregates under the two scenarios: (i) when the increase in government spending is financed through debt; and (ii) when it is financed by money supply. We calibrate the magnitude of the shock to a one standard deviation.

In the debt-financing scenario the nominal interest rate exhibits a stronger increase relative to inflation. As a consequence, the higher real interest rate crowds-out consumption. The standard multiplier effect leads to an increase in output, though the increase is only half as large and persistent compared to the monetary-financed scenario.

A monetary-financed government spending shock leaves real public debt unchanged, while it contributes to a rise in inflation. The increase in inflation in this scenario is significantly greater compared to the debt-financed scenario. The central bank does not react to the increased inflation and adjusts the money supply to accommodate the fiscal stimulus implementation. Consequently, the nominal interest rate experiences a marginal increase, driven by an adjustment inside the government constraint. However, this increase is minor on impact, and it soon turns negative. This process leads to a decrease in the real rate and a resulting positive shift in the consumption response. This aspect is key for our analysis, as a monetary-financed government spending increase crowds-in consumption, while keeping the value of real public debt unchanged.

Graphs in Figure 4 show the impact of an increase in transfers on the main economic variables in the two scenarios: (i) when the increase in transfers is financed by public debt; and (ii) when it is financed through money supply. The magnitude of the shock is once again calibrated to its estimated value.

In the first scenario, due to the Ricardian equivalence, an increase in transfers does not affect economic aggregates. Consumers anticipate that an increase in transfers today will be offset by higher future taxes, leading them to maintain their consumption behaviour unchanged. This causes output, and inflation to remain unaffected. Furthermore, neither money supply nor interest rates need to be adjusted by the central bank. On the contrary, the increase in transfers financed by money supply has an expansionary impact on consumption, investment and output. This happens because the increase in transfers is perceived by households as a direct increase in their disposable income. Following the increase in money supply, the nominal interest rate adjusts downwards. As inflation increases, the real interest rate declines, affecting positively consumption and investment, and finally output. The increase in output together with a constant debt level reduces the debt-to-output ratio. Moreover, a higher inflation rate has an additional positive impact on levels of pre-existing debt, because it wipes-out part of its real value.

The reason why Ricardian equivalence holds only in the case of a debt-financed increase in government transfers and not when transfers are monetary-financed lies in the behaviour of households. In the first scenario, households anticipate that a future increase in lump-sum taxes or a decrease in transfers is needed to offset the current rise in transfers. In the second case, they anticipate that an increase in transfers needs not to be paid back in the future through a tax rise, as it is financed by money supply. Therefore, an increase in money supply issued to fund the expansionary fiscal policy results in a corresponding direct increase in real balances. Since real balances contribute to consumers' wealth, the improvement in wealth translates into an increase in consumption and output.

Finally, figure 5 shows the difference between impulse response functions for the two fiscal stimuli when the financing occurs through money supply. The blue line shows the impact of a money-financed increase in government transfers, while the orange line shows the impact of a money-financed increase in government spending. As shown in the graphs of the previous figures, the case in which the fiscal stimulus (either increase in transfers or increase in government spending) is financed through money supply has an expansionary impact on the main economic aggregates. The response of consumption to an increase in government spending reaches a peak at a value higher than 0.4%, while its response to an increase in transfers peaks approximately at 0.15%. Similarly, regarding output, our model predicts an increase of approximately 0.9% on impact after an increase in government spending, and approximatively 0.3% after an increase in transfers.

6 Robustness analysis

In this section, we provide several robustness exercises to confirm our analysis. Firstly, we split the entire data sample into two sub-periods, 1960Q1 - 1979Q2 (the so-called Great Inflation period) and 1984Q1 - 2007Q2 (the so-called Great Moderation period). Secondly, we focus on different hypothetical scenarios of debt-to-GDP ratios.

For the first robustness analysis, we select the two sub-periods following Ascari et al. (2023). The authors explain that this division matches well two periods that in the literature are known as, respectively, a fiscally-led regime and a monetary-led regime. We estimate the model under the debt-financed scenario for each of the sub-samples and compare the estimated parameters across both sub-samples, as well as with those for the entire sample. We then compare the impulse response functions obtained under the debt-financed scenario and the monetary-financed scenario for each of the two sub-periods.

Previous literature has analysed the importance of different fiscal positions concerning the impact of fiscal shocks on macroeconomic aggregates and on the magnitude of fiscal multipliers (Ilzetzki et al., 2013; Huidrom et al., 2020). Therefore, as a second robustness check, we present responses to government spending and transfers shocks for different levels of debt-to-GDP ratios. Specifically, we compare the impulse response functions obtained for monetary-financed fiscal shocks in cases of public debt-to-GDP ratios set at 60% (used in the benchmark model), 30% and 120%.

6.1 Sub-samples

Tables 4 and 5 report the posterior means of the estimated parameters for the entire sample and the two sub-samples. The priors used for the two sub-periods are exactly the same as those employed for the entire sample (see Table 2).[11] For a number of shocks, the standard errors of exogenous processes are similar over the two sub-samples. However, the standard error of the cost-push shock is significantly higher over the entire sample compared to the two sub-periods, and lower during the Great Inflation period compared to the Great Moderation

[11]The only exception is ϕ_y, for which the prior used to estimate the model over the sub-sample 1960Q1 - 1979Q2 is set to 0.2.

period. Moreover, the money supply shock displays nearly double the value for the first sub-sample compared to the second sub-sample. Finally, the productivity shock standard error is higher over the entire sample compared to the sub-samples. Persistence parameters for the productivity and monetary policy shocks are lower during the Great Inflation period compared to the Great Moderation period. The exogenous processes for government spending and transfers show similar persistence across the two sub-periods. Lastly, the cost-push persistence parameter exhibits greater magnitude during the Great Inflation period.

Table 4 reports the values of the estimated endogenous parameters across the entire sample and the two sub-periods. For instance, the parameter ψ_{yt}, which measures the elasticity of transfers with respect to output, is lower during the Great Moderation period compared to the other sub-period. Conversely, the parameter ψ_{bt}, which measures the elasticity of transfers with respect to public debt, is higher during the Great Moderation period than in the other sub-period. The weight of inflation on the interest rate in the Taylor rule, the wage indexation parameter and the price stickiness parameter are lower in the first sub-sample compared to the second sub-sample. On the contrary, the interest rate smoothing parameter is higher during the Great Inflation period compared with the Great Moderation period.

Figures 6, 7, 8 and 9 show the effects of debt-financed and monetary-financed fiscal stimuli on macroeconomic aggregates using estimated model parameters for the two sub-periods. Qualitatively, the graphs confirm the results presented in Section 5. On the one hand, monetary-financed fiscal stimuli have positive effects on consumption, investment, hours worked and output. On the other hand, inflation increases to a greater extent in this scenario compared to the more traditional debt-financed scenario. Finally, the real debt remains unchanged, which results in a decline of the debt-to-GDP ratio.

Responses to an increase in government spending in both scenarios and over both sub-samples closely resemble those over the entire sample in the main analysis.[12] Following a monetary-financed government spending increase, using data from the Great Inflation period (Figure 6), inflation increases to a greater extent compared to the Great Moderation (Figure 7) period. Conversely, in the debt-financed scenario during the second sub-sample, the response of the nominal interest rate to inflation is amplified relative to the first sub-sample, which

[12]See Figure 3 for a comparison.

align with the evolution of monetary policy during this period of time. The increased response of the central bank to a change in inflation is confirmed by our estimated values of ϕ_π as well. Finally, the increase of the debt-to-GDP ratio in this scenario is double as much compared to its evolution during the Great Inflation.

Figure 8 shows less persistent responses to a monetary-financed transfers shock compared to results obtained in the main analysis (Figure 4), with one notable exception: the nominal interest rate reacts positively. This effect is driven by a higher increase in the money demand compared to the money supply. However, this response is only observed on impact, as the nominal interest rate quickly declines into negative territory thereafter. The lower reaction of the nominal interest rate compared to the reaction of inflation results in a decrease in the real rate, which stimulates consumption, investment and output. Conversely, in the debt-financed scenario, due to the Ricardian equivalence, an increase in transfers leaves all economic aggregates unchanged.

Finally, graphs in Figure 9 indicate that a monetary-financed increase in transfers would have had an amplified positive impact on the economy during the Great Moderation period. Notably, output, consumption, hours worked and particularly investment exhibit a higher response in magnitude to the fiscal stimulus shock in this sub-period compared to the first sub-period. However, inflation also shows a stronger response. The nominal interest rate is in positive territory only on impact and falls below zero immediately thereafter. The higher response of inflation relative to the nominal interest rate results in a decline in the real interest rate which, in turn, implies crowding-in of consumption and investment.

6.2 Debt-to-GDP level

Figures 10 and 11 show simulated impulse response functions under the monetary-financed scenario with different levels of public debt-to-GDP ratios. It appears evident from the graphs that fiscal shocks exert a more pronounced positive impact on the economy when the debt-to-GDP ratio is lower. This result holds true for both increases in monetary-financed government spending and transfers. Indeed, impulse responses show a reduced advantage of resorting to monetary-financing when the public debt-to-GDP ratio increases. Our results align with findings in Checherita-Westphal and Rother (2012) and Cecchetti et al. (2011), among others.

These papers have found that high ratios of public debt-to-GDP are detrimental for GDP growth. Moreover, a fiscal stimulus in economies with high government debt was found to be associated with lower private consumption compared to economies with lower government debt levels (Ilzetzki et al., 2013).

Our analysis contributes to the above-mentioned papers, as we focus on the effects of fiscal stimuli that are monetary-financed across different public debt-to-GDP ratios. Despite increases in public debt-to-GDP ratios, the impact of a monetary-financed fiscal stimulus remains positive. However, under higher levels of public debt-to-GDP, impulse response functions reveal not only a lower positive impact on output, but also on consumption, investment and hours worked. Moreover, following an increase in both types of fiscal stimuli, under higher public debt-to-GDP ratios, inflation increases to a lesser extent compared to settings with lower public debt-to-GDP ratios. The lower increase in inflation is driven by a reduced positive impact on aggregate demand. Finally, the amplified impact on output contributes to a more pronounced reduction in the debt-to-GDP ratio over time.

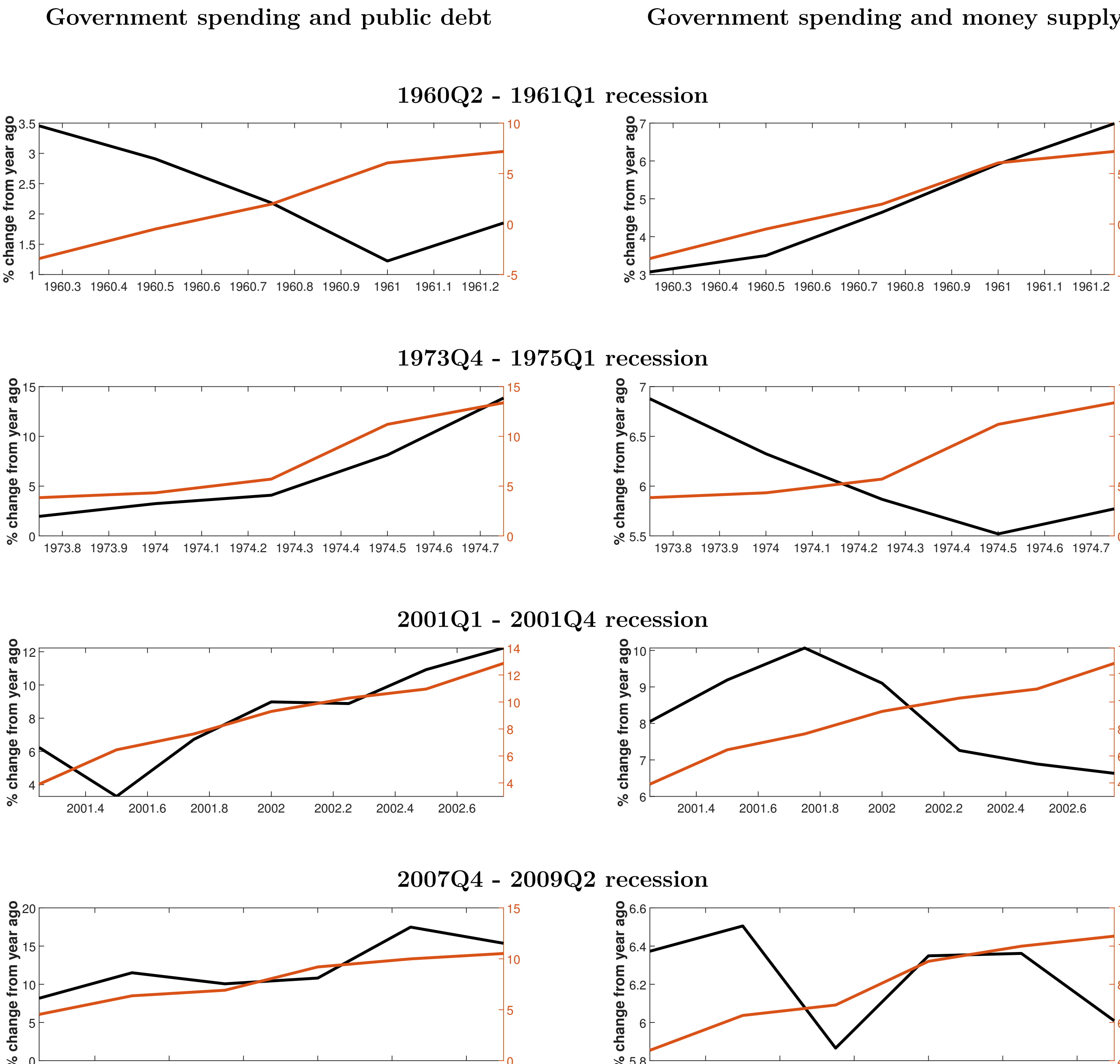
7 Conclusions

The collaboration between monetary policy and fiscal policy has proven to be an effective tool in mitigating the negative consequences of both economic and non-economic shocks. Given the rising levels of US government debt, the need for implementation of fiscal stimulus packages, and the prolonged period of low inflation observed in the US over the past years, we consider it pertinent to conduct a counterfactual analysis of monetary-financed fiscal stimuli. To carry out this analysis, we develop a New Keynesian model that incorporates fiscal policy. We employ Bayesian methods to estimate the model parameters using US data. Subsequently, we conduct a simulation analysis by augmenting the model with a feature representing a monetary-financed fiscal stimulus, using the previously estimated parameters. This allows us to quantitatively evaluate the expansionary impact of this alternative method to finance a fiscal stimulus. We show that a monetary financing scheme for fiscal stimuli has positive impacts on economic aggregates.

However, this comes at a cost: a higher increase in inflation compared to the alternative debt-financing method. Additional analysis shows that the impact of a monetary-financed fiscal stimulus remains positive, but varies slightly according to the estimation sub-period, when the sample is split into two. Lastly, we show that the higher the level of the public debt-to-GDP ratio, the lower are the positive effects of a monetary-financed fiscal stimulus on the economy.

A caveat of our model is worth noting. Our model does not incorporate financial frictions and the implications for central bank balance sheets. If monetary financing is to be the focus of policy advice, it would be useful to include these features in the analysis.

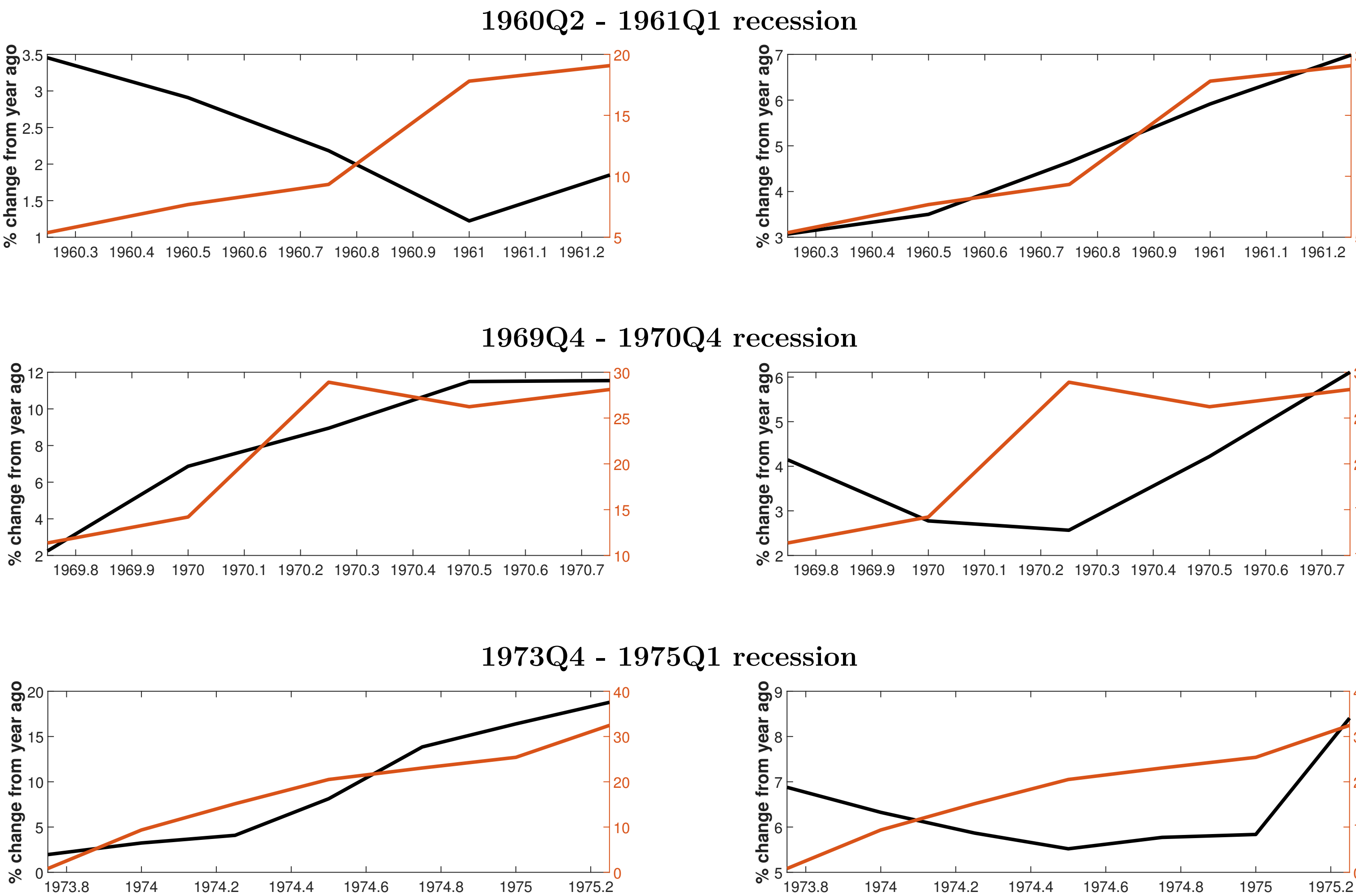
Figure 1: Government spending, public debt and money supply



Notes: Source: FRED, Federal Reserve Bank of St. Louis. The series are in percentage changes from the previous year. The orange line represents government spending. The black line represents either public debt (left column) or money supply (right column). Public debt is measured two quarters ahead.

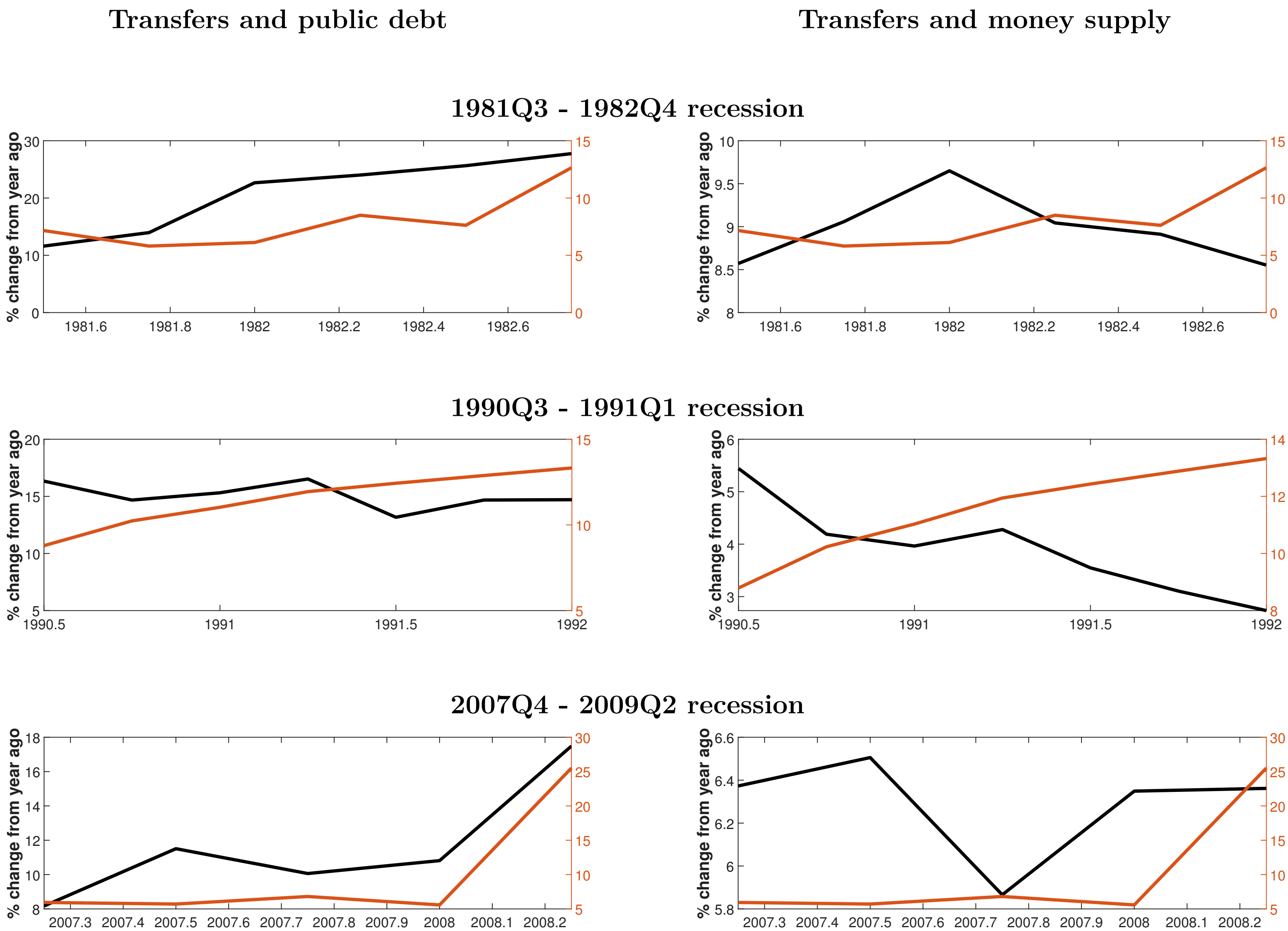
Figure 2a: Transfers, public debt and money supply

Transfers and public debt | **Transfers and money supply**



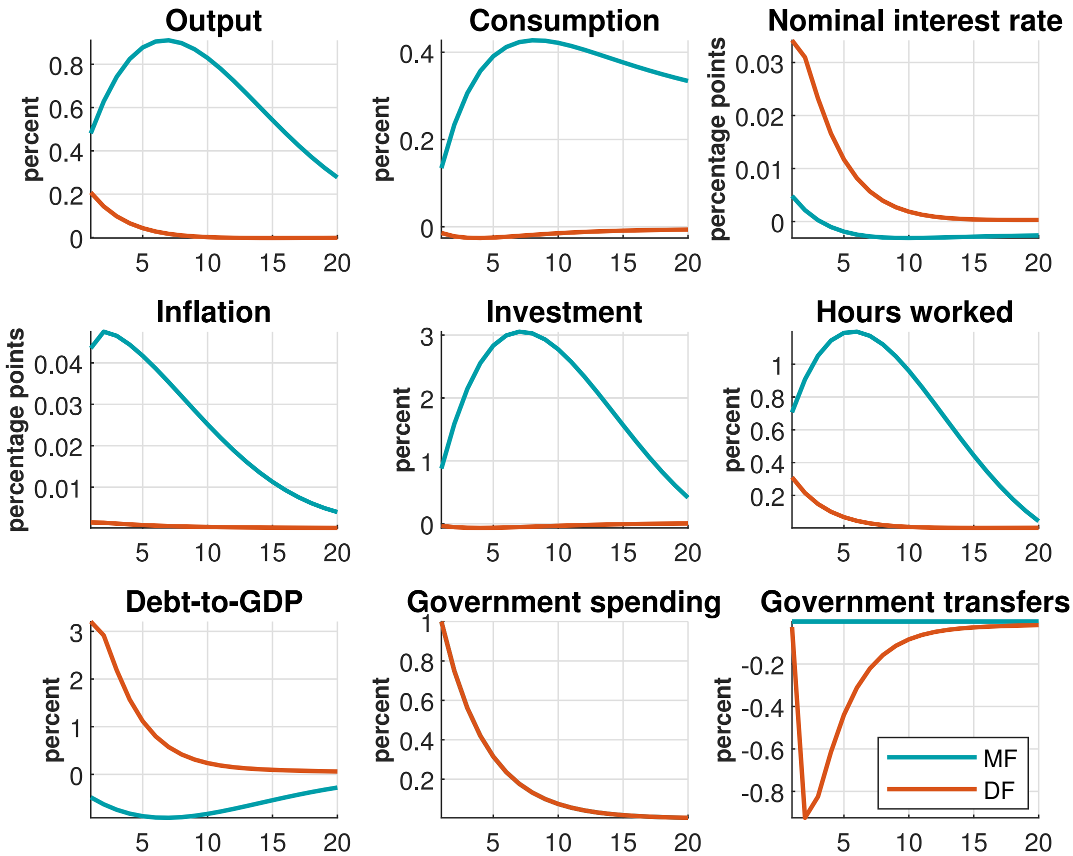
Notes: Source: FRED, Federal Reserve Bank of St.Louis. The series are in percentage changes from the previous year. The orange line represents government transfers.The black line represents either public debt (left column) or money supply (right column). Public debt is measured two quarters ahead.

Figure 2b: Transfers, public debt and money supply



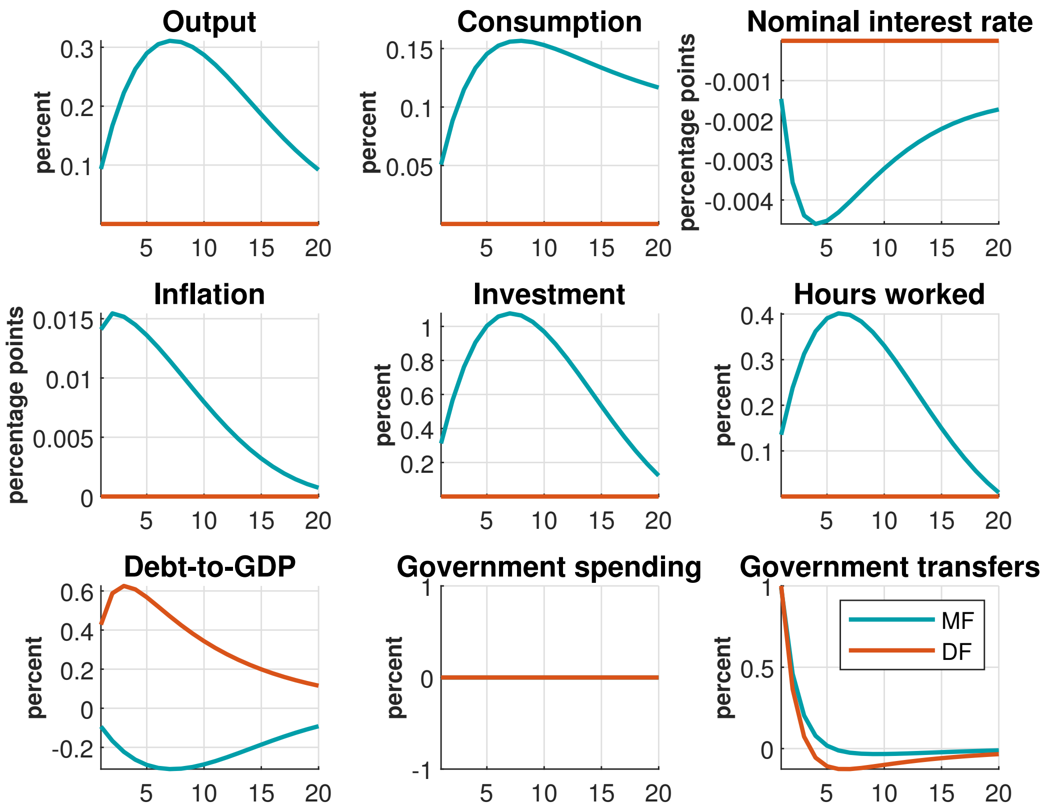
Notes: Source: FRED, Federal Reserve Bank of St.Louis. The series are in percentage changes from the previous year. The orange line represents government transfers. The black line represents either public debt (left column) or money supply (right column). Public debt is measured two quarters ahead.

Figure 3: Government spending increase: debt financing vs monetary financing



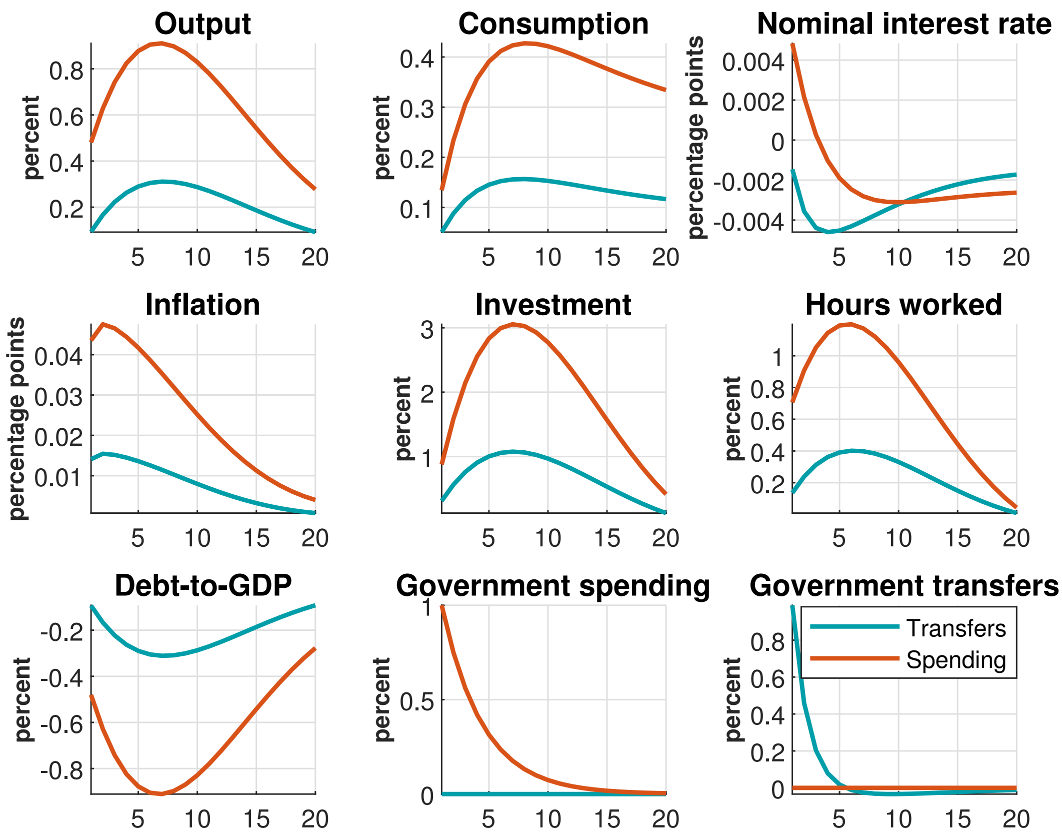
Notes: The impulse responses are obtained from a simulated one standard deviation shock to government spending. The values of the model parameters are set equal to their mean estimates of the posterior distribution. Horizontal axis: quarters after shock. The blue line represents responses to a monetary-financed government spending increase, while the orange line represents responses to a debt-financed government spending increase.

Figure 4: Transfers increase: debt financing vs monetary financing



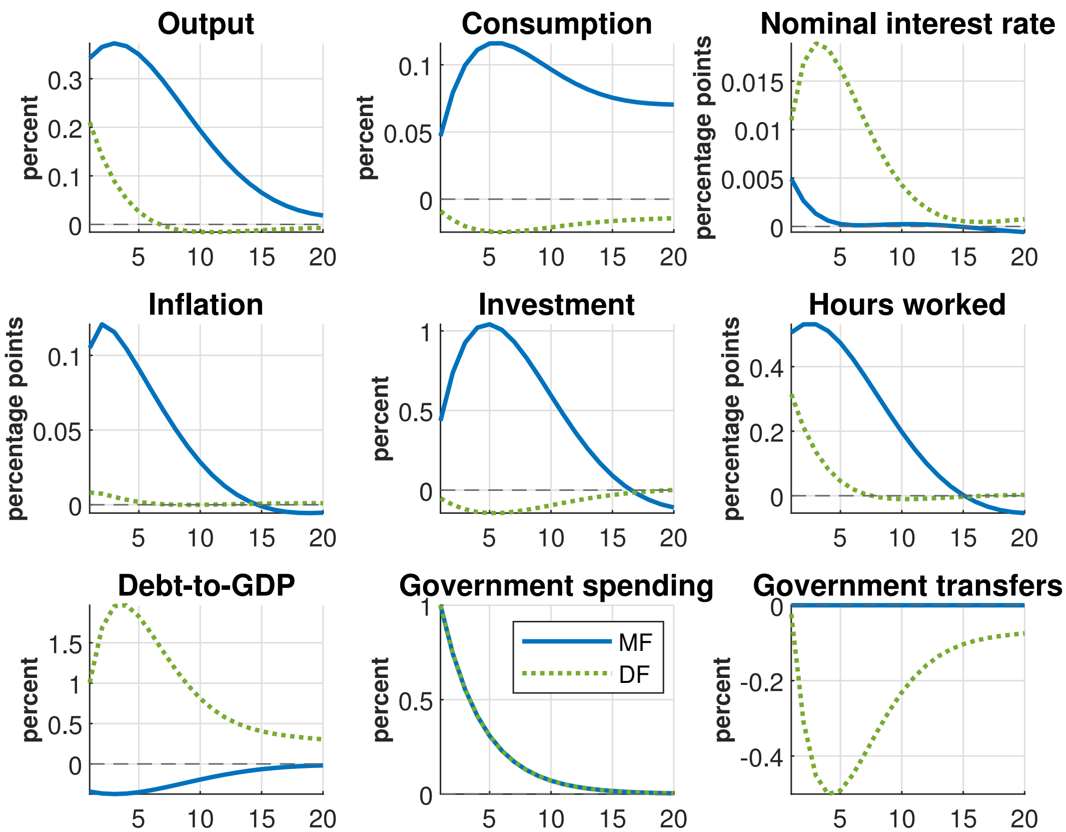
Notes: The impulse responses are obtained from a simulated one standard deviation shock to government transfers. The values of the model parameters are set equal to their mean estimates of the posterior distribution. Horizontal axis: quarters after shock. The blue line represents responses to the monetary-financed transfers increase, while the orange line represents responses to the debt-financed transfers increase.

Figure 5: Government spending and transfers increase: monetary financing



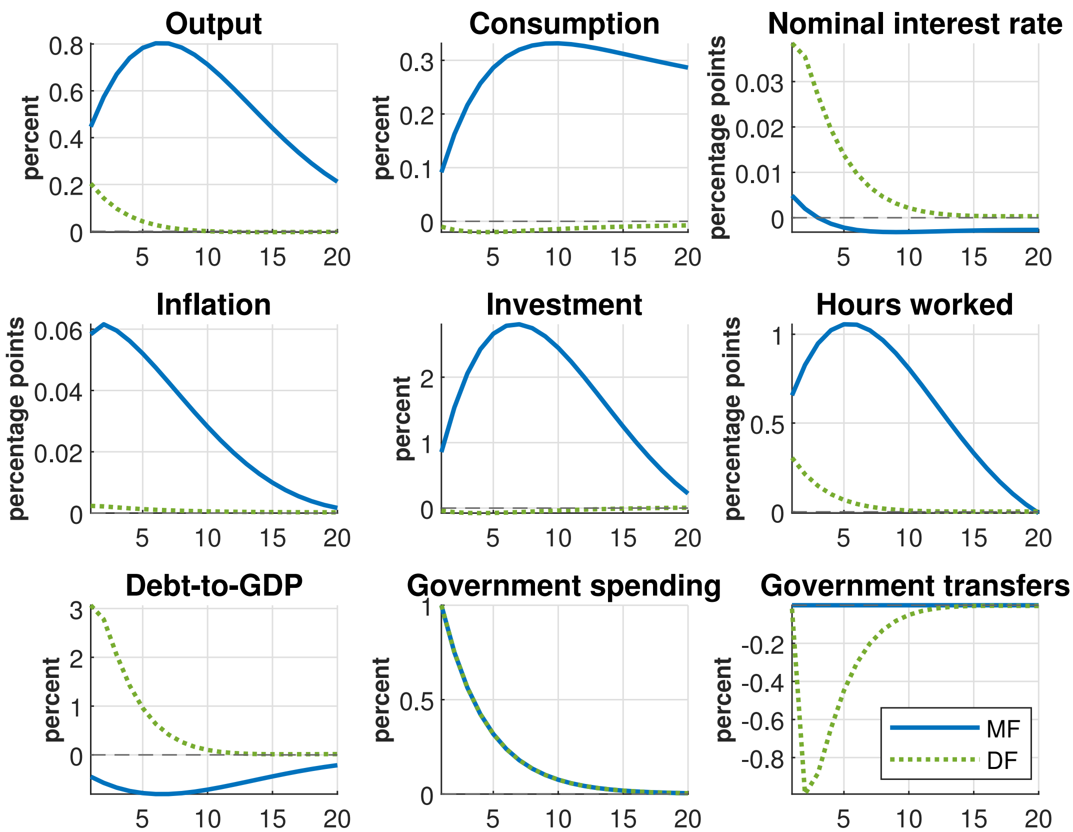
Notes: The impulse responses are obtained from a simulated one standard deviation shock to government spending and transfers. The values of the model parameters are set equal to their mean estimates of the posterior distribution. Horizontal axis: quarters after shock. The blue line shows responses to a monetary-financed transfers increase. The orange line shows responses to a monetary-financed government spending increase.

Figure 6: Government spending increase: 1960Q1 - 1979Q2 (S1)



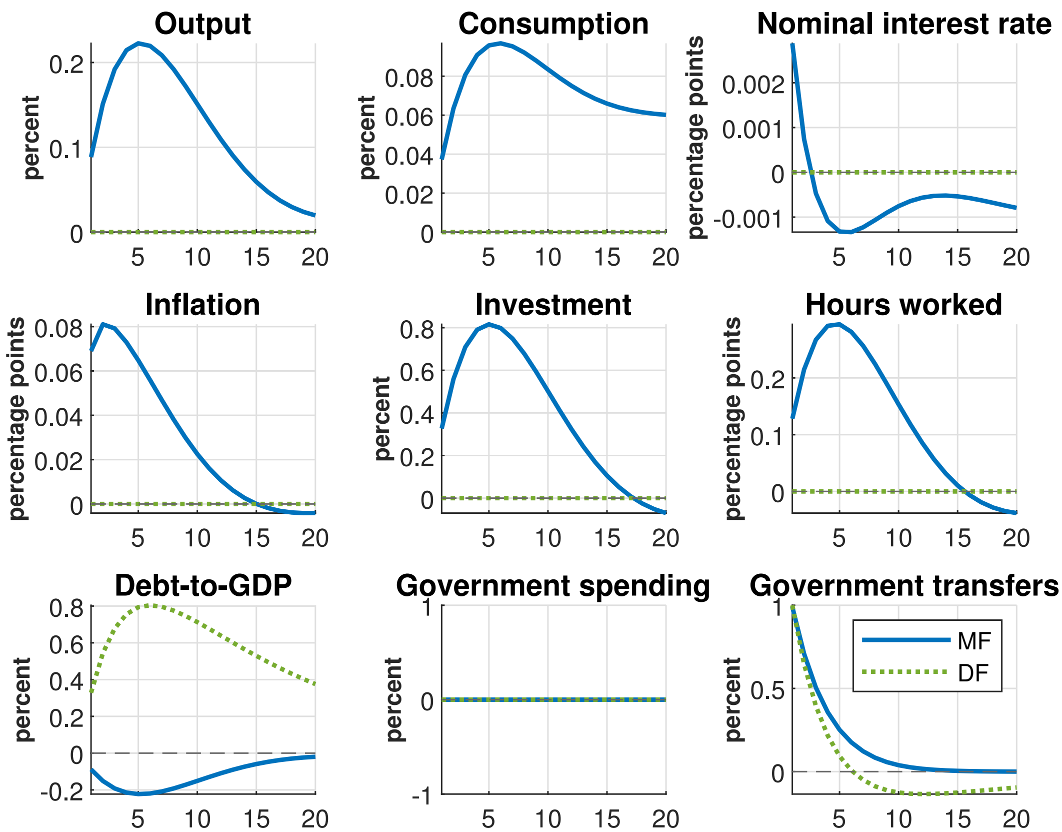
Notes: The impulse responses are obtained from a simulated one standard deviation shock to government spending. The values of the model parameters are set equal to their mean estimates of the posterior distribution. Horizontal axis: quarters after shock. The blue line represents responses to a monetary-financed government spending increase, while the green dashed line represents responses to a debt-financed government spending increase.

Figure 7: Government spending increase: 1984Q1 - 2007Q2 (S2)



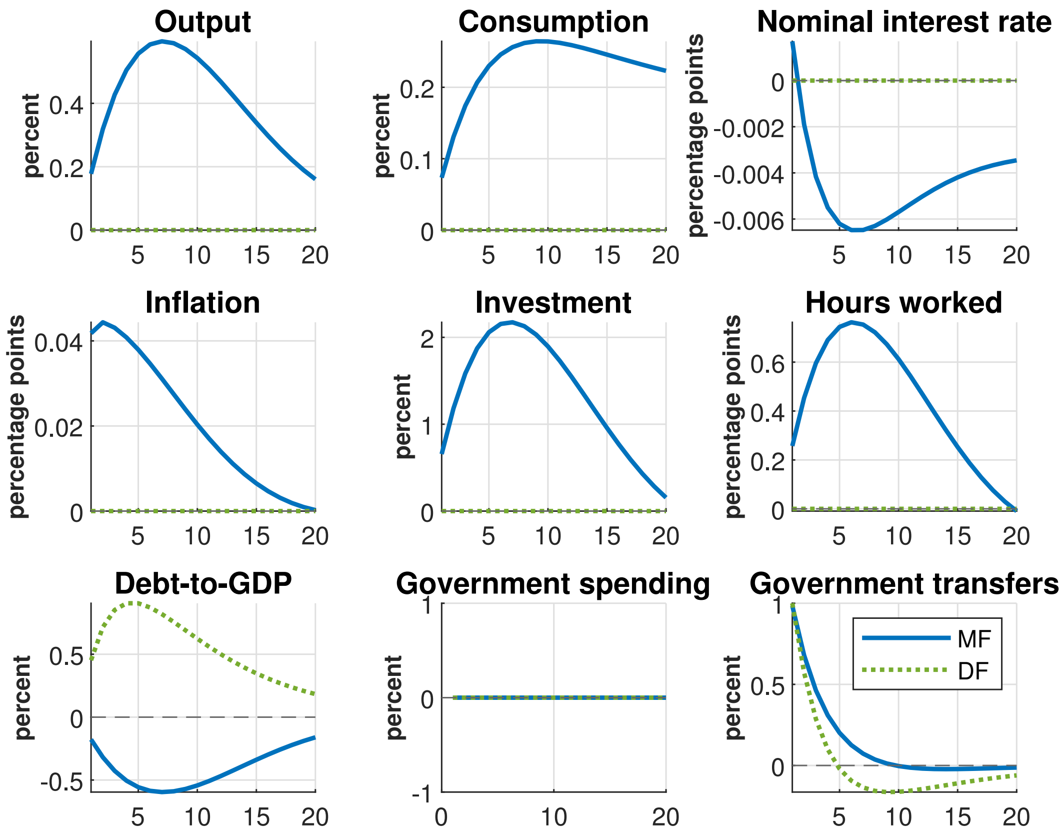
Notes: The impulse responses are obtained from a simulated one standard deviation shock to government spending. The values of the model parameters are set equal to their mean estimates of the posterior distribution. Horizontal axis: quarters after shock. The blue line represents responses to a monetary-financed government spending increase, while the green dashed line represents responses to a debt-financed government spending increase.

Figure 8: Transfers increase: 1960Q1 - 1979Q2 (S1)



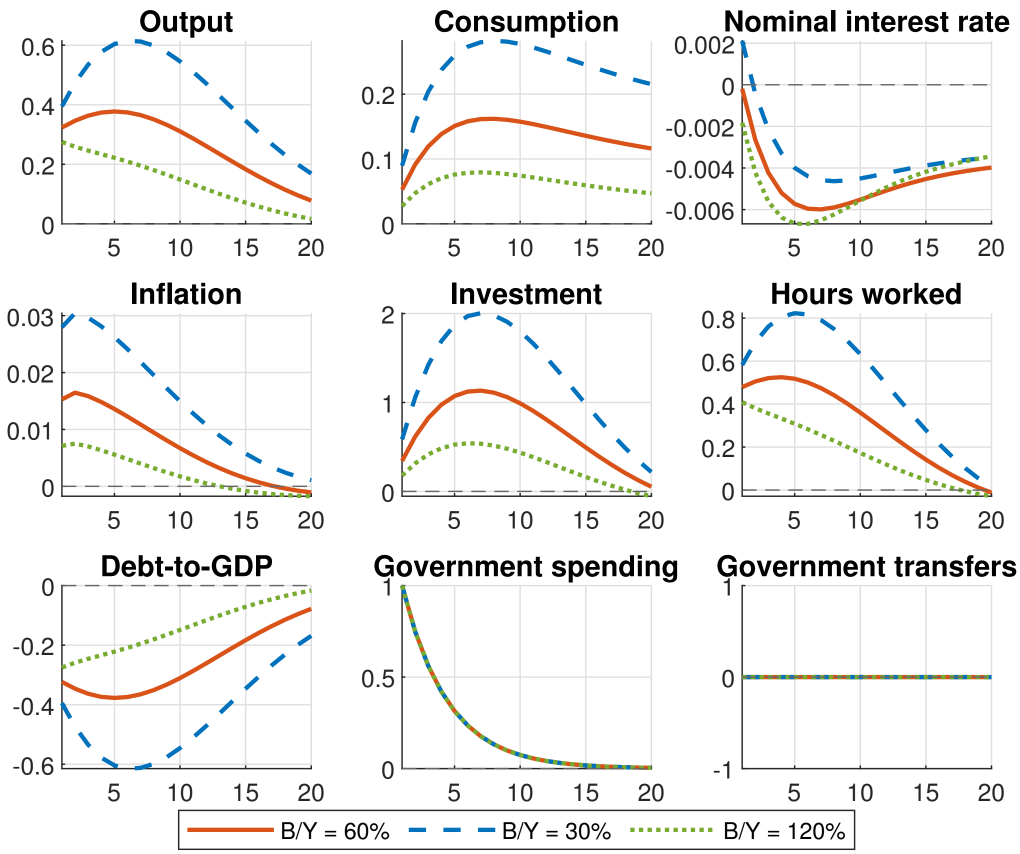
Notes: The impulse responses are obtained from a simulated one standard deviation shock to government transfers. The values of the model parameters are set equal to their mean estimates of the posterior distribution. Horizontal axis: quarters after shock. The blue line represents responses to a monetary-financed transfers increase, while the green dashed line represents responses to a debt-financed transfers increase.

Figure 9: Transfers increase: 1984Q1 - 2007Q2 (S2)



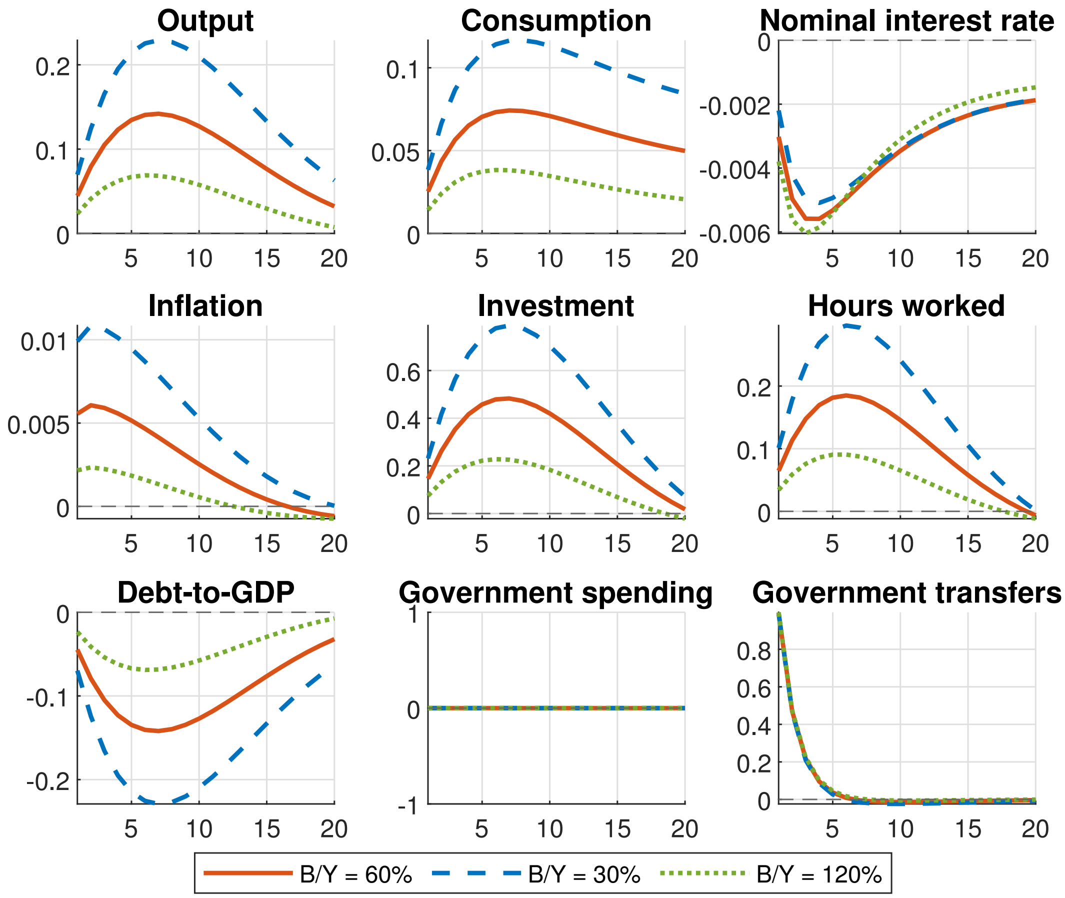
Notes: The impulse responses are obtained from a simulated one standard deviation shock to government transfers. The values of the model parameters are set equal to their mean estimates of the posterior distribution. Horizontal axis: quarters after shock. The blue line represents responses to a monetary-financed transfers increase, while the green dashed line represents responses to a debt-financed transfers increase.

Figure 10: Monetary-financed government spending increase under different levels of debt-to-GDP



Notes: The graphs show responses to a monetary-financed government spending increase. The orange line refers to a model with a steady-state debt-to-GDP ratio of 60%. The blue dashed line refers to a model with a steady-state debt-to-GDP ratio of 30%. The green line refers to a model with a steady-state debt-to-GDP ratio of 120%

Figure 11: Monetary-financed transfers increase under different levels of debt-to-GDP



Notes: The graphs show responses to a monetary-financed transfers increase. The orange line refers to a model with a steady-state debt-to-GDP ratio of 60%. The blue dashed line refers to a model with a steady-state debt-to-GDP ratio of 30%. The green line refers to a model with a steady-state debt-to-GDP ratio of 120%

Table 1: Fixed parameters according to quarterly data

Param.	**Description**	**Value**	**Source**
β	Households' discount factor	0.99	to match 4% real annual int. rate
α	Labour share in the Cobb Douglas function	0.33	Del Negro et al. (2007)
δ	Capital depreciation rate	0.025	Del Negro et al. (2007)
ν_m	Inv. elast. of substitution btw money&consumption	1	Galí (2015)
λ_w	Wage markup	0.14	Bianchi et al. (2023)
λ_p	Price markup	0.14	Bianchi et al. (2023)
$\frac{B}{Y}$	Share of public debt on GDP	2.4	Galí (2020a)
$\frac{G}{Y}$	Share of government spending on GDP	0.22	From our data sample
$\frac{T}{Y}$	Share of government transfers on GDP	0.26	From our data sample
χ	Steady state inverse velocity of money supply	0.52	From our data sample

Notes: The table reports the name and the description of the fixed parameters, their calibrated values, and the target or the source.

Table 2: Priors and posteriors for the endogenous parameters

		Prior			**Posterior**		
Param.	**Description**	*Distribution*	*Mean*	*St. Dev.*	*Mean*	10%	90%
ν_l	Inverse Frisch elasticity	Gamma	2	0.25	1.6537	1.3291	1.9655
h	Consumption habits	Beta	0.7	0.1	0.7990	0.7497	0.8498
ϕ_r	Interest rate smoothing parameter	Beta	0.5	0.1	0.1835	0.1210	0.2476
ϕ_π	Weight of inflation on the interest rate	Gamma	2.00	0.2	3.3592	3.1434	3.8991
ϕ_y	Weight of output on the interest rate	Gamma	0.125	0.1	0.1763	0.1366	0.2147
Γ	Investment adjustment costs	Normal	6.00	0.5	6.1163	5.3326	6.9292
ψ_{bt}	Transfers parameter for debt	Gamma	0.25	0.1	0.2657	0.1442	0.3832
ψ_{yt}	Transfers parameter for output	Gamma	0.1	0.05	0.1209	0.0296	0.2055
ζ_w	Wage stickiness	Beta	0.5	0.1	0.4731	0.4144	0.5307
ι_w	Wage indexation	Beta	0.5	0.2	0.4644	0.1659	0.7525
ζ_p	Price stickiness	Beta	0.5	0.1	0.9619	0.9558	0.9681
ι_p	Price indexation	Beta	0.5	0.2	0.1082	0.0558	0.1595

Notes: The table reports the name and the description, the prior distributions, means and standard deviations, as well as the posterior means, the 10 percent and 90 percent credible sets of the endogenous parameters.

Table 3: Priors and posteriors for the exogenous processes parameters

		Prior			Posterior		
Param.	**Description**	*Distribution*	*Mean*	*St. Dev.*	*Mean*	10%	90%
ρ_z	Productivity persistence parameter	Beta	0.7	0.2	0.3026	0.2009	0.4035
ρ_b	Preference persistence parameter	Beta	0.7	0.2	0.4542	0.3289	0.5773
ρ_g	Government spending persistence parameter	Beta	0.7	0.2	0.7490	0.6880	0.8099
ρ_μ	Investment persistence parameter	Beta	0.7	0.2	0.3013	0.2079	0.3950
ρ_r	Monetary policy persistence parameter	Beta	0.7	0.2	0.9955	0.9913	0.9998
ρ_π	Cost push persistence parameter	Beta	0.7	0.2	0.6535	0.5651	0.7417
ρ_t	Transfers persistence parameter	Beta	0.7	0.2	0.4796	0.3823	0.5762
ρ_m	Money supply persistence parameter	Beta	0.7	0.2	0.8153	0.7543	0.8750
σ_z	Productivity shock standard error	Inv. gamma	0.1	2	0.1265	0.0850	0.1669
σ_b	Preference shock standard error	Inv. gamma	0.1	2	0.0222	0.0172	0.0269
σ_g	Government spending shock standard error	Inv. gamma	0.1	2	0.0250	0.0231	0.0269
σ_μ	Investment shock standard error	Inv. gamma	0.1	2	0.1689	0.1405	0.1987
σ_r	Monetary policy shock standard error	Inv. gamma	0.1	2	0.0085	0.0076	0.0093
σ_π	Cost push shock standard error	Inv. gamma	0.1	2	1.2591	0.7855	1.7167
σ_t	Transfers shock standard error	Inv. gamma	0.1	2	0.0422	0.0391	0.0455
σ_m	Money supply shock standard error	Inv. gamma	0.1	2	0.2181	0.2016	0.2341

Notes: The table shows the name and the description, the prior distributions, means and standard deviations, as well as the posterior means, 10 percent and 90 percent credible sets of the parameters for the exogenous processes.

Table 4: Priors and posteriors for the endogenous parameters - sub-samples

Param.	**Description**	**Posterior mean**		
		Full sample (1960Q1 - 2019Q4)	S1 (1960Q1 - 1979Q2)	S2 (1984Q1 - 2007Q2)
ν_l	Inverse Frisch elasticity	1.6537	2.0728	1.8319
Γ	Investment adjustment costs	6.1163	5.8614	6.0796
h	Consumption habits	0.7990	0.8687	0.8501
ϕ_π	Weight of inflation on the interest rate	3.5292	2.2243	3.1951
ψ_{yt}	Transfers parameter for output	0.1209	0.1097	0.0880
ψ_{bt}	Transfers parameter for debt	0.2657	0.2424	0.2994
ι_w	Wage indexation	0.4644	0.3564	0.4684
ζ_p	Price stickiness	0.9619	0.8738	0.9542
ι_p	Price indexation	0.1082	0.2056	0.0761
ζ_w	Wage stickiness	0.4731	0.4400	0.3887
ϕ_r	Interest rate smoothing parameter	0.1835	0.7938	0.1922
ϕ_y	Weight of output on the interest rate	0.1763	0.1660	0.1965

Notes: The table reports the name and the description of the structural parameters, as well as their posterior means. The first column shows the posterior means for the entire sample, while the second and the third columns show the posterior means for the first and the second sub-samples respectively.

Table 5: Priors and posteriors for the exogenous processes parameters - sub-samples

Param.	Description	Posterior mean		
		Full sample (1960Q1 - 2019Q4)	S1 (1960Q1 - 1979Q2)	S2 (1984Q1 - 2007Q2)
σ_z	Productivity shock standard error	0.1265	0.0686	0.0745
σ_b	Preference shock standard error	0.0222	0.0381	0.0245
σ_g	Government spending shock standard error	0.0250	0.0273	0.0214
σ_μ	Investment shock standard error	0.1689	0.1943	0.1303
σ_r	Monetary policy shock standard error	0.0085	0.0094	0.0089
σ_π	Cost push shock standard error	1.2591	0.3768	0.5097
σ_t	Transfers shock standard error	0.0422	0.0319	0.0226
σ_m	Money supply shock standard error	0.2181	0.2472	0.1360
ρ_z	Productivity persistence parameter	0.3026	0.1940	0.2693
ρ_b	Preference persistence parameter	0.4542	0.3891	0.2819
ρ_π	Cost push persistence parameter	0.6535	0.8201	0.7454
ρ_m	Money supply persistence parameter	0.8153	0.7954	0.8880
ρ_g	Government spending persistence parameter	0.7490	0.7451	0.7510
ρ_μ	Investment persistence parameter	0.3013	0.2613	0.2392
ρ_t	Transfers persistence parameter	0.4796	0.7248	0.7073
ρ_r	Monetary policy persistence parameter	0.9955	0.2328	0.9825

Notes: The table shows the name and the description of the parameters for the exogenous processes, as well as their posterior means. The first column shows the posterior means for the entire sample, while the second and the third columns show the posterior means for the first and the second sub-samples respectively.

References

Altig, D., Christiano, L. J., Eichenbaum, M., and Linde, J. (2011). Firm-specific capital, nominal rigidities and the business cycle. *Review of Economic Dynamics*, 14(2):225–247.

Ascari, G., Beck-Friis, P., Florio, A., and Gobbi, A. (2023). Fiscal foresight and the effects of government spending: It's all in the monetary-fiscal mix. *Journal of Monetary Economics*, 134:1–15.

Benigno, P. and Nisticò, S. (2022). The economics of helicopter money. *CEPR Discussion Papers 14555*.

Bernanke, B. (2003). *Some thoughts on monetary policy in Japan*. Remarks before the Japan Society on Monetary Economics, Tokyo, May 31, 2003.

Bernanke, B. (2016). What tools does the Fed have left? Part 3: Helicopter money. *Brookings Blogs*, 11(4).

Bianchi, F., Faccini, R., and Melosi, L. (2020). Monetary and fiscal policies in times of large debt: Unity is strength. Technical report, National Bureau of Economic Research.

Bianchi, F., Faccini, R., and Melosi, L. (2023). A fiscal theory of persistent inflation. *The Quarterly Journal of Economics*, 138(4):2127–2179.

Bianchi, F. and Melosi, L. (2019). The dire effects of the lack of monetary and fiscal coordination. *Journal of Monetary Economics*, 104:1–22.

Buiter, W. H. (2014). The simple analytics of helicopter money: Why it works—always. *Economics*, 8(1):20140028.

Cecchetti, S. G., Mohanty, M. S., and Zampolli, F. (2011). The real effects of debt. *BIS Working Paper*.

Checherita-Westphal, C. and Rother, P. (2012). The impact of high government debt on economic growth and its channels: An empirical investigation for the Euro Area. *European Economic Review*, 56(7):1392–1405.

Christiano, L., Eichenbaum, M., and Rebelo, S. (2011). When is the government spending multiplier large? *Journal of Political Economy*, 119(1):78–121.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. (2005). Nominal rigidities and the dynamic effects of a shock to monetary policy. *Journal of Political Economy*, 113(1):1–45.

Cukierman, A. (2020). Covid-19, helicopter money & the fiscal-monetary nexus.

Das, P. (2021). Fiscal financing components in a simple model of policy interaction. *Economic Modelling*, 96:257–276.

Davig, T. and Leeper, E. M. (2011). Monetary-fiscal policy interactions and fiscal stimulus. *European Economic Review*, 55(2):211–227.

Davig, T., Leeper, E. M., Galí, J., and Sims, C. (2006). Fluctuating macro policies and the fiscal theory [with comments and discussion]. *NBER macroeconomics annual*, 21:247–315.

Del Negro, M. and Schorfheide, F. (2008). Forming priors for DSGE models (and how it affects the assessment of nominal rigidities). *Journal of Monetary Economics*, 55(7):1191–1208.

Del Negro, M., Schorfheide, F., Smets, F., and Wouters, R. (2007). On the fit of New Keynesian models. *Journal of Business & Economic Statistics*, 25(2):123–143.

Di Giorgio, G. and Traficante, G. (2018). Fiscal shocks and helicopter money in open economy. *Economic Modelling*, 74:77–87.

English, W. B., Erceg, C. J., and Lopez-Salido, D. (2017). Money-financed fiscal programs: A cautionary tale. FEDS Working paper No. 2017-60.

Galí, J. (2015). *Monetary policy, inflation, and the business cycle: an introduction to the New Keynesian framework and its applications.* Princeton University Press.

Galí, J. (2020a). The effects of a money-financed fiscal stimulus. *Journal of Monetary Economics*, 115:1–19.

Galí, J. (2020b). Helicopter money: The time is now. *Mitigating the COVID Economic Crisis: Act Fast and Do Whatever*, 31:31–39.

Giavazzi, F. and Tabellini, G. (2014). How to jumpstart the Eurozone economy. *VoxEU, August.*

Greenwood, J., Hercowitz, Z., and Krusell, P. (1997). Long-run implications of investment-specific technological change. *The American Economic Review*, pages 342–362.

Greenwood, J., Hercowitz, Z., and Krusell, P. (2000). The role of investment-specific technological change in the business cycle. *European Economic Review*, 44(1):91–115.

Hall, G. J. and Sargent, T. J. (2011). Interest rate risk and other determinants of post-WWII US government debt/GDP dynamics. *American Economic Journal: Macroeconomics*, 3(3):192–214.

Huidrom, R., Kose, M. A., Lim, J. J., and Ohnsorge, F. L. (2020). Why do fiscal multipliers depend on fiscal positions? *Journal of Monetary Economics*, 114:109–125.

Ilzetzki, E., Mendoza, E. G., and Végh, C. A. (2013). How big (small?) are fiscal multipliers? *Journal of Monetary Economics*, 60(2):239–254.

Iskrev, N. (2010). Local identification in DSGE models. *Journal of Monetary Economics*, 57(2):189–202.

Leeper, E. M. (1991). Equilibria under "active" and "passive" monetary and fiscal policies. *Journal of Monetary Economics*, 27(1):129–147.

Leeper, E. M., Plante, M., and Traum, N. (2010). Dynamics of fiscal financing in the United States. *Journal of Econometrics*, 156(2):304–321.

Leeper, E. M., Traum, N., and Walker, T. B. (2017). Clearing up the fiscal multiplier morass. *American Economic Review*, 107(8):2409–2454.

Mertens, K. R. and Ravn, M. O. (2014). Fiscal policy in an expectations-driven liquidity trap. *The Review of Economic Studies*, pages 1637–1667.

Ng, S. (2021). Modeling macroeconomic variations after COVID-19. Technical report, National Bureau of Economic Research.

Okano, E. and Eguchi, M. (2023). The effects of a money-financed fiscal stimulus in a small open economy. *IMF Economic Review*, pages 1–26.

Pfeifer, J. (2014). A guide to specifying observation equations for the estimation of DSGE models. *Research Series*, pages 1–150.

Punzo, C. and Rossi, L. (2023). A money-financed fiscal stimulus: redistribution and social welfare. *Journal of Money, Credit and Banking*, 55(2-3):595–617.

Qu, Z. and Tkachenko, D. (2012). Identification and frequency domain quasi-maximum likelihood estimation of linearized Dynamic Stochastic General Equilibrium models. *Quantitative Economics*, 3(1):95–132.

Reichlin, L., Turner, A., and Woodford, M. (2013). Helicopter money as a policy option. *VoxEU. org*, 20.

Sargent, T. J. and Wallace, N. (1973). Rational expectations and the dynamics of hyperinflation. *International Economic Review*, pages 328–350.

Sargent, T. J., Wallace, N., et al. (1981). Some unpleasant monetarist arithmetic. *Federal Reserve Bank of Minneapolis Quarterly Review*, 5(3):1–17.

Schmitt-Grohé, S. and Uribe, M. (2000). Price level determinacy and monetary policy under a balanced-budget requirement. *Journal of Monetary Economics*, 45(1):211–246.

Schmitt-Grohé, S. and Uribe, M. (2012). What's news in business cycles. *Econometrica*, 80(6):2733–2764.

Sims, C. A. (1994). A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy. *Economic Theory*, 4:381–399.

Smets, F. and Wouters, R. (2007). Shocks and frictions in US business cycles: A Bayesian DSGE approach. *American Economic Review*, 97(3):586–606.

Taylor, J. B. (1993). Discretion versus policy rules in practice. In *Carnegie-Rochester Conference Series on Public Policy*, volume 39, pages 195–214. Elsevier.

Turner, A. (2013). Debt, money, and mephistopheles: how do we get out of this mess?

Turner, A. (2015). The case for monetary finance–an essentially political issue. In *16th Jacques Polak Annual Research Conference*, pages 5–6.

Turner, A. (2017). *Between debt and the devil: Money, credit, and fixing global finance*. Princeton University Press.

Woodford, M. (2012). Methods of policy accommodation at the interest-rate lower bound. available at https://doi.org/10.7916/D8Z899CJ.