On the Interactions between Money Supply and Fiscal Stimuli

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Abstract

At the onset of the crisis triggered by the global spread of the COVID-19 pandemic, numerous scholars advocated for utilizing money supply issued by the central bank to support expansionary fiscal interventions. This paper aims to further investigate and evaluate this proposal. Specifically, we develop and estimate a New Keynesian model to analyze the effects of a fiscal stimulus that does not result in an increase in public debt and is financed by money supply. Through our impulse response analysis, we validate the findings of Galí (2020a), which indicate that an increase in monetary-financed government spending and monetary-financed government transfers have positive economic impacts on consumption and output. Notably, our model also demonstrates similarly positive effects on investment. The estimation of the model is conducted using US data, thereby contributing to the existing literature by providing a quantitative counterfactual analysis of the utilization of money supply for financing fiscal stimuli.

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1 Introduction

The interactions between monetary policy and fiscal policy have been extensively examined in the economic literature. Notably, studies by Sargent et al. (1981), Leeper (1991), Sims (1994), Schmitt-Grohé & Uribe (2000) and Davig & Leeper (2011), among others, investigate the implications the fiscal-monetary policy mix on various economic variables. Bianchi et al. (2020) and Mertens & Ravn (2014) examine the collaborative nature of monetary and fiscal policies as an effective tool for mitigating the adverse effects of economic and non-economic shocks.

The outbreak of the COVID-19 pandemic has resulted in disruptions to both aggregate demand and aggregate supply, leading to adverse global consequences such as unemployment and increased inequalities. Among others, Benigno & Nisticò (2020) highlight the ongoing debate among academics and policymakers, suggesting that cooperation between governments and central banks could lead to effective measures in mitigating the adverse impact of the crisis.

Our analysis primarily focuses on periods characterized by high levels of public debt, low inflation, and subdued aggregate demand. In this economic context, our model demonstrates the expansionary economic impact of a monetary-financed fiscal stimulus. As noted in Bianchi et al. (2023), the share of government transfers in relation to GDP has exhibited an upward trend over the past decades. This is shown in figure 1. In our analysis, we will examine the effects of both government transfers and government spending.

Additionally, figure 2 depicts the evolution of the M2 monetary aggregate and government spending over the last four decades. The figures demonstrate a similar pattern of percentage changes in both the M2 and government spending series. Moreover, the aftermath of the COVID-19 crisis in 2020-2021 has contributed to a significant increase in US public debt, leading to the implementation of President Biden's $1.9 trillion 2021 COVID-19 Stimulus Package. Therefore, we find it pertinent to conduct a counterfactual analysis to examine the economic impact of fiscal stimuli combined with money supply. During and in the aftermath of the COVID-19 pandemic, central banks worldwide have taken measures to address the economic challenges. This included reducing interest rates to historically low levels and implementing policies aimed at facilitating lending procedures, both to businesses and financial institutions. Furthermore, central banks have undertaken substantial investments through asset-purchasing programs to support financial markets and stabilize the economy. Concurrently, governments have implemented significant fiscal stimuli, leading to a further increase in sovereign debt levels.

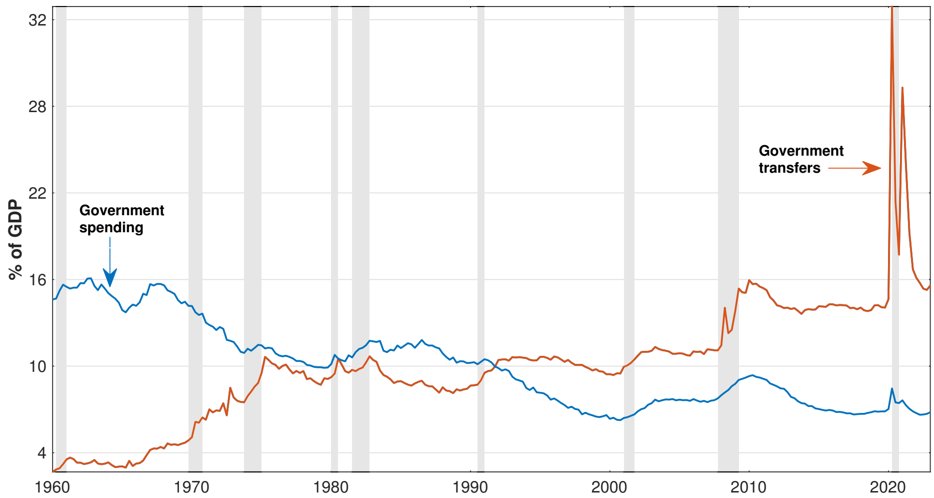
In this economic landscape, constrained by the zero lower bound on interest rates, high levels of public debt, and substantial fiscal stimulus, the concept of a "money-financed fiscal stimulus" Galí (2020a) has gained growing consensus among scholars[1].

According to Galí (2020b), in practice, the monetary-financed fiscal stimulus would involve a credit to the government account held at the central bank or the acquisition of non-redeemable government debt from the central bank. Consequently, this debt would be permanently held on the balance sheet of the central bank. Another line of literature, as proposed by (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 experiences a permanent increase[2]. The use of monetary-financing is typically reserved for extreme circumstances when public debt levels are already high and interest rates are too low to provide an effective tool for economic recovery and combating low inflation. During times of aggregate demand disruptions, Woodford (2012) and Turner (2015) demonstrate that monetary-financing would stimulate aggregate demand to a greater extent compared to debt-financing.

[1]Some authors (e.g. Bernanke (2003)) refer to the concept using Milton Friedman's terminology "Helicopter money", which refers to lump-sum transfers to households financed by newly printed money. Cukierman (2020) and Galí (2020a) discuss seignoirage, which is defined as the purchasing power of increased money supply used by the central bank to directly purchase *newly issued* government debt. In this case, the central bank would buy government debt and the government would not have to repay the debt, nor the interest on it. Giavazzi & Tabellini (2014) propose the issuance of long-term maturity debt, such as 30 years, which would be bought by the central bank. Andolfatto et al. (2013) analyzes the monetization of public debt, which involves the permanent purchase of government bonds from the central bank.

[2]It is worth noting that this distinguishes monetary-financed fiscal stimuli from quantitative easing, which has only a temporary impact on the monetary base.

Figure 1: Government spending and government transfers as a percent of US GDP



Note: Shaded areas represent NBER recessions.

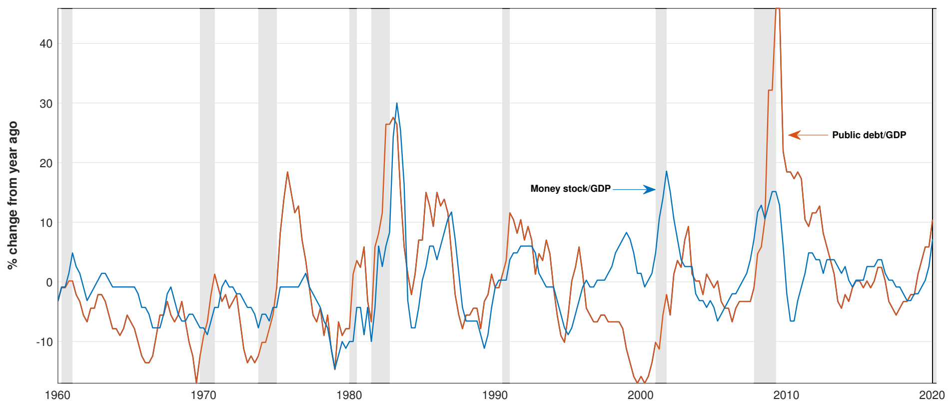
Turner (2015) further argues that monetary-financing is more desirable and optimal compared to alternative policies measures.

Bernanke (2003) advocates for providing fiscal stimulus through a tax cut or government spending backed by money creation. He emphasizes the importance of clearly stating that "much or all of the money creation should be viewed as permanent" (Bernanke (2003)). By utilizing money supply to finance a fiscal stimulus through a permanent increase in the monetary base, it becomes possible to address the issue of Ricardian equivalence[3] that undermine the efficiency of fiscal stimuli.

A policy measure involving the cooperation between the central bank and the government to achieve monetary-financing of public debt has raised concerns regarding the potential consequences of hyperinflation (Sargent & Wallace, 1973). However, our analysis focuses on a counterfactual scenario involving monetary-financed fiscal stimuli during a period when the central bank has limited scope to implement

[3]Ricardian consumers are individuals who recognize that a tax cut or increase in transfers today will eventually lead to higher taxes in the future. As a result, they tend to save the additional funds gained from the tax cut rather than spending them, thereby undermining the effectiveness of fiscal stimuli.

Figure 2: Money supply and debt to GDP ratio in the US



Note: Money supply aggregate is represented by M2. Shaded areas represent NBER recessions.

expansionary monetary policy due to low interest rates. Therefore, our economic setting differs from a high inflation period in which central banks raise policy rates to combat inflation and manage inflation expectations. Given the persistent low inflation and well-anchored inflation expectations observed over the past decade, as well as the recognition of the credibility and independence of central banks in developed countries by the market, some authors argue that the risk of hyperinflation may be of lesser concern (Cukierman, 2020). Lawson & Feldberg (2020) explain that "countries with consistently low inflation, credible central banks, and strong economic fundamentals could potentially monetize certain COVID-19 expenditures without experiencing excessive inflation or compromising central bank independence." Furthermore, past instances of hyperinflation resulting from the monetization of public spending occurred during periods when central banks and governments were not separate entities.

Another criticism comes from the political sphere, as highlighted by Giavazzi & Tabellini (2014) and Turner (2015). They argue that the use of the money-financing policy may be misleading and lead to its excessive and unwarranted utilization. Turner (2015) further contends 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 money-financing policy becomes the optimal approach to stimulate aggregate demand.

As assessed in previous literature and corroborated in our analysis, a monetary-financed fiscal policy that does not increase public debt has the potential to increase inflation levels. As mentioned earlier, the focus of this paper is to evaluate the macroeconomic impact of a monetary-financed fiscal stimulus during periods of low aggregate demand and when interest rates are constrained by the effective lower bound. Given the limited scope for expansionary monetary policy in such a liquidity trap scenario, it becomes pertinent to quantitatively investigate this alternative proposal. In this particular setting, characterized by persistently low inflation levels (as observed in the US over the past decade), an inflationary effect resulting from monetary-financed fiscal stimuli can serve to mitigate a portion of the government debt burden through the process of "inflating-away." Bianchi et al. (2023) develop a theoretical framework that allows for partially unfunded fiscal shocks. Similar to the monetary financing scheme, unfunded fiscal shocks have a positive impact on real variables. In their model, the central bank controls monetary policy while the government controls fiscal policy. However, the central bank accommodates the necessary increase in inflation to support the unfunded fiscal shocks. Our quantitative analysis contributes to the existing literature on monetary-financed fiscal stimuli, specifically in the context of US data. By conducting a counterfactual analysis of the utilization of money supply to finance fiscal stimuli, we provide insights into the potential implications and outcomes of such a policy approach.

From a theoretical point of view, we adopt the framework proposed by Galí (2020a), in which money supply is determined endogenously and finances the fiscal stimuli. This framework is integrated into a medium-scale New Keynesian model that includes habits on consumption, nominal rigidities, capital, investment adjustment costs. Our model features a rich set of shocks enabling us to disentangle the effects of a monetary-financed fiscal stimulus. In our analysis we compare the impact on aggregate demand of an increase in government spending and lump-sum transfers financed by money supply, with the same fiscal stimulus financed by debt. On the fiscal side, our model incorporates shocks to government transfers to households and government spending. These models have been proven to provide a relatively good fit for US business cycle fluctuations (Del Negro et al. (2007), Smets & Wouters (2007), L. Christiano et al. (2011)). We therefore estimate our model with Bayesian techniques for the sample period 1960Q1:2019Q4 using US data. We proceed with a counterfactual analysis employing the estimated parameters derived from our model. To conduct this analysis, we extend our model to incorporate a "monetary-financing" component, wherein the money supply becomes an integral part of the government budget constraint. Within this framework, the central bank accommodates fiscal policy and shifts its emphasis from interest rate management to controlling the money supply.

Through our impulse response analysis, we validate the expansionary effects associated with this alternative monetary strategy. In Section 5 we discuss these effects more in detail.

The rest of the paper is structured as follows. Section 2 describes the theoretical model. In section 3 data and calibration are presented. Section 4 discusses the estimation results. Section 5 shows simulation results comparing a scenario in which fiscal stimulus is monetary-financed and a scenario in which fiscal stimulus is debt-financed. Section 6 describes robustness analysis, and section 7 concludes.

2 Theoretical model

In this section the theoretical model is described. The structure of the model is similar to medium-scale new Keynesian models studied in the literature (Smets & Wouters (2007), L. J. Christiano et al. (2005), Del Negro & Schorfheide (2008), Leeper et al. (2017)).

The economy is populated by a continuum of agents, intermediate good firms, a final good firm, a government and a central bank. Intermediate firms are monopolistically competitive, rent capital from households, produce goods by setting prices à la Calvo (Calvo, 1983). The final good is produced and packed by a final good firm and is then sold to households. The wage is set on a frictional labor market. The households in turn provide labor to intermediate firms, obtain dividends from the firms, and utility from consumption, real balances, labor and fiscal policies. For the fiscal policy side, we focus on transfers and government consumption. The government issuing (expansionary) fiscal policies faces a scenario in which additional public debt emerging from the expansionary fiscal policy is debt-financed, that is through issuance of government bonds. We estimate this model on US data. We then run a counterfactual analysis in which the central bank and the government act jointly to finance the increase in public debt. In this analysis, the central bank pursues a monetary policy strategy that requires to totally give up the control on the interest rate, and focus instead on the quantity of money supply. The government finances the increase in public debt through an increase in money supply. This is the "monetary-financed scenario", opposed to the more traditional "debt-financed scenario". We can therefore analyse the macroeconomic impact of a monetary-financing strategy making use of estimated parameters obtained from our "debt-financed scenario" model.

Henceforth, upper case variables with a time subscript are variables in levels, steady state variables are letters without a time subscript and lower case variables with a hat are linearized variables. Linearization is made in terms of log deviations of a variable from its steady state value, in line with the literature on DSGE models.

2.1 Households

The household derives utility from consumption, real balances and labor according to the following utility function:

$$E_t \left\{ \sum_{t=0}^{\infty} \beta^s b_{t+s} \left[\left(ln\left(C_{t+s}(j) - hC_{t+s-1}(j)\right) + \frac{\chi}{1-\nu_m} \left(\frac{M_{t+s}(j)}{P_{t+s}} \right)^{1-\nu_m} \right) - \frac{\phi_t}{1+\nu_l} L_{t+s}(j)^{1+\nu_l} \right] \right\} \tag{1}$$

where C_t, $\frac{M_t}{P_t}$, L_t represent respectively consumption, real balances and labor, β_t is the discount factor, b_t represents a preference shifter to the household's utility function, h is a parameter representing habits, ϕ_t and χ_t are two preference shifters affecting the marginal utility of leisure and money holdings. The preference shifters follow AR(1) processes as follows:

$$ln\,\phi_t = (1-\rho_\phi)\,ln\,\phi + \rho_\phi\,ln\,\phi_{t-1} + \sigma_{\phi,t}\,\epsilon_{\phi,t}, \text{with}\,\epsilon_{\phi,t} \sim N(0,1) \tag{2}$$

$$ln\,b_t = (1-\rho_b)\,ln\,b + \rho_b\,ln\,b_{t-1} + \sigma_{b,t}\,\epsilon_{b,t}, \text{with}\,\epsilon_{b,t} \sim N(0,1) \tag{3}$$

In our model consumption and real money balances enter the household‘s objective function in a separable way, following Del Negro & Schorfheide (2008). This utility function implies that the consumer‘s Euler equation does not depend on money balances, in line with most empirical evidence (Punzo & Rossi, 2022).

The budget constraint the household faces is given by:

$$\begin{aligned} &P_{t+s}C_{t+s}(j) + P_{t+s}I_{t+s}(j) + B_{t+s}(j) + M_{t+s}(j) \\ &= R_{t+s-1}B_{t+s-1}(j) + M_{t+s-1}(j) + R^k_{t+s}(j)K_{t+s-1}(j) \\ &+ W_{t+s}(j)N_{t+s}(j) + P_{t+s}D_{t+s}(j) + P_{t+s}T_{t+s}(j) \end{aligned} \tag{4}$$

and the following equation for capital accumulation:

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

where I_t is investment, K_t is capital and R^k_t is the rate of return on capital. Bonds B_t pay a price of $R_t = 1 + i_t$. Households receive T_t transfers from the government and D_t represent dividends obtained from firms. W_t is the nominal wage obtained by the households. $S(\cdot)$ is a function representing the investment adjustment costs, with $S''(\cdot) > 0$. δ is the depreciation rate of capital.

μ_t represents a shock to investment, and follows an AR(1) process:

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

2.2 Labor packers

The economy is populated by labor packers, which hire households providing labor, combine it into labor services, L_t, and provide it to intermediate firms.

$$L_t = \left[\int_0^1 L_t(j)^{1/(1+\lambda_w)}di\right]^{1+\lambda_w} \tag{7}$$

We follow Del Negro & Schorfheide (2008), and we set λ_w as a parameter. We obtain a labor demand function and the price of aggregated L_t:

$$L_t(j) = \left(\frac{W_t(j)}{W_t}\right)^{-(1+\lambda_w)/\lambda_w} L_t \tag{8}$$

and

$$W_t = \left[\int_0^1 W_t(j)^{-1/\lambda_w} di\right]^{-\lambda_w} \tag{9}$$

The wage setting is subject to nominal rigidities a la Calvo. Each period a fraction ξ of households cannot optimize nor change their wage. For these households, the wage increases at the geometrically weighted average of the steady state rate of inflation $\pi^\star$ and of last period‘s inflation π_{t-1} with weights $1-\iota_w$ and ι_w. The problem for the households that can adjust their wages is:

$$\begin{aligned}
&\max_{\tilde{W}_t} E_t \sum_{t=0}^{\infty} \zeta_w^s \beta^s b_t \left[-\frac{\phi_t}{1+\nu_l} L_t(j)^{1+\nu_l}\right] \\
&\text{s.t. } L_t(j) = \left(\frac{W_t(j)}{W_t}\right)^{-\frac{1+\lambda_w}{\lambda_w}} L_t \\
&\text{eq. (4) and} \\
&W_{t+s}(j) = \left(\prod_{l=1}^{s} (\pi^*)^{1-\iota_w} (\pi_{t+l-1})^{\iota_w}\right) \tilde{W}_t(j)
\end{aligned} \tag{10}$$

The first order condition of the problem above is:

$$W_t = \left[(1-\zeta_w)\,\tilde{W}_t^{-1/\lambda_w} + \zeta_w \left((\pi^*)^{1-\iota_w} (\pi_{t-1})^{\iota_w} W_{t-1}\right)^{-1/\lambda_w}\right]^{-\lambda_w} \tag{11}$$

2.3 Final good firms

Final good firms operate in a perfectly competitive market and produce an homogeneous good Y_t. The final good firms buy intermediate goods from intermediate firms and pack and sell the final good Y_t to consumers. Thus, Y_t is an index represented by a continuum of intermediate goods $Y_t(i)$:

$$Y_t = \left[\int_0^1 Y_t(i)^{\frac{1}{1+\lambda_t^p}} di\right]^{1+\lambda_t^p} \tag{12}$$

with λ_t^p following an AR (1) process:

$$ln\lambda_t^p = (1-\lambda_t^p)\, ln\lambda^p + \rho_{\lambda^p}\, ln\lambda_{t-1}^p + \sigma_{\lambda^p}\, \epsilon_{\lambda_t^p} \tag{13}$$

$$\text{and } \epsilon_{\lambda_t^p} \sim N(0,1) \tag{14}$$

We obtain that

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

and the price of the final goods firm is:

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

where the price of the final good is P_t and the price of the intermediate good (i) is $P_t(i)$.

2.4 Intermediate good firms

The representative intermediate goods firm follows a Cobb Douglas technology that makes use of capital K_t and labor L_t through the following relation:

$$Y_t(i) = max\left\{A_t^{1-\alpha} K_t(i)^{\alpha} L_t(i)^{1-\alpha} - A_t\Omega, 0\right\} \tag{15}$$

where Y_t is the output produced in period t and A_t represents fixed technology across all firms. The logarithm of A_t, a_t follows an AR(1) process:

$$a_t = \rho_a a_{t-1} + \sigma_a \epsilon_t^a,\ \epsilon_t^a \sim N(0,1)$$

The intermediate firm decides on the quantity of capital stock to rent from households and on the quantity of labor to employ. Capital and labor represent costs for the firms, and as a consequence the firm's problem is to maximize its profits and minimize the costs, according to the following problem:

$$\min_{K_t N_{it}} W_t N_{it} + R_t^k K_t$$

that results in a capital-labor ratio which is equal for all firms:

$$\frac{K_t(i)}{L_t(i)} = \frac{\alpha}{1-\alpha}\frac{W_t}{R_t^k} \tag{16}$$

Intermediate goods firms set their prices à la Calvo (1983). Calvo price setting allows a number $1-\theta$ of firms to reset their prices in period t, while the remaining θ fraction of firms keep their prices indexed to the inflation rate in period $t-1$. Those firms that cannot adjust their prices will have a price increasing with the steady state inflation π and the inflation in period $t-1$, π_{t-1}. Firms that may change their price, choose a price P_t^* today taking into consideration the impact of P_t^* on future profits. The price P_t^* is the same across all firms readjusting it.

The price setting for intermediate good firms follows the same process as for wages. A fraction of firms $1-\zeta^p$ adjust their prices, while a fraction ζ^p cannot adjust them. Prices for the non adjusting firms follow:

$$P_t(i) = (\pi_{t-1})^{\iota^p} (\pi^*)^{1-\iota^p} \tag{17}$$

and the firms able to adjust their prices, follow the optimal price equation:

$$\max_{\tilde{P^*}_t} \sum_{s=0}^{\infty} \zeta_p^s \beta^s \Xi_{t+s}^p \left(\tilde{P}_t(i) \left(\prod_{l=1}^{s} \pi_{t+l-1}^{\iota^p} \pi^{*1-\iota^p} \right) - MC_{t+s} \right) Y_{t+s}(i) \tag{18}$$

where $\tilde{P}_t(i)$ is the newly set price and MC_{t+s} is the marginal cost. ι^p represents the price indexation parameter and Ξ_{t+s}^p is the Lagrange multiplier.

Aggregate price dynamics, considering the Calvo pricing parameter is given by:

$$P_t = \left[(1-\zeta_p) \tilde{P}_t(i)^{-\frac{1}{\lambda_{f,t}}} + \zeta_p \left(\pi_{t-1}^{\iota_p} \pi_\star^{1-\iota_p} P_{t-1} \right)^{-\frac{1}{\lambda_{f,t}}} \right]^{-\lambda_{f,t}}$$

The aggregate price is thus given by a weighted average of the price set by the firms that adjust it and the price of firms that keep it indexed to last period's inflation, with a weight given by ζ_p.

2.5 Monetary policy

The central bank adjusts the nominal interest rate r_t according to changes in inflation and the difference between output and potential output (the output gap as in Taylor (1993)). In this setting, the central bank therefore focuses on the interest rate and the money supply adjusts automatically, in order to match the household's money demand. The central bank follows the following empirical Taylor rule:

$$\frac{R_t}{R^*} = \left(\frac{R_{t-1}}{R^*} \right)^{\rho_m} \left[\left(\frac{\pi_t}{\pi^*} \right)^{\phi_\pi} \left(\frac{Y_t}{Y^*} \right)^{\phi_y} \right]^{1-\rho_m} e^{\sigma_m \epsilon_t^m} \tag{19}$$

where R^* and Y^* are the target level of interest rate and output set by the central bank, π^* is the inflation target, and ρ_m captures the degree of interest rate smoothing. ϕ_π and ϕ_y are the so called Taylor rule parameters, describing the relation between inflation and output, and the interest rate. ϵ_t^m is a monetary policy exogenous shock and it is assumed to follow an AR (1) process:

$$\epsilon_t^m = \rho_m \epsilon_{t-1}^m + \mu_t^m, \, \mu_t^m \sim N(0,1)$$

2.6 Fiscal policy

The government budget constraint is:

$$P_t G_t + B_{t-1}(1 + i_{t-1}) = P_t T_t + B_t + \Delta M_t \tag{20}$$

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

In line with Galí (2020a), transfers follow a fiscal rule, that we construct based on Leeper et al. (2010).

$$T_t = -\psi_{yt} Y_t - \psi_{bt} \frac{B_{t-1}}{P_{t-1}} + t_t^* \tag{21}$$

where t_t^* is a shock to taxes and it is assumed to follow the AR process:

$$t_t^* = \rho^t t_{t-1}^* + \sigma^t \epsilon_t^t, \, \epsilon_t^t \sim N(0,1) \tag{22}$$

The government spending shock follows an AR process:

$$g_t = \rho^g g_{t-1} + \sigma^g \epsilon_t^g, \, \epsilon_t^g \sim N(0,1) \tag{23}$$

In this analysis, we focus on transfers adjusting to the level of output and public debt. For this reason, government spending follows an autoregressive process. We do this because transfers have exhibited an upward trend since 1960, as shown in Figure 1 and noted in Bianchi et al. (2023). Furthermore, transfers are an important instrument for fiscal policy, especially during a recession.

3 Data and calibration

The data is quarterly and is available on the website of the Federal Reserve Bank of St. Louis. All observable variables are constructed as in Smets & Wouters (2007), while fiscal variables are constructed following the methodology described in Leeper et al. (2010).

3.1 Data construction

In this section we describe the data construction. In what follows, the following FRED data series are used: GDPDEF is the implicit price deflator that is seasonally adjusted, with 2012=100. POPINDEX is a population index such that population in 1992Q3=1. CNP16OV is the civil non institutional population 16 year and older. The series is non seasonally adjusted, and it is expressed in thousands. The variables are constructed as follows:

1. Consumption:

$$100\text{*LN}\left(\frac{\text{Non durable goods and services/GDPDEF}}{\text{POPINDEX}}\right) \tag{24}$$

2. Output:

$$100\text{*LN}\left(\frac{\text{Real Gross Domestic Product(GDPC1)}}{\text{POPINDEX}}\right) \tag{25}$$

3. Investment:

$$100\text{*LN}\left(\frac{\text{Fixed Private Investment(FPI)}}{\text{POPINDEX}}\right) \tag{26}$$

4. Hours worked:

$$100\text{*LN}\left(\frac{\text{Nonfarm Business: Average Weekly Hours(PRS85006023)*Employment(CE16OV)}}{\text{POPINDEX}}\right) \tag{27}$$

5. Real wage:

$$100\text{*LN}\left(\frac{\text{Nonfarm Business Sector: Real Hourly Compensation (COMPRNFB)}}{\text{GDPDEF}}\right) \tag{28}$$

6. Inflation:

$$100\text{*LN}\left(\Delta\text{GDPDEF}\right) \tag{29}$$

For a first analysis, considering the prolonged period with interest rates hitting their effective lower bound, we use the Shadow rate as in Wu & Xia (2016)[4]. However, we also estimated our model with the short term nominal interest rate. Estimation results are robust to both interest rate time series. Shadow rates and short term

[4]The series are available here: https://www.atlantafed.org/cqer/research/wu-xia-shadow-federal-funds-rate.

interest rates are constructed as:

7. Shadow rate and nominal interest rate:

$$\frac{\text{Shadow rate}}{4} \tag{30}$$

$$\frac{\text{Effective federal funds rate (FEDFUNDS)}}{4} \tag{31}$$

Fiscal variables are available on the Bureau of Economic Analysis website, and are retrieved from the NIPA tables available at https://www.bea.gov/data/government/receipts-and-expenditures.

8. Government spending:

$$100{*}\mathrm{LN}\left(\frac{\mathrm{GS/GDPDEF}}{\mathrm{POPINDEX}}\right) \tag{32}$$

where GS = (Government consumption expenditure + government gross investment + government net purchases of non-produced assets) - consumption of fixed capital

9. Transfers:

$$100{*}\mathrm{LN}\left(\frac{\mathrm{T/GDPDEF}}{\mathrm{POPINDEX}}\right) \tag{33}$$

where T = [(current transfer payments - current transfer receipts) + (capital transfer payments - capital transfer receipts) + subsidies] (table 3.2, lines 26, 19, 46, 42, 36) - [(current tax receipts + contributions for government social insurance + income receipts on assets + current surplus of government enterprises) (table 3.2, lines 2, 10, 13, 23) - *total tax revenues*]
and:
total tax revenues = consumption tax revenues + labor tax revenues + capital tax revenues
with:
consumption tax revenues = excise taxes + custom duties
labor tax revenues = average labor income tax rate * tax base
capital tax revenues = average capital income tax rate * tax base

10. Money supply:

$$100^*\text{LN}\left(\frac{\text{M2(M2SL)/GDPDEF}}{\text{POPINDEX}}\right) \tag{34}$$

3.2 Calibration

Table 1 describes calibrated values for parameters. We fix the household's discount factor to 0.999 to match a 2% annualized real interest rate. We obtain an average annual inflation that closely matches the one in our sample, equal to 4.90%. The labor share in our production function is calibrated to be 0.33, a standard value in literature. The capital depreciation rate is set at 0.025. We follow Galí (2015) to fix the inverse elasticity of substitution between money and consumption, and set the parameter to 1. Finally, the inverse velocity of money supply is calibrated to 0.52, the average value in our sample.

Table 1: Calibrated parameters and source

Parameter	**Value**	**Source**
β Household's discount factor	0.999	to match 2% annual int.rate
α Labor share in Cobb Douglas function	0.33	Del Negro et al. (2007)
δ Capital depreciation rate	0.025	Del Negro et al. (2007)
ν Inverse elasticity of substitution consumption to money	1	Galí (2015)
χ Inverse velocity of money supply	0.52	Our sample

4 Estimation results

Table 2, 3, 4 show results for parameters estimated with Bayesian estimation.

Table 2: Standard errors of shocks

Parameter	Prior			Posterior		
	Distribution	*Mean*	*St. Dev*	*Mean*	10%	90%
σ_z Productivity shock standard error	Inv. gamma	0.1	2	1.19	1.09	1.28
σ_b Risk premium shock standard error	Inv. gamma	0.1	2	2.80	2.35	4.14
σ_g Government spending shock standard error	Inv. gamma	0.1	2	2.61	2.42	2.82
σ_i Investment shock standard error	Inv. gamma	0.1	2	13.98	8.69	19.29
σ_r Monetary policy shock standard error	Inv. gamma	0.1	2	0.26	0.24	0.28
σ_π Inflation shock standard error	Inv. gamma	0.1	2	9.44	5.58	14.38
σ_t Transfers shock standard error	Inv. gamma	0.1	2	4.46	4.12	4.80
σ_m Money supply shock standard error	Inv. gamma	0.1	2	24.48	55.45	64.63
σ_l Labor supply shock standard error	Inv. gamma	0.1	2	57.75	36.78	84.84

Table 3: Persistence parameters

Parameter	Prior			Posterior		
	Distribution	*Mean*	*St. Dev*	*Mean*	10%	90%
ρ_z Productivity persistence parameter	Beta	0.7	0.2	0.63	0.56	0.69
ρ_b Risk premium persistence parameter	Beta	0.7	0.2	0.36	0.25	0.48
ρ_g Government spending persistence parameter	Beta	0.7	0.2	0.63	0.55	0.71
ρ_μ Investment persistence parameter	Beta	0.7	0.2	0.34	0.24	0.44
ρ_r Monetary policy persistence parameter	Beta	0.7	0.2	0.21	0.11	0.31
ρ_π Inflation persistence parameter	Beta	0.7	0.2	0.64	0.55	0.74
ρ_t Transfers persistence parameter	Beta	0.7	0.2	0.35	0.26	0.45
ρ_m Money supply persistence parameter	Beta	0.7	0.2	0.77	0.70	0.84
ρ_l Labor supply persistence parameter	Beta	0.7	0.2	0.09	0.02	0.16

Table 4: Other parameters

Parameter	Prior			Posterior		
	Distribution	*Mean*	*St. Dev*	*Mean*	10%	90%
h Consumption habits	Beta	0.7	0.1	0.82	0.80	0.89
ρ_r Interest rate smoothing parameter	Beta	0.75	0.1	0.74	0.71	0.80
ϕ_π Taylor rule parameter inflation	Normal	2.00	0.1	0.84	1.70	2.04
ϕ_y Taylor rule parameter for output	Normal	0.25	0.1	0.04	0.00	0.07
Γ Investment adjustment costs	Normal	4.00	1.5	4.59	2.95	6.31
ψ_{bt} Transfers parameter for debt	Gamma	0.25	0.1	0.36	0.14	0.47
ψ_{yt} Transfers parameter for output	Gamma	0.1	0.05	0.11	0.03	0.20
ζ_w Wage stickyness	Beta	0.5	0.1	0.68	0.64	0.74
ι_w Wage indexation	Beta	0.5	0.2	0.13	0.01	0.23
ζ_p Price stickyness	Beta	0.5	0.1	0.85	0.83	0.88
ι_p Price indexation	Beta	0.5	0.2	0.07	0.01	0.14

5 Effects of monetary-financed fiscal stimuli

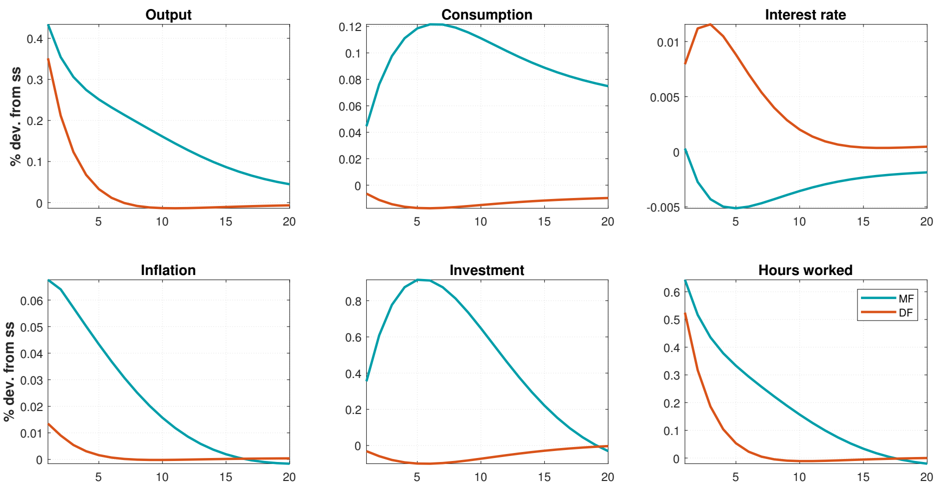
In this section we analyze two scenarios in which the government and the central bank work together to issue expansionary fiscal policies through fiscal stimuli. Two types of fiscal stimuli are analyzed: an increase in government transfers to households and an increase in government spending. We divide our analysis into two scenarios. We call the first scenario the “debt-financed fiscal stimuli” scenario. In this setting, the central bank pursues a monetary policy based on inflation targeting, which reflects empirical evidence from western countries and a number of developing and emerging countries. In this setting, the central bank focuses on controlling the policy rate. The model is a standard New Keynesian medium-scale model with all the rigidities necessary to match US agggregate data. We estimate the model representing this scenario. We call the second scenario “monetary-financed fiscal stimuli” scenario. Here, the central bank gives up of the control on the policy rate and focuses on the money supply. We adapt the second scenario to include the “monetary-financing” part and simulate the model with the parameters calibrated to the estimated parameters obtained from the “debt-financed fiscal stimuli” scenario. In the “debt-financed fiscal stimuli” scenarios, the model features a Taylor rule, as described by equation (19). In the opposite scenario, i.e. when the fiscal stimulus is financed by money supply, the fiscal and monetary authorities increase the money growth together with the fiscal stimuli in order to keep the public debt constant. Having constant debt implies that the deviation of the debt from its steady state value has to be equal to zero: $\hat{b}_t = 0$. In this case, the linearized version of equation (20) becomes:

$$\Delta m_t = \frac{1}{\chi}\left[\frac{g}{y}g_t + \frac{t}{y}t_t + \frac{b}{y}\frac{r}{\pi}\left(i_{t-1} - \pi_t\right)\right] \tag{35}$$

Figure 3 shows the impact of a one percent increase in government spending on the main economic variables in the two scenarios: when the government spending increase is financed by debt and when the government spending increase is financed by money. In this case, output increases in both scenarios, though the increase is much more persistent in the monetary-financing scenario. After an increase in government spending and the increase in nominal interest rates due to financing of government spending through debt, inflation needs to be stabilized. The monetary authority increases the nominal interest rate, decreases the money supply and the government increases future taxes. As a result, real rates increase, driving consumption down. A money-financed government spending increase leaves transfers and debt unchanged, while increasing inflation and lowering the real rate. This is key for our analysis, as consumption is no longer crowded-out. Thus, the monetary-financing setting represents one of the means through which consumption is crowded in after an increase in government spending (see e.g. Coenen & Straub (2005), Asimakopoulos et al. (2020)). Given the increase in consumption, also the impact on output is expansionary. The government and monetary authorities allow an increase in inflation, as they do not intervene to stabilize inflation. Therefore the positive shift in the consumption response is driven by the slightly higher nominal interest rate, which combined with the increase in inflation brings about a decrease in the real interest rate. The nominal interest rate increases only in response to an adjustment process inside the government budget constraint, thus by a smaller amount, as the government spending is not financed by debt.

Figure 4 shows the impact of a one percent increase in transfers on the main economic variables in the two scenarios: when the increase in transfers is financed by

Figure 3: Government spending: debt vs monetary-financing



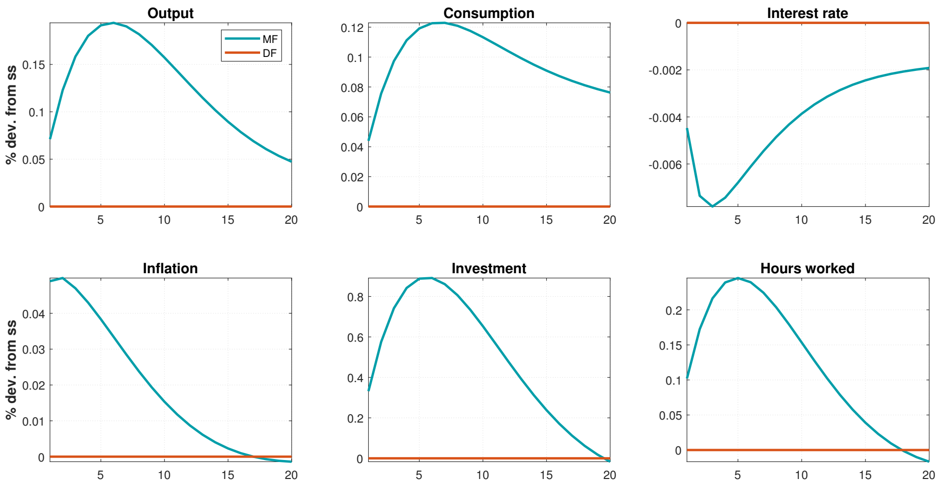
Note: The blue line represents the monetary-financed government spending, while the orange line is the debt-financed government spending

debt and when the increase in transfers is financed by money. The figure shows that economic variables are only impacted in the second scenario.

In the first scenario, the lack of impact on economic variables is explained by the effect of the Ricardian equivalence. When the fiscal stimulus is debt-financed, the monetary authority pursues an inflation targeting strategy to control inflation through a response to inflation in the nominal interest rate rule. A debt-financed increase in transfers has no or very little impact on economic variables, as consumers understand that a transfer increase today is payed back by higher future taxes. This causes output, consumption, and inflation to remain unchanged. Furthermore, the fiscal and monetary authorities do not need to adjust neither money supply nor interest rates in response to a debt-financed increase in transfers.

On the other hand, the increase in transfers financed by money has an expansionary impact on output and consumption, as the increase in transfers to households counts as a direct increase in disposable income. After the increase in money supply, the nominal interest rate adjusts accordingly. Consequently, also real interest rates decrease. This has a positive impact on spending, consumption and invest-

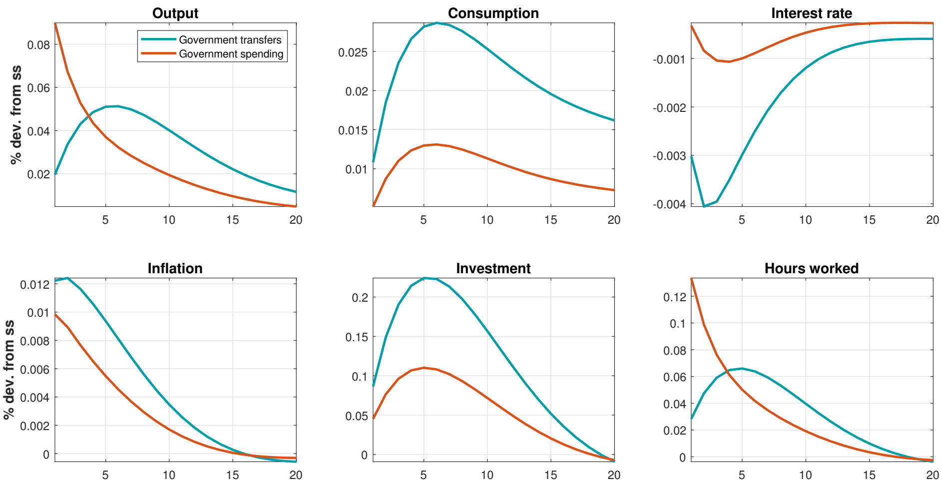
Figure 4: Transfers to households: debt vs monetary-financing



Note: The blu line represents the monetary-financed government transfers, while the orange line represents the debt-financed transfers

ment, which brings about an increase in output. The increase in output together with a constant debt level lowers the debt-to-output ratio. Inflation expectations increase, and this leads to an increase in quarterly inflation. The monetary-financed transfers shock explains the transmission mechanism of the expectations channel. Consumers understand that an increase in transfers in time t, that leaves public debt unchanged in time $t + k$ does not imply a taxes increase in the future. The result is that, without the Ricardian effect, the economy experiences an increase in spending, and consequently an expansionary impact on nominal GDP and consumption. Inflation expectations rise temporarily, bringing about an increase in inflation and, since the interest rates are near to zero, real interest rates remain low or decrease. This further enhances the raising level of spending. Moreover, higher inflation has an additional positive impact on levels of pre-existing debt, because it removes part of its value. Figure 5 shows the difference between 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 described in the previous

Figure 5: Monetary financing: spending and transfers



Note: The orange line shows the response to a government spending increase in a monetary-financing scenario. The blue line shows the response to a transfers increase

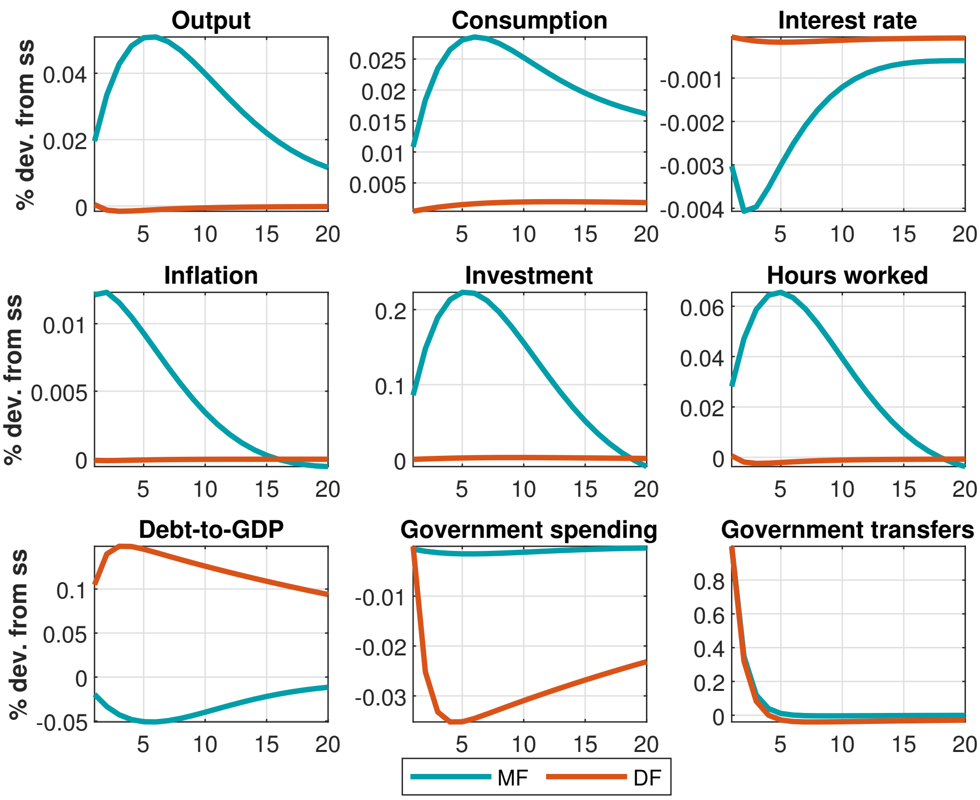
figures, the case in which the fiscal stimulus (either increase in transfers or increase in government spending) is financed by money has an expansionary impact on the main economic variables. Interestingly, the response of consumption to an increase in government spending is very similar to the increase in transfers. For output, the opposite holds: our model predicts a higher increase in output after an increase in government spending than after an increase in transfers.

6 Robustness analysis

In the previous section, we conducted a counterfactual analysis for a model where transfers follow a fiscal rule, as described in Galí (2020a), and government spending follows an AR process. Now, we will also incorporate a fiscal rule for government spending. The fiscal rule for government spending will be similar to the fiscal rule applied to transfers.

$$G_t = \psi_{yg} Y_t + \psi_{bg} \frac{B_{t-1}}{P_{t-1}} + g_t^* \tag{36}$$

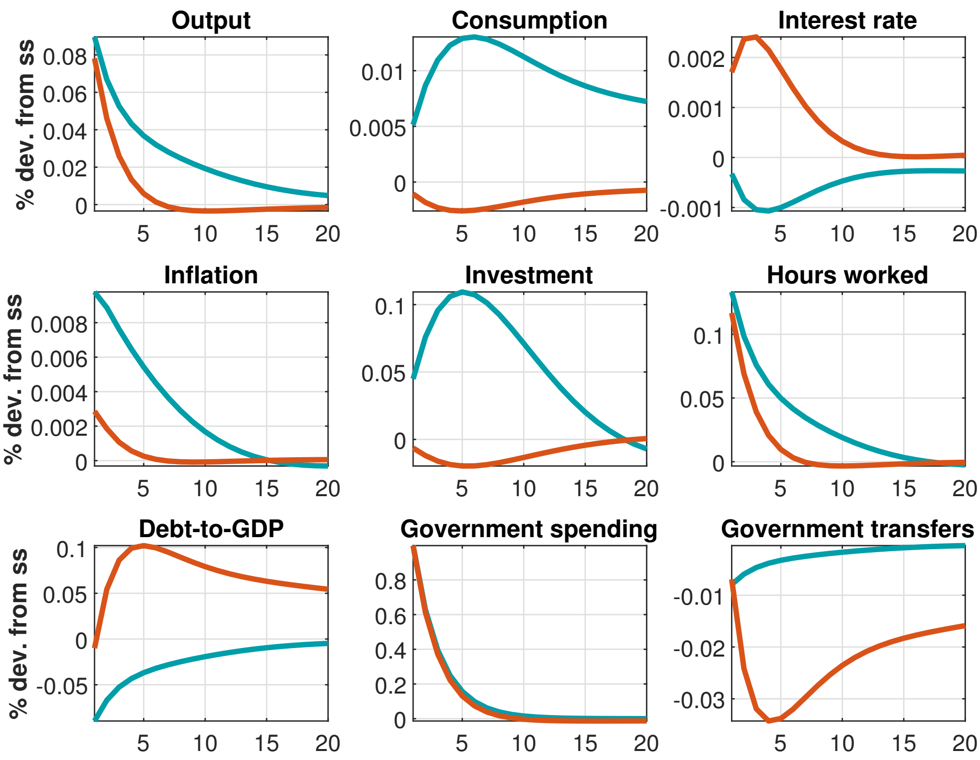
Figure 6: Transfers to households: debt vs monetary-financing



Note: The blue line represents the monetary-financed government transfers, while the orange line represents the debt-financed transfers

where g_t^* is an exogenous component, following an AR(1) process. The results are shown in Figure 6 and 7. When employing two fiscal rules, the results closely resemble those of the main analysis. As a second robustness check, we allow for one instrument to remain unchanged while the other is utilized for a fiscal stimulus. Therefore, we "shut down" transfers when implementing a positive shock to government spending, and likewise, we "shut down" government spending in the presence of a positive shock to transfers. Results for this analysis are shown in figures 8 and 9

Figure 7: Government spending: debt vs monetary-financing

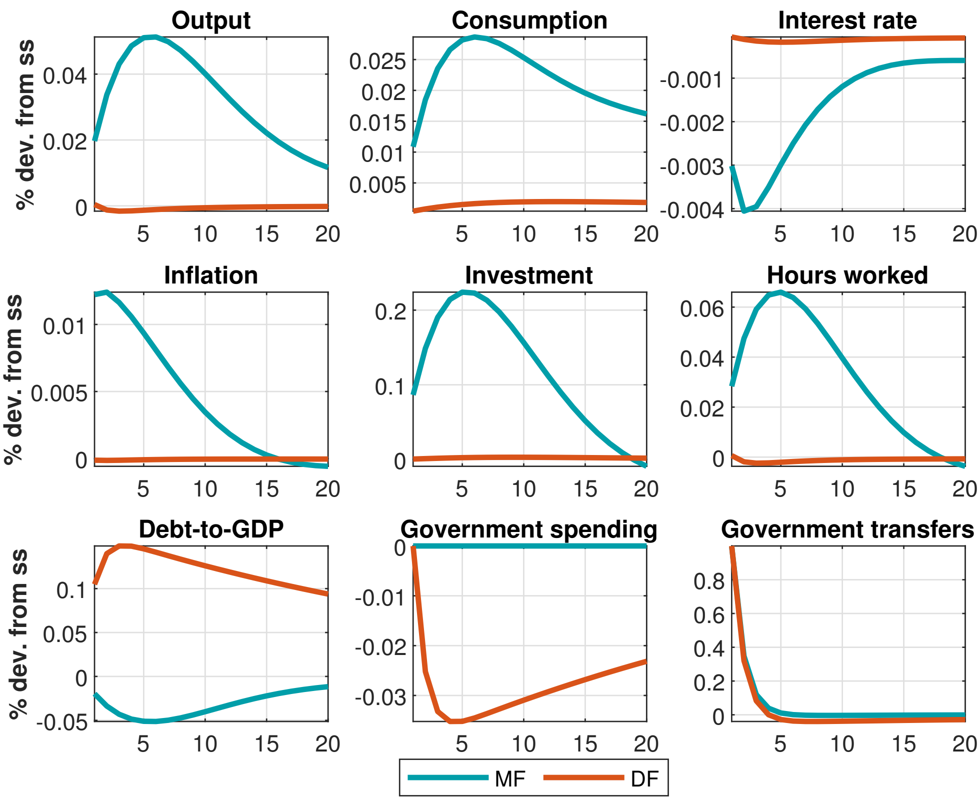


Note: The blue line represents the monetary-financed government spending, while the orange line represents the debt-financed government spending

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 context of the COVID-19 crisis, the rising levels of US government debt, the implementation of the massive ARPA stimulus package, and the prolonged period of low inflation observe 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, and employ Bayesian methods to estimate its parameters using US data. Subsequently, we conduct a simulation analysis by augmenting the model

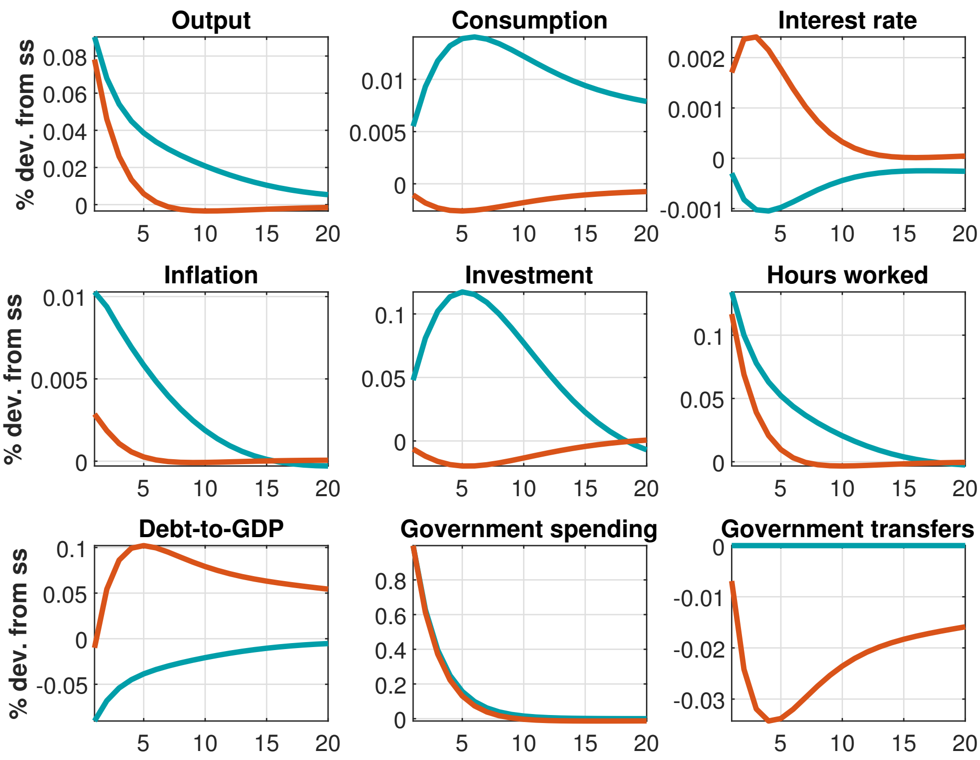
Figure 8: Transfers to households: debt vs monetary-financing



Note: The blu line represents the monetary-financed government transfers, while the orange line represents the debt-financed transfers

with a part representing a monetary-financed fiscal stimulus, using the previously estimated parameters. This allows us to quantitatively evaluate the expansionary impact of this alternative method of financing fiscal stimuli. We demonstrate that a monetary financing scheme for fiscal stimuli has positive impacts on all economic variables. However, this comes at a cost: an increase in inflation. 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, these features should be included in the model first.

Figure 9: Government spending: debt vs monetary-financing



Note: The blu line represents the monetary-financed government spending, while the orange line represents the debt-financed government spending

8 Log-linearized equations

Euler equation

$$(1-h\beta)(1-h)\ \xi_t =$$
$$(1-h)\ b_t - \left(\beta\, h^2\right) c_t + h\, c_{t-1} - \beta h\,(1-h)\,\mathbb{E}_t\left[b_{t+1}\right] + \beta h\,\mathbb{E}_t\left[c_{t+1}\right] \tag{37}$$

where $\quad \xi_t = r_t - \mathbb{E}_t\left[\pi_{t+1}\right] + \mathbb{E}_t\left[\xi_{t+1}\right]$

Money demand

$$\nu_m m_t = \chi_t + b_t - \frac{1}{R-1} r_t - \xi_t \tag{38}$$

Investment FOC

$$i_t - \frac{\beta}{1+\beta}\,\mathbb{E}_t\left[i_{t+1}\right] = \frac{1}{1+\beta} i_{t-1} + \frac{1}{\omega\left(1+\beta\right)} q_t - \frac{1}{\omega\left(1+\beta\right)}\xi_t + \frac{1}{\omega\left(1+\beta\right)}\epsilon_t^i \tag{39}$$

Law of motion of capital

$$k_t = \left(1 - \frac{i}{k}\right) k_{t-1} + \frac{i}{k} i_t + \frac{i}{k}\epsilon_t^i \tag{40}$$

Production function

$$y_t = a_t + \alpha k_t + \left(1-\alpha\right) n_t \tag{41}$$

Capital-labor relation

$$r_t^k = w_t + n_t - k_t \tag{42}$$

Household's FOC for capital

$$q_t = \frac{r^k}{r^k + (1-\delta)}\,\mathbb{E}_t\left[r_{t+1}^k\right] + \frac{(1-\delta)}{r^k + (1-\delta)}\,\mathbb{E}_t\left[q_{t+1}\right] + \frac{r^k}{r^k + (1-\delta)}\,\mathbb{E}_t\left[\xi_{t+1}\right] \tag{43}$$

Marginal cost

$$\Lambda_t = \alpha r_t^k + \left(1-\alpha\right) w_t - a_t \tag{44}$$

Wages

$$\begin{aligned} &w_t - w_{t-1} + \pi_t - \iota^w \pi_{t-1} = \\ &\frac{1-\omega^w}{\omega^w}\frac{1-\beta\omega^w}{1+\nu_l\frac{1+\lambda^w}{\lambda^w}}\left(b_t + \phi_l + \nu_l n_t - \xi_t - w_t\right) + \beta\,\mathbb{E}_t\left(w_{t+1} - w_t + \pi_{t+1} - \iota^w \pi_t\right) \end{aligned} \tag{45}$$

New Keynesian Phillips curve

$$\pi_t = \frac{\left(1-\omega^p\,\beta\right)\left(1-\omega^p\right)}{\left(1+\beta\,\iota^p\right)\;\omega^p}\left(\Lambda_t + \frac{\lambda^p}{1+\lambda^p}\epsilon_{\lambda_t^p}\right) + \frac{\iota^p}{1+\iota^p\beta}\,\pi_{t-1} + \frac{\beta}{1+\beta\,\iota^p}\;\mathbb{E}_t\left[\pi_{t+1}\right] \tag{46}$$

Aggregate economy

$$y_t = \frac{c}{y}\,c_t + \frac{i}{y}\,i_t + \frac{g}{y}\,g_t \tag{47}$$

Monetary policy

$$r_t = \left(1-\rho_m\right)\left(\phi_\pi \pi_t + \phi_y y_t\right) + \rho_m r_{t-1} + \lambda_t^m \tag{48}$$

Government budget constraint

$$\frac{b}{y}\frac{r}{\pi}\left(b_{t-1}+r_{t-1}-\pi_t\right)+\frac{g}{y}g_t+\frac{t}{y}t_t=\frac{b}{y}b_t+\chi_m\Delta m_t \tag{49}$$

Fiscal rules

$$t_t=-\psi_{yt}y_t-\psi_{bt}b_{t-1}+t_t^*$$
$$g_t=-\psi_{yg}y_t-\psi_{bg}b_{t-1}+g_t^*$$

Law of motion of money

$$m_{t-1}=m_t+\pi_t-\Delta m_t \tag{50}$$

Exogenous processes

Cost push: $\lambda_t^p=\rho_p\,\lambda_{t-1}^p+\epsilon_t^p$

Investment: $\lambda_t^i=\rho_i\,\lambda_{t-1}^i+\epsilon_t^i$

Monetary policy: $\lambda_t^m=\rho_m\,\lambda_{t-1}^m+\epsilon_t^m$

Equity premium: $\lambda_t^b=\rho_b\,\lambda_{t-1}^b+\epsilon_t^b$

Technoglogy: $a_t=\rho_a\,a_{t-1}+\epsilon_t^a$

Money demand: $\chi_t=\rho_\chi\,\chi_{t-1}+\epsilon_t^\chi$

Labor: $\phi_t^l=\rho_l\,\phi_{t-1}^l+\epsilon_t^l$

Transfers: $t_t^*=\rho_t^t t_{t-1}^*+\epsilon_t^t$

Gov. spending: $g_t^*=\rho_t^g g_{t-1}^*+\epsilon_t^g$

Appendix 8.A Additional figures

Figure 10: Multivariate convergence diagnostics

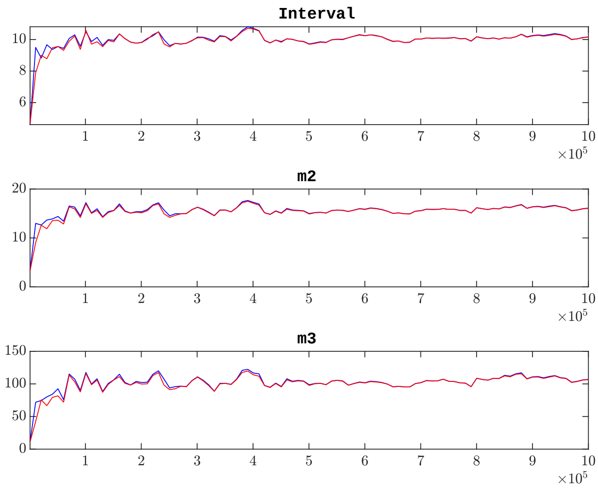
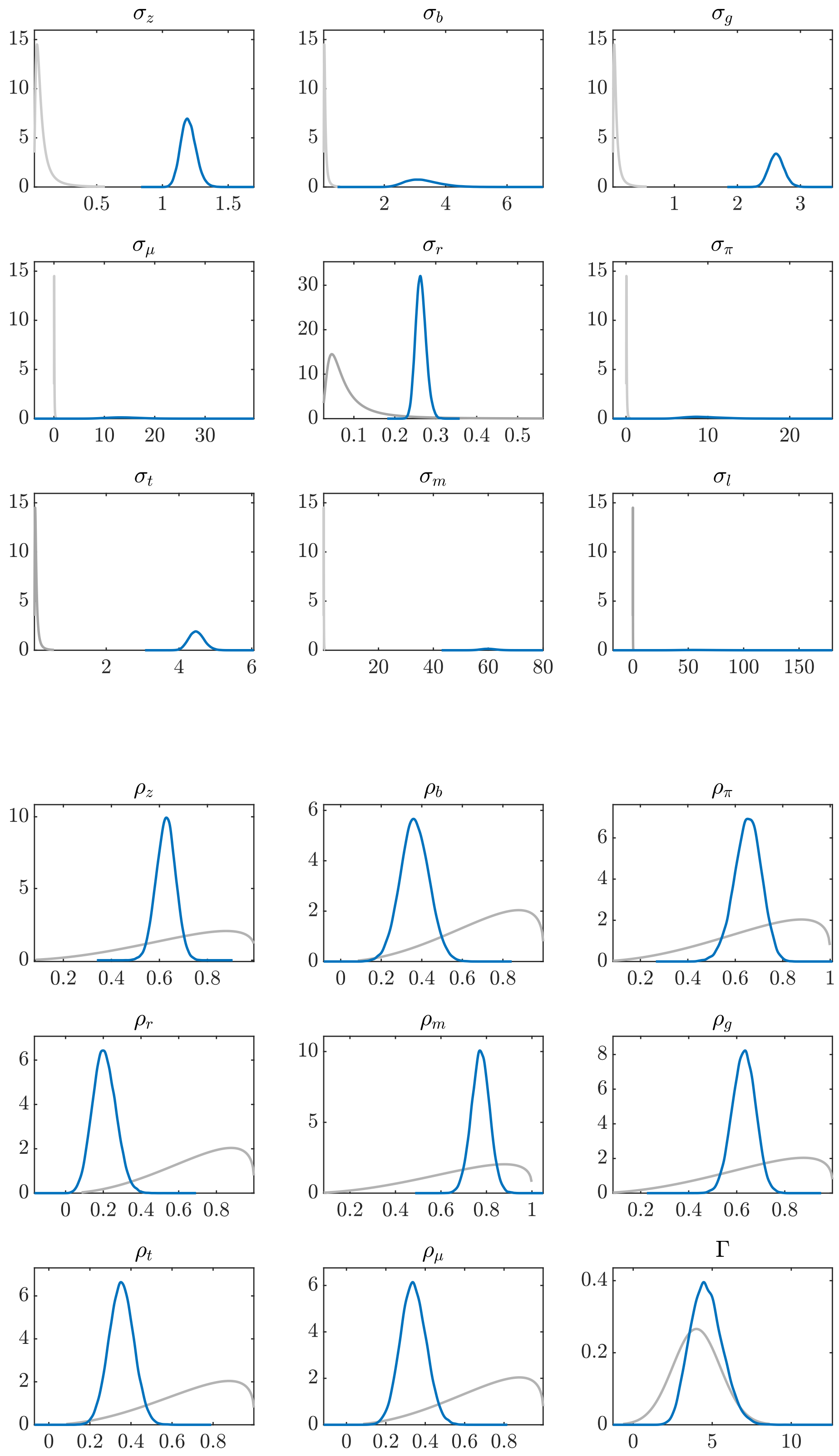
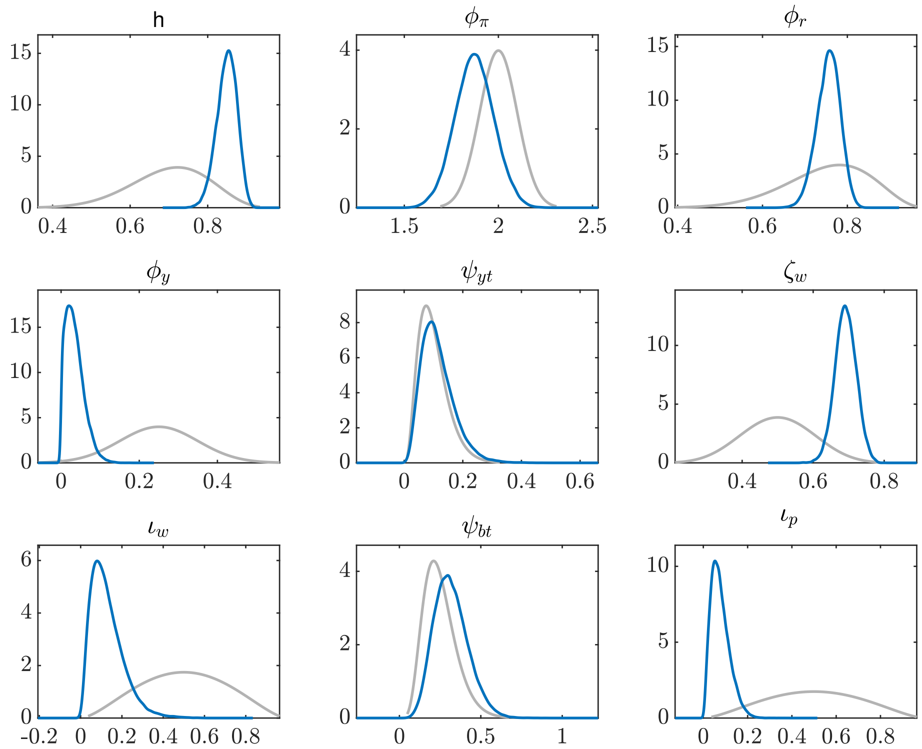


Figure 11: Priors and posteriors plots




h
ϕ_π
ϕ_r
ϕ_y
ψ_{yt}
ζ_w
ι_w
ψ_{bt}
ι_p

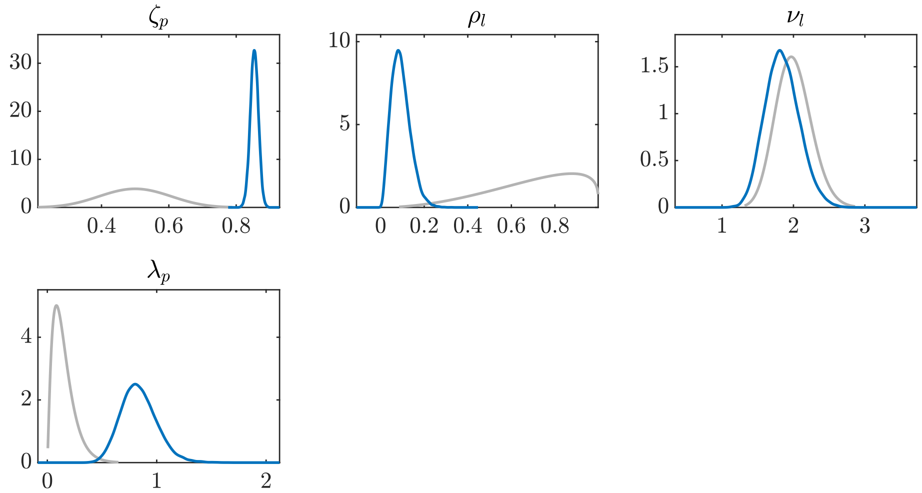

ζ_p
ρ_l
ν_l
λ_p

Figure 12: Smoothed shocks

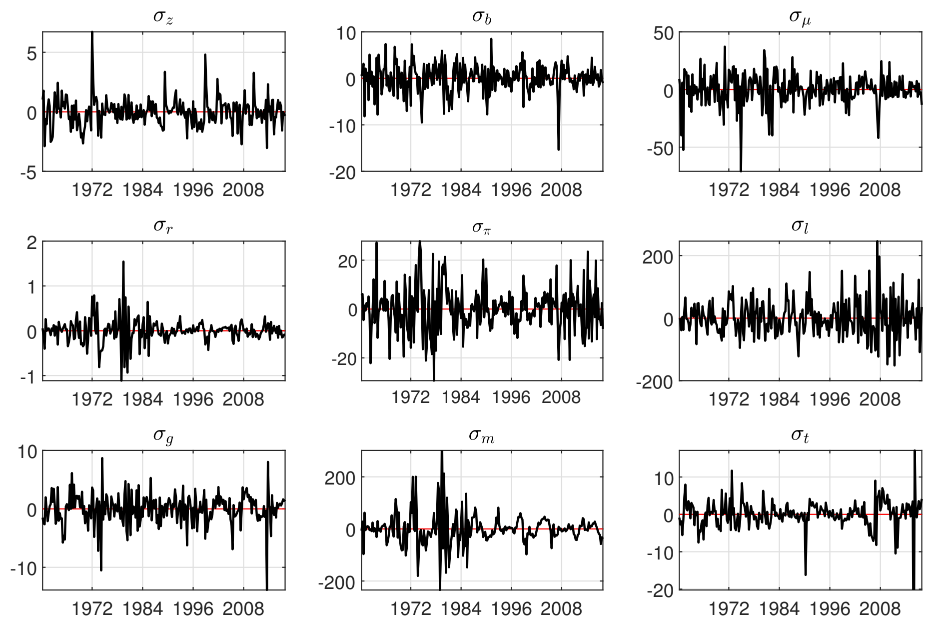
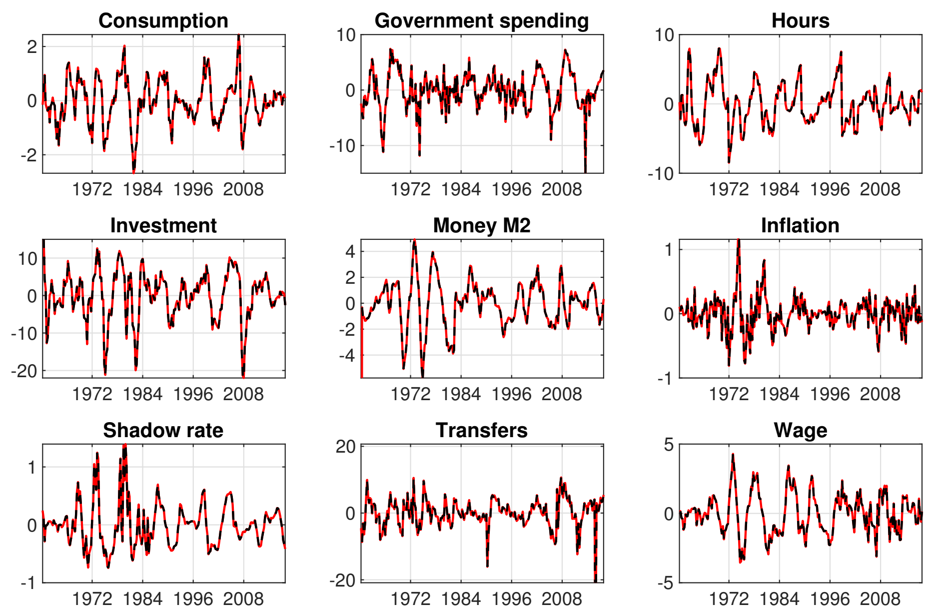


Figure 13: Historical and smoothed variables



References

Andolfatto, D., Li, L., et al. (2013). Is the fed monetizing government debt? *Economic Synopses*.

Asimakopoulos, S., Lorusso, M., & Pieroni, L. (2020). Can public spending boost private consumption? *Canadian Journal of Economics*.

Benigno, P., & Nisticò, S. (2020). The economics of helicopter money.

Bernanke, B. (2003). *Some thoughts on monetary policy in japan.* Board of Governors of the Federal Reserve System.

Bernanke, B. (2016). What tools does the fed have left? part 3: Helicopter money. *Brookings Institution*.

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

Bianchi, F., Faccini, R., & Melosi, L. (2023). A fiscal theory of persistent inflation. *The Quarterly Journal of Economics*, qjad027.

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of monetary Economics*, *12*(3), 383–398.

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

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

Coenen, G., & Straub, R. (2005). Does government spending crowd in private consumption? theory and empirical evidence for the euro area. *International finance*, *8*(3), 435–470.

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

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

Del Negro, M., & 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., & Wouters, R. (2007). On the fit of new keynesian models. *Journal of Business & Economic Statistics*, *25*(2), 123–143.

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., & Tabellini, G. (2014). How to jumpstart the eurozone economy. *VoxEU, August*.

Lawson, A., & Feldberg, G. (2020). Monetization of fiscal deficits and covid-19: A primer. *Journal of Financial Crises*, *2*(4), 1–35.

Leeper, E. M. (1991). Equilibria under âFIXME˜activeâFIXME™and âFIXME˜passiveâFIXME™monetary and fiscal policies. *Journal of monetary Economics*, *27*(1), 129–147.

Leeper, E. M., Plante, M., & Traum, N. (2010). Dynamics of fiscal financing in the united states. *Journal of Econometrics*, *156*(2), 304–321.

Leeper, E. M., Traum, N., & Walker, T. B. (2017). Clearing up the fiscal multiplier morass. *American Economic Review*, *107*(8), 2409–54.

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

Punzo, C., & Rossi, L. (2022). A money-financed fiscal stimulus: Redistribution and social welfare. *Journal of Money, Credit and Banking*.

Sargent, T. J., & Wallace, N. (1973). Rational expectations and the dynamics of hyperinflation. *International Economic Review*, 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., & Uribe, M. (2000). Price level determinacy and monetary policy under a balanced-budget requirement. *Journal of Monetary Economics*, *45*(1), 211–246.

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*(3), 381–399.

Smets, F., & 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* (Vol. 39, pp. 195–214).

Turner, A. (2015). The case for monetary finance–an essentially political issue. In *16th jacques polak annual research conference* (pp. 5–6).

Woodford, M. (2012). Methods of policy accommodation at the interest-rate lower bound.

Wu, J. C., & Xia, F. D. (2016). Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit and Banking*, *48*(2-3), 253–291.