Money supply, fiscal stimulus and distortionary taxation

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January 14, 2022

Abstract

At the beginning of the crisis generated by the spread of COVID-19, a number of scholars advocated the use of money supply issued by the central bank to finance fiscal interventions. In this work, we further investigate this proposal. In particular, we develop and estimate a new Keynesian model for the analysis of a fiscal stimulus that does not contribute to an increase in public debt, but it is financed by money supply. We extend the model of Galí (2020a) by introducing distortionary taxation on capital and labour income. 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. We estimate our model with Bayesian techniques for the sample period 1959Q3-2021Q3 using US data. Most of the estimated parameters of our model are well identified. Our impulse response analysis confirms the results obtained by Galí (2020a), where an increase in a monetary-financed government spending and an increase in monetary-financed government transfers have expansionary economic effects. Therefore, our contribution to literature on monetary-financed fiscal stimuli is twofold. Firstly, our model is estimated on US data. In this regard, we provide a counterfactual analysis of the use of money supply to finance fiscal stimuli based on our estimated model. Secondly, we examine the macroeconomic impact of distortionary taxes.

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1 Introduction

During his intervention regarding the liquidity trap period in Japan, Bernanke (2016) explains that when interest rates are very low, monetary policy may not have enough efficient tools to prevent too low inflation. Nowadays the COVID-19 outbreak led to disruptions in aggregate demand and aggregate supply having highly negative consequences on employment and inequalities worldwide. Among others, Benigno & Nisticò (2020) state that the ongoing debate both in academia and among policy makers is suggesting that cooperation between governments and central banks could result in effective measures aimed at reducing the adverse impact of the crisis. Since March 2020, both governments and central banks have been directing their attention towards policies aimed at reducing the dramatic impact of the pandemic crisis. On the one hand, central banks worldwide have lowered their interest rates, focusing on easing loan conditions to firms and banks, and have been devoting considerable investments to asset-purchasing programs. On the other hand, governments have spent large amounts on fiscal stimuli causing sovereign debt to increase further. In this scenario constrained by the zero lower bound on interest rates, high figures of public debt and massive fiscal stimulus, the idea of a"money-financed fiscal stimulus" Galí (2020a) has been gaining consensus among scholars.[1]

According to Galí (2020b), in practice, the monetary-financed fiscal stimulus would originate from a credit to the government account held at the central bank or, equivalently, from the acquisition from the central bank of non-redeemable government debt. Thus, this debt would be held permanently on the balance sheet of the central bank. Bernanke (2016) also proposes the creation of a new government's account at the central bank, used only in emergency situations. In all cases, when the central bank operates through monetary-financing of the public debt, money supply is increased permanently[2] This measure would be used in extreme situations, when the public debt is already high and interest rates are already too low to provide an effective tool to support economic recovery and to combat low inflation. Considering times of disruptions in aggregate demand, Woodford (2012) and Turner (2015) show that monetary-financing would stimulate aggregate demand much more than debt financing. Turner (2015) also argues that monetary-financing would be much more desirable and optimal compared to other types of policies. Finally, the author cites Galí (2020a)'s DSGE model as a validation of

[1] Some authors (e.g. Bernanke (2003)) refer to the concept using Milton Friedman's terminology "Helicopter money", i.e. lump-sum transfers to households financed by newly printed money. Cukierman (2020) and Galí (2020a) write about "seignoirage", 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 debt of long term maturity e.g. 30 years, which would be bought by the central bank Andolfatto et al. (2013) analyzes a "monetization of public debt", defining it as a permanent purchase of government bonds from the central bank.

[2] The permanent increase in the money supply base constitutes the difference between quantitative easing and a monetary-financed fiscal stimuli. While the latter increases the money supply base permanently, as it does not require debt nor interest to be paid back, quantitative easing impacts the money supply temporarily.

his arguments from a formal point of view.

Bernanke (2003) advocates providing fiscal stimulus by means of a tax cut or of government spending backed by money creation and argues this measure should be accompanied by the clear statement that "much or all of the money creation should be viewed as permanent" (Bernanke (2003)). Using money supply to finance a fiscal stimulus through the permanent increase of the monetary base could solve the problem of Ricardian consumers [3] that undermine the efficiency of fiscal stimuli. The transmission channel of monetary financing would indeed be the expectation channel, to the extent that consumers would understand that a tax cut today leaving public debt unchanged means no higher taxes in the future. Without the Ricardian effect there would be an increase in spending, and consequently an expansionary impact on nominal GDP and consumption. Moreover, because the public debt would remain unchanged, the debt to GDP ratio would increase. Inflation expectations would temporarily rise, bringing about an increase in inflation and, since the interest rates are near to zero, real interest rates would remain low or decrease. This would further enhance the raising level of spending. Moreover, higher inflation would have an additional positive impact on levels of pre-existing debt, because it would wipe out part of its value.

A policy measure of cooperation between the central bank and the government that would produce the monetary-financing of the public debt is often of concern because of consequences of hyperinflation (Sargent & Wallace (1973)). However, considering the persistent low inflation, the very well anchored inflation expectations, and that in developed countries the credibility and the independence of central banks is acknowledged by the market, some authors argue that the risk of hyperinflation may be the last of concerns (Cukierman, 2020). Lawson & Feldberg (2020) explain that "countries that have persistently low inflation, credible central banks, and strong economic fundamentals could potentially monetize some of the COVID-19 spending without excessive inflation or a loss of central bank independence." Past episodes of monetization of public spending that lead to hyperinflation have happened in times when central bank and governments were not two separate entities as they are nowadays. Moreover, analysing Canadian data over the time span 1935-1975, Ryan-Collins (2015) finds that there is no link between monetary financing of public debt and inflation.

Another critics could come from the political side, as Giavazzi & Tabellini (2014) and Turner (2015) argue. Using the money-financing policy once can be misleading and lead to its overuse. Turner (2015) argues that the monetary-financing policy is desirable all the time, and the only obstacle would be to check limitations from a policy perspective. Once these are removed, money-financing policy is the optimal way to stimulate aggregate demand.

In this paper we argue that a monetary financing is an effective macroeconomic policy in

[3]Ricardian consumers are the consumers who understand that a tax cut (or a transfer increase) today triggers a tax rise in the future, triggering higher levels in saving of the amount gained through the tax cut rather than spending it

times of high debt and low aggregate demand. Fiscal stimuli that would be issued to stimulate aggregate demand could be financed through debt or money supply. We argue that financing through money supply would be a preferred alternative to debt financing, as it keeps debt constant. This is particularly preferable for governments with a high level of debt. We develop a New Keynesian Model starting from a DSGE model as in Galí (2020a). The model features an increase in government transfers to households and an increase in government spending financed by an increase in money supply. We augment the model with distortionary taxation, capital and investment adjustment costs. The model is then expected to be estimated with Bayesian estimation techniques. The quarterly data are US data over a time period spanning from 1959Q4 to 2021Q3. Adopting the proposal in Bernanke (2003), we expect to estimate the impact of a distortionary tax cut financed by money creation with respect to the same tax cut financed by debt creation. The contribution of this work is twofold. Firstly, to our knowledge, previous literature analyses the effects of a lump sum tax cut financed by money supply. We extend this literature by introducing government transfers and distortionary taxation on consumption, labour and capital. A second contribution to literature concerns the estimation of the model. Indeed we estimate the impact of a monetary-financed increase in government transfers and reduction in distortionary taxes on economic variables using Bayesian estimation.

The rest of the paper is planned to be structured as follows. Section 2 describes the theoretical model. In section 3 data is briefly presented. Section 4 discusses the estimation results up to now. 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.

2 Theoretical model

The notation is the following:

- upper case variables with a time subscript are variables in levels
- steady state values are letters without a time subscript
- lower case variables with a hat are linearized variables

The household utility function is the following:

$$E_0 \sum_{t=0}^{\infty} \beta^t \mathcal{U}\left(C_t, L_t, N_t; Z_t\right)$$

with period $\mathcal{U}(.)$ utility function taking the form: $\mathcal{U} = \left(U\left(C, L\right) - V\left(N\right)\right) Z$

where $L_t \equiv M_t/P_t$ are the real money balances, M_t is the nominal stock of money held by the household and P_t is the price, C is the consumption, N_t is employment, and Z_t represents a preference shifter.

The Lagrangian is:

$$\mathcal{L} = \beta\left(U\left(C, L\right) - V\left(N\right)\right) Z - \lambda_t\left(P_t C_t + B_t + M_t - B_{t-1}\left(1 - i_{t-1}\right) - M_{t-1} - W_t N_t - D_t - P_t T_t\right)$$

with B_t bonds paying a price in t equal to $(1 - i_{t-1})$, W_t is the nominal wage, D_t are dividends that households receive and T_t are the transfers households receive from the government.
The first order conditions are:

$$\frac{\partial \mathcal{L}}{\partial C_t} : \beta\, U_{c,t} Z_t - \lambda_t P_t = 0 \Rightarrow \beta\, U_{c,t} Z_t = \lambda_t P_t \Rightarrow \lambda_t = \frac{\beta\, U_{c,t} Z_t}{P_t} \tag{1}$$

$$\frac{\partial \mathcal{L}}{\partial N_t} : -\beta V_{n,t} Z_t + \lambda_t W_t = 0 \Rightarrow \beta Z_t V_{n,t} = \lambda_t W_t \Rightarrow \lambda_t = \frac{\beta\, V_{n,t} Z_t}{W_t} \tag{2}$$

$$\frac{\partial \mathcal{L}}{\partial M_t} : \beta \frac{1}{P_t} U_{l,t} Z_t - \lambda_t + \lambda_{t+1} = 0 \Rightarrow \beta \frac{1}{P_t} U_{l,t} Z_t = \lambda_t - \lambda_{t+1} \tag{3}$$

$$\frac{\partial \mathcal{L}}{\partial B_t} : -\lambda_t + \lambda_{t+1}\left(1 + i_t\right) = 0 \Rightarrow \frac{\lambda_t}{\lambda_{t+1}} = 1 + i_t \tag{4}$$

The Euler equation is obtained by substituting $\frac{\lambda_t}{\lambda_{t+1}}$ in equation (4) with the derivation of λ_t obtained from (1):

$$U_{c,t} = \beta\, \left(1 + i_t\right) \frac{Z_{t+1}}{Z_t} \frac{P_t}{P_{t+1}} U_{c,t+1} \tag{5}$$

The labor supply equation is derived from equations (1) and (2):

$$\frac{W_t}{P_t} = \frac{V_{n,t}}{U_{c,t}} \tag{6}$$

Finally, the money demand is derived from equations (1), (3) and (4).
From (1):

$$\beta = \frac{\lambda_t P_t}{Z_t U_{c,t}}$$

From (3):

$$\beta = \frac{\lambda_t - \lambda_{t+1}}{\frac{Z_t U_{l,t}}{P_t}}$$

equating them:

$$\begin{aligned}
&\frac{\lambda_t P_t}{Z_t U_{c,t}} = (\lambda_t - \lambda_{t+1}) \frac{P_t}{Z_t U_{l,t}} \Rightarrow \\
&\frac{\lambda_t P_t}{Z_t U_{c,t}} U_{l,t} Z_t = (\lambda_t - \lambda_{t+1}) P_t \Rightarrow \\
&\lambda_t P_t \frac{U_{l,t}}{U_{c,t}} = P_t \lambda_t - P_t \lambda_{t+1} \Rightarrow \\
&\frac{U_{l,t}}{U_{c,t}} = 1 - \frac{1}{1+i_t} \Rightarrow \\
&\frac{U_{l,t}}{U_{c,t}} = \frac{P_t \lambda_t - P_t \lambda_{t+1}}{\lambda_t P_t} \Rightarrow \\
&\frac{U_{l,t}}{U_{c,t}} = 1 - \frac{P_t \lambda_{t+1}}{P_t \lambda_t}
\end{aligned}$$

after cancelling out P_t and substituting $\frac{\lambda_{t+1}}{\lambda_t}$ as in (4), we obtain:

$$\frac{U_{l,t}}{U_{c,t}} = 1 - \frac{1}{1+i_t} = \frac{i_t}{1+i_t}$$

Defining $\frac{U_{l,t}}{U_{c,t}} = h\left(\frac{L_t}{C_t}\right)$, the money demand can be written as:

$$\frac{U_{l,t}}{U_{c,t}} = h\left(\frac{L_t}{C_t}\right) = \frac{i_t}{1+i_t} \tag{7}$$

2.1 Steady state equations

2.1.1 First steady state relationship

First, the price mark-up has to be derived to obtain the first steady state equation. To do so, the MPN_t^n marginal productivity of labor is defined as:

$$MPN_t^n = \frac{\partial Y_t}{\partial N_t} = (1-\alpha) N_t^{-\alpha} \tag{8}$$

The nominal marginal cost using labor is W_t. The nominal marginal gain of firms by using labor is the income increase, that is the price times the marginal increase in production by adding a little more labor. Thus, the real marginal cost is the nominal cost relative to the nominal gain:

$$MC_t^r = \frac{W_t}{P_t \, MPN_t^n} \tag{9}$$

Substituting for MPN_t as in equation (8) we obtain:

$$MC_t^r = \frac{W_t}{P_t \, (1-\alpha) N_t^{-\alpha}} \tag{10}$$

Like in Galí (2015), the firms' mark up is equal to the inverse of the real marginal cost, as:

$$MC^r = \frac{\epsilon - 1}{\epsilon} \Rightarrow -mc^r = -ln\frac{\epsilon - 1}{\epsilon} = ln\frac{\epsilon}{\epsilon - 1} = ln\left(1 + \frac{\epsilon - \epsilon + 1}{\epsilon - 1}\right) \approx \frac{1}{\epsilon - 1} = \frac{\epsilon}{\epsilon - 1} - 1 \equiv \mu \tag{11}$$

Therefore:

$$\mu_t = \frac{(1-\alpha)\, P_t}{W_t N_t^{\alpha}} \tag{12}$$

Where μ_t is the price mark-up.

In steady state, the mark-up is equal to the desired mark-up:

$$\mu = \frac{(1-\alpha)\, P}{W N^{\alpha}} = \frac{\epsilon}{\epsilon - 1} \tag{13}$$

Denoting $\frac{\epsilon}{\epsilon-1} = \mathcal{M}$, from (13) it follows that:

$$(1-\alpha)\, P = \mathcal{M} W N^{\alpha} \tag{14}$$

and considering equation (6) evaluated at steady state,

$$\frac{W}{P} = \frac{V_n}{U_c} \tag{15}$$

equation (14) becomes:

$$(1-\alpha) = \mathcal{M} \frac{W}{P} N^{\alpha} \tag{16}$$

$$(1-\alpha) = \mathcal{M} \frac{V_n}{U_c} N^{\alpha} \tag{17}$$

$$(1-\alpha)\, U_c = \mathcal{M} V_n N^{\alpha} \tag{18}$$

which is equivalent to writing:

$$(1-\alpha)\ U_c \left(N^{1-\alpha}, L\right) = \mathcal{M}\, V_n\, (N)\, N^{\alpha} \tag{19}$$

2.1.2 Second steady state relationship

The second equation describing the steady state is obtained from the money demand:

$$h\left(\frac{L}{C}\right) = \frac{i}{1+i} \tag{20}$$

where $i = \rho$ in steady state. This can be derived from the definition of β and the Euler equation evaluated at steady state. Therefore, equation (20) can be rewritten as:

$$h\left(\frac{L}{N^{1-\alpha}}\right) = \frac{\rho}{1+\rho} \tag{21}$$

2.2 Linearized model

2.2.1 Economic identity

Non-linearized economic identity:

$$Y_t = C_t + G_t \tag{22}$$

Using the steady state definitions $G = 0$, $\frac{Y_t - Y}{Y} = \hat{y}_t$, $\frac{C_t - C}{C} = \hat{c}_t$, $\frac{G_t - G}{Y} = \hat{g}_t$, equation (22) becomes:

$$\frac{Y_t - Y}{Y} = \frac{C_t - C}{Y} + \frac{G_t - G}{Y}$$

$$\hat{y}_t = \frac{C_t - C}{C + G} + \hat{g}_t$$

$$\hat{y}_t = \hat{c}_t + \hat{g}_t \tag{23}$$

2.2.2 Euler equation

The non-linearized Euler equation:

$$U_{c,t} = \beta\left(1+i_t\right)\frac{P_t}{P_{t+1}}\frac{Z_{t+1}}{Z_t}U_{c,t+1}$$
$$= \frac{1+i_t}{1+\rho}\frac{P_t}{P_{t+1}}\frac{Z_{t+1}}{Z_t}U_{c,t+1} \quad (24)$$

where $\beta = \frac{1}{1+\rho}$. Dividing $U_{c,t}$ and $U_{c,t+1}$ by their steady state values and taking the log of each term:

$$ln\left(\frac{U_{c,t}}{U_c}\right) = ln\left(\frac{1+i_t}{1+\rho}\right) ln\left(\frac{P_t}{P_{t+1}}\right) ln\left(\frac{U_{c,t+1}}{U_c}\right) ln\left(\frac{Z_{t+1}}{Z_t}\right) \quad (25)$$

Now defining:

$$\hat{i}_t = ln\left(\frac{1+i_t}{1+\rho}\right) \quad (26)$$
$$\pi_t = ln\frac{P_t}{P_{t-1}} \quad (27)$$
$$\hat{\xi}_t = ln\left(\frac{U_{c,t}}{U_c}\right)$$
$$\hat{\rho} = -ln\left(\frac{Z_{t+1}}{Z_t}\right)$$

The Euler equation becomes:

$$\hat{\xi}_t = \hat{\xi}_{t+1} + \hat{i}_t - \pi_{t+1} - \hat{\rho}_t \quad (28)$$

2.2.3 Non-separable household utility function

Equation (17) describes the two linearized components of the utility function $U(C, L)$.

$$\hat{\xi}_t = ln\left(\frac{U_{c,t}}{U_c}\right)$$
$$= \hat{c}_t C\frac{U_{cc}}{U_c} + \hat{l}_t L\frac{U_{cl}}{U_c}$$
$$= -\sigma\hat{c}_t + \nu\hat{l}_t \quad (29)$$

where $U_{c,t} = U(C_t, L_t)$, $\sigma \equiv -C\frac{U_{cc}}{U_c}$ and $\nu \equiv L\frac{U_{cl}}{U_c}$

2.2.4 Price mark-up

The first step is to derive the equilibrium equation in the labor market:

Linearizing equation (12):

$$\hat{\mu}_t = ln\left(1-\alpha\right) + \hat{p}_t - \hat{w}_t - \alpha\hat{n}_t \quad (30)$$

The next step is to linearize the labor supply F.O.C., equation (6) by taking logs and dividing the two utility functions $V_{n,t}$ and $U_{c,t}$ by their steady state values, V_n and U_c. The result is:

$$lnW_t - lnP_t = ln\left(\frac{V_{n,t}}{V_n}\right) - ln\left(\frac{U_{c,t}}{U_c}\right)$$
$$\hat{w}_t - \hat{p}_t = \hat{n}_t N\frac{V_{nn}}{V_n} - ln\left(\frac{U_{c,t}}{U_c}\right)$$
$$\hat{w}_t - \hat{p}_t = \varphi\hat{n}_t - \hat{\xi}_t \quad (31)$$

where $N\frac{V_{nn}}{V_n} \equiv \varphi$. Using equation (31), equation (30) becomes:

$$\hat{\mu}_t = -\varphi \hat{n}_t + \hat{\xi}_t + ln\,(1-\alpha) - \alpha\,\hat{n}_t \tag{32}$$

Solving for linearized employment N_t from the firms' technology $Y_t = N_t^{1-\alpha}$:

$$\hat{y}_t = (1-\alpha)\,\hat{n}_t$$
$$\hat{n}_t = \frac{\hat{y}_t}{1-\alpha}$$

substituting the latter in equation (32), and removing the constant term $ln\,(1-\alpha)$:

$$\hat{\mu}_t = -\varphi \frac{\hat{y}_t}{1-\alpha} + \hat{\xi}_t - \alpha\,\frac{\hat{y}_t}{1-\alpha}$$
$$\hat{\mu}_t = -\hat{y}_t \left(\frac{\varphi}{1-\alpha} + \frac{\alpha}{1-\alpha}\right) + \hat{\xi}_t$$
$$\hat{\mu}_t = \hat{\xi}_t - \hat{y}_t \left(\frac{\alpha+\varphi}{1-\alpha}\right) \tag{33}$$

Equation (33) is the price mark-up equation.

2.2.5 Money demand

The non-linearized money demand is:

$$\frac{U_{l,t}}{U_{c,t}} = h\left(\frac{L_t}{C_t}\right) = \frac{i_t}{1+i_t} \tag{34}$$

The linearized eq. (20) in Gali's paper should be:

$$\hat{l}_t = \hat{c}_t - \eta \hat{i}_t$$

where:

$$\eta = \frac{\epsilon_{l,c}}{\rho}\ \textbf{and}\ \epsilon_{l,c} = -\frac{1}{h'}\frac{\rho}{1+\rho}V = \frac{1}{\sigma_l + \nu}$$

and by definition $\frac{U_{ll}}{U_l}L = -\sigma_l$

2.1. On the left hand side of equation (34):

$$\hat{U}_{c,t} \equiv ln\left(\frac{U_{c,t}}{U_c}\right) = \hat{c}_t C \frac{U_{cc}}{U_c} + \hat{l}_t L \frac{U_{cl}}{U_c} \tag{35}$$
$$\hat{U}_{l,t} \equiv ln\left(\frac{U_{l,t}}{U_l}\right) = \hat{l}_t L \frac{U_{ll}}{U_l} + \hat{c}_t C \frac{U_{lc}}{U_l} \tag{36}$$

and using the definitions $\sigma \equiv -C\frac{U_{cc}}{U_c}$, $\nu \equiv L\frac{U_{cl}}{U_c}$ and $-\sigma_l \equiv \frac{U_{ll}}{U_l}L$

$$\widehat{\frac{U_{l,t}}{U_{c,t}}} = \sigma_l \hat{l}_t + \hat{c}_t C \frac{U_{cl}}{U_l} - \sigma \hat{c}_t + \nu \hat{l}_t$$
$$\widehat{\frac{U_{l,t}}{U_{c,t}}} = \hat{l}_t\,(\sigma_l + \nu) + \hat{c}_t C \frac{U_{cl}}{U_l} - \sigma \hat{c}_t$$

2.2. On the right hand side:

Using the definition $\hat{i}_t = ln\left(\frac{1+i_t}{1+\rho}\right)$ and using the steady state $i = \rho$, on the right hand side of equation (34):

$$
\begin{aligned}
& ln\left(\frac{i_t}{1+i_t}/\frac{\rho}{1+\rho}\right) \\
& ln\left(\frac{i_t}{1+i_t}\frac{1+\rho}{\rho}\right) \\
& ln\left(\frac{1+\rho}{1+i_t}\right) + ln\left(\frac{i_t}{\rho}\right) \\
& -\hat{i}_t + ln\left(\frac{i_t}{\rho}\right) \\
& -\hat{i}_t + ln1 + \frac{\rho}{i}\left(i_t - i\right) \\
& -\hat{i}_t + \left(i_t - i\right)
\end{aligned}
$$

Putting together left hand side and right hand side:

$$
\begin{aligned}
\hat{l}_t\left(\sigma_l + \nu\right) + \hat{c}_t C\frac{U_{cl}}{U_l} - \sigma\hat{c}_t &= -\hat{i}_t + \left(i_t - i\right) \\
\hat{l}_t\left(\sigma_l + \nu\right) &= \hat{c}_t\left(C\frac{U_{cl}}{U_l} + \sigma\right) - \hat{i}_t + \left(i_t - i\right)
\end{aligned}
$$

2.2.6 Relation between real balances, inflation and money growth

This equation is obtained from the linearization of the equivalence $L_t \equiv \frac{M_t}{P_t}$.

$$\hat{l}_t = \hat{m}_t - \hat{p}_t \tag{37}$$

Subtracting from each variable its lagged value:

$$
\begin{aligned}
& \hat{l}_t - \hat{l}_{t-1} = \left(\hat{m}_t - \hat{m}_{t-1}\right) - \left(\hat{p}_t - \hat{p}_{t-1}\right) \\
& \hat{l}_t - \hat{l}_{t-1} = \Delta\hat{m}_t - \pi_t \text{ and} \\
& \hat{l}_{t-1} = \hat{l}_t + \pi_t - \Delta\hat{m}_t
\end{aligned}
$$

where $\hat{m}_t - \hat{m}_{t-1} = ln\left(\frac{M_t}{M_{t-1}}\right) = \Delta\hat{m}_t$ and $\hat{p}_t - \hat{p}_{t-1} = ln\left(\frac{P_t}{P_{t-1}}\right) = \pi_t$.

2.2.7 Fiscal rule

The fiscal rule shows that the deviation of transfers from the steady state value depends on the deviation of the real debt from its steady state value in period $t-1$, all expressed as fraction of the steady state output.

$$
\begin{aligned}
T_t &= \psi_b\frac{B_{t-1}}{P_{t-1}} + t_t^* \Rightarrow \\
T_t &= \psi_b\mathcal{B}_{t-1} + t_t^* \qquad (38)
\end{aligned}
$$

with $\mathcal{B}_t = B_t/P_t$. A Taylor approximation of (38), and using the steady state relation $T = \psi_b \mathcal{B}$ yields:

$$
\begin{aligned}
&T_t - T = \psi_b(\mathcal{B}_{t-1} - \mathcal{B}) + t_t^* - 0 \Rightarrow \\
&Y\frac{T_t - T}{Y} = Y\psi_b\frac{\mathcal{B}_{t-1} - \mathcal{B}}{Y} + Y\frac{t_t^* - 0}{Y} \Rightarrow \\
&Y\hat{t}_t = Y\hat{b}_{t-1} + Y\hat{t}_t^* \Rightarrow \\
&\hat{t}_t = \psi_b\hat{b}_{t-1} + \hat{t}_t^*
\end{aligned} \tag{39}
$$

where:

$$
\begin{aligned}
\hat{b}_t &= \frac{\mathcal{B}_t - \mathcal{B}}{Y} \\
\hat{t}_t &= \frac{T_t - T}{Y}
\end{aligned}
$$

2.2.8 Linearization of seignoirage term $\chi\Delta m_t$

Non-linearized seignoirage as a ratio of steady state output Y:

$$
\frac{\Delta M_t}{P_t}\frac{1}{Y} = \frac{\Delta M_t}{M_{t-1}}\frac{P_{t-1}}{P_t}\frac{L_{t-1}}{Y} \tag{40}
$$

Linearizing equation (40) yields:

$$
\begin{aligned}
&\frac{1}{Y}ln\Delta M_t - \frac{1}{Y}lnP_t \Rightarrow \\
&\frac{1}{Y}\Delta m_t - \frac{1}{Y}\hat{p}_t \Rightarrow \\
&\frac{L}{Y}\Delta m_t - \frac{L}{Y}\hat{p}_t \Rightarrow \\
&\frac{L}{Y}\left(\Delta m_t - \hat{p}_t\right) \approx \frac{L}{Y}\Delta m_t = \chi\Delta m_t
\end{aligned} \tag{41}
$$

where $m_t = ln(M_t)$, and the inverse velocity of money demand is $\chi = \frac{L}{Y}$

2.2.9 Government budget constraint

The non linearized budget constraint is:

$$
G_t + \mathcal{B}_{t-1}\mathcal{R}_{t-1} = \mathcal{B}_t - T_t + \Delta M_t/P_t \tag{42}
$$

And given the following definitions:

$$
\begin{aligned}
&\frac{G_t - G}{Y} \equiv \hat{g}_t \\
&\frac{\mathcal{B}_t - \mathcal{B}}{Y} \equiv \hat{b}_t \\
&\frac{T_t - T}{Y} \equiv \hat{t}_t \\
&\frac{\Delta M_t}{P_t}\frac{1}{Y} \approx \chi\Delta m_t \\
&\mathcal{R}_{t-1} = (1 + i_t)\,\frac{P_{t-1}}{P_t}
\end{aligned} \tag{43}
$$

Equation (42) is linearized by doing a Taylor expansion, multiplying and dividing by steady state output Y and further multiplying and dividing the term $\mathcal{B}_{t-1}\mathcal{R}_{t-1}$ by $\mathcal{R}$.

$$
\begin{aligned}
&Y\,\frac{G_t - G}{Y} + Y\,\mathcal{R}\,\frac{\mathcal{B}_t - \mathcal{B}}{Y} + Y\,\frac{B}{Y}\,(\mathcal{R}_{t-1} - \mathcal{R}) = \frac{\mathcal{B}_t - \mathcal{B}}{Y} - Y\,\frac{T_t - T}{Y} + Y\,\frac{\Delta M_t}{P_t}\,\frac{1}{Y} \Rightarrow \\
&Y\hat{g}_t + Y\mathcal{R}\,\hat{b}_{t-1} + Y b\,(\mathcal{R}_{t-1} - \mathcal{R}) = -Y\hat{t}_t + Y\hat{b}_t + Y\chi\Delta m_t \Rightarrow \\
&\hat{g}_t + \mathcal{R}\,\hat{b}_{t-1} + b\mathcal{R}\,\frac{\mathcal{R}_{t-1} - \mathcal{R}}{\mathcal{R}} = -\hat{t}_t + \hat{b}_t + \chi\Delta m_t \Rightarrow \\
&\hat{g}_t + (1+\rho)\,\hat{b}_{t-1} + b\,(1+\rho)\,\frac{\mathcal{R}_{t-1} - \mathcal{R}}{\mathcal{R}} = -\hat{t}_t + \hat{b}_t + \chi\Delta m_t \Rightarrow \\
&\hat{g}_t + (1+\rho)\,\hat{b}_{t-1} + b\,(1+\rho)\,\left(\hat{i}_{t-1} - \pi_t\right) = -\hat{t}_t + \hat{b}_t + \chi\Delta m_t \qquad (44)
\end{aligned}
$$

where

$$
b = \frac{\mathcal{B}}{Y}
$$
$$
\mathcal{R} = 1 + \rho
$$

and using the definitions in (26) and (27):

$$
\frac{\mathcal{R}_{t-1} - \mathcal{R}}{\mathcal{R}} \approx \ln\left(\frac{\mathcal{R}_{t-1}}{\mathcal{R}}\right) = ln\left[\left(\frac{1 + i_{t-1}}{1+\rho}\right)\frac{P_{t-1}}{P_t}\right] = \hat{i}_{t-1} - \pi_t
$$

Finally, combining the fiscal rule in equation (39) and equation (44), we obtain the government budget constraint:

$$
\hat{b}_t = (1 + \rho + \psi_b)\,\hat{b}_{t-1} + b\left(\hat{i}_{t-1} - \pi_t\right) + \hat{g}_t + \hat{t}_t^* - \chi\Delta m_t \qquad (45)
$$

2.2.10 Output multiplier with flexible prices

To derive the multiplier under flexible prices, note that firms set prices as a constant markup over cost: $\hat{\mu}_t = 0$. Under the assumption of separability of real balances $\nu = 0$, from (33):

$$
0 = \hat{\xi}_t - \hat{y}_t\left(\frac{\alpha + \varphi}{1 - \alpha}\right) \qquad (46)
$$

and from (29):

$$
\hat{\xi}_t = -\sigma\hat{c}_t \qquad (47)
$$

Substituting the latter into (46):

$$
\begin{aligned}
0 &= -\sigma\hat{c}_t - \hat{y}_t\left(\frac{\alpha + \varphi}{1 - \alpha}\right) \Rightarrow \\
\sigma\hat{c}_t &= -\hat{y}_t\left(\frac{\alpha + \varphi}{1 - \alpha}\right) \Rightarrow \\
\hat{c}_t &= -\hat{y}_t\left(\frac{\alpha + \varphi}{1 - \alpha}\right)\frac{1}{\sigma}
\end{aligned}
$$

and substituting the latter into the identity equation (23):

$$\hat{y}_t = -\hat{y}_t \frac{\alpha + \varphi}{\sigma (1-\alpha)} + \hat{g}_t \Rightarrow$$
$$\hat{y}_t \left(1 + \frac{\alpha + \varphi}{\sigma (1-\alpha)}\right) = \hat{g}_t \Rightarrow$$
$$\hat{y}_t = \hat{g}_t \frac{(1-\alpha)\sigma}{(1-\alpha)\sigma + \alpha + \varphi}$$

2.2.11 New Keynesian Phillips Curve

Firms in the economy change their prices following a Calvo price setting, as in Calvo (1983). This means, there is a fraction of firms θ that cannot change their price over time. $1-\theta$ fraction of firms adjust their price over time, with a price P_t^* which is the same across all firms readjusting the price. These firms that may change their price, choose a price today taking into consideration the impact on future profits. The aggregate price dynamics is

$$\Pi_t^{1-\epsilon} = \theta + (1-\theta)\left(\frac{P_t^*}{P_{t-1}}\right)^{1-\epsilon}$$

and the linearized version of it, doing a first order Taylor expansion:

$$\pi_t = (1-\theta)\left(p_t^* - p_{t-1}\right) \tag{48}$$

Next, the firms' optimizing problem is:

$$\max_{P_t^*} \left\{ \sum_{k=0}^{\infty} \theta^k E_t \left[\left(\beta^k \left(\frac{C_{t+k}}{C_t}\right)^{-\sigma} \frac{P_t}{P_{t+k}} \right) \left(P_t^* Y_{it+k|t} - TC^n_{it+k|t}\left(Y_{it+k|t}\right) \right) \right] \right\} \tag{49}$$

under the following set of demand constraints:

$$Y_{it+k|t} = \left(\frac{P_t}{P_{t+k}}\right)^{-\epsilon} Y_{t+k} \tag{50}$$

where P_t^* is the price that maximizes present value of profits while having that price and it is set by the firms. $Y_{it+k|t}$ is the output produced while having that price, and $TC^n_{it+k|t}\left(Y_{it+k|t}\right)$ is the total cost a firm faces given that price. $\beta^k \left(\frac{C_{t+k}}{C_t}\right)^{-\sigma} \frac{P_t}{P_{t+k}}$ is the discount factor derived from the Euler equation. The first order condition for price P_t^* is

$$\sum_{k=0}^{\infty} \theta^k E_t \left\{ Q_{t,t+k}\, Y_{it+k|t} \left(P_t^* - \mu\, MC^n_{t+k|t} \right) \right\} = 0 \tag{51}$$

where $\mu = \frac{\epsilon}{\epsilon - 1}$ and $Q_{t,t+k} = \beta^k \left(\frac{C_{t+k}}{C_t}\right)^{-\sigma} \frac{P_t}{P_{t+k}}$ solving for P_t^* and dividing everything by P_t to obtain variables in real terms:

$$\frac{P_t^*}{P_t} = \frac{\epsilon}{\epsilon - 1} \frac{E_t \sum_{k=0}^{\infty} \theta^k \beta^k C_{t+k}^{1-\sigma} P_{t+k}^{\epsilon} MC^r_{t+k|t}}{E_t \sum_{k=0}^{\infty} \theta^k \beta^k C_{t+k}^{1-\sigma} P_{t+k}^{\epsilon-1}} \tag{52}$$

where $MC^r_{t+k|t}$ is the real marginal cost in $t+k$ given the price set in period t. In case of flexible prices, $\theta = 0$ and eqaution (52) becomes: $P_t^* = \frac{\epsilon}{\epsilon-1} MC_t^r$. This is the desired frictionless mark-up, which firms would face in monopolistic competition. In steady state $MC^r_{t+k|t} = MC^r = \frac{\epsilon - 1}{\epsilon}$.

The linearized version of (52) is:

$$p_t^* = \mu + (1+\theta\beta)\, E_t \sum_{k=0}^{\infty} \theta^k \beta^k \left(mc_{t+k|t}^r + p_{t+k} \right) \tag{53}$$

with $\mu = -mc_t^r = \frac{\epsilon}{\epsilon-1}$ being the desired mark-up. This is true, because of equation (11).

In equilibrium from (30) and (11) the firm's real marginal cost is:

$$mc_t^r = w_t - p_t + \alpha \frac{y_t}{1-\alpha} - ln(1-\alpha) \tag{54}$$

Calculating it in period $t+k$:

$$mc_{it+k|t}^r = w_{t+k} - p_{t+k} + \alpha \frac{y_{t+k|t}}{1-\alpha} - ln(1-\alpha) \tag{55}$$

and calculating the log-linearised market demand constraints (50) in period $t+k$:

$$y_{t+k|t} = -\epsilon \left(p_{t+k|t} - p_{t+k} \right) + y_{t+k} \tag{56}$$

and using this to obtain:

$$\begin{aligned}
& mc_{it+k|t}^r - mc_{t+k}^r = \\
& = \left[w_{t+k} - p_{t+k} + \alpha \frac{y_{t+k|t}}{1-\alpha} - ln(1-\alpha) \right] - \\
& - \left[w_{t+k} - p_{t+k} + \alpha \frac{y_{t+k}}{1-\alpha} - ln(1-\alpha) \right] = \\
& - \frac{\alpha\epsilon}{1-\alpha} \left(p_t^* - p_{t+k} \right) \Rightarrow \\
& \Rightarrow mc_{it+k|t}^r = mc_{t+k}^r - \frac{\alpha\epsilon}{1-\alpha} \left(p_t^* - p_{t+k} \right)
\end{aligned}$$

This relation shows that the real marginal cost depends on the production cost. In order to find the NK Phillips curve we use this relation and substitute it into (53). Rewriting equation (53), using equation (48) and solving for pi_t, we obtain:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda \widehat{mc}_t^r \tag{57}$$

where

$$\lambda = \frac{(1-\theta)(1-\theta\beta)}{\theta} \frac{1-\alpha}{1-\alpha+\alpha\epsilon}$$

AR processes for shocks to government spending, government transfers and preferences are given by:

$$\begin{aligned}
\hat{t}_t^* &= \delta_t \hat{t}_{t-1}^* + \sigma_t \epsilon^t,\ \epsilon^t \sim N(0,1) \\
\hat{g}_t &= \delta_g \hat{g}_{t-1} + \sigma_g \epsilon^g,\ \epsilon^g \sim N(0,1) \\
\hat{z}_t &= \rho_z \hat{z}_{t-1} + \sigma_z \epsilon^z,\ \epsilon^z \sim N(0,1)
\end{aligned}$$

3 Data and calibration

The linearized model is estimated using Bayesian estimation techniques on FRED US quarterly data from 1959Q3 to 2021Q3. Data is constructed following Leeper et al. (2010).

3.1 Data construction

Consumption (C) = Non durable goods + services, NIPA table 1.1.5., lines 5 and 6

GDPDEF = implicit price deflator, 2012=100, seasonally adjusted, source: US Bureau of Economic Analysis

CNP16OV (Pop) = LNS100000000 in Leeper and SW, Civil non institutional population 16+, Non seasonally adjusted, in thousands, source: US Bureau of Labor Statistics

Popindex: Index such that Pop in 1992Q3=1

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

Transfers = [(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*] where:

total tax revenues = consumption tax revenues + labor tax revenues + capital tax revenues where:

consumption tax revenues = excise taxes + custom duties (NIPA table 3.2, lines 5 and 6)

labor tax revenues = average labor income tax rate * tax base

capital tax revenues = average capital income tax rate * tax base

Average consumption tax rate = Consumption tax revenues/(Consumption - Consumption tax revenues - state and local sales taxes) (NIPA table 3.3. line 7)

Labor income tax revenues =

Capital income tax revenues =

All observable variables are constructed as in Leeper et al. (2010):

X= ln (x/Popindex) * 100,

where:

x = Consumption, Government spending, Transfers

3.2 Calibration

Table 1 describes calibrated values for parameters.

Table 1: Calibrated parameters and source

Parameter	Value	Source
σ Inverse elasticity of intertemporal substitution	1	Galí (2015)
φ Inverse Frish elasticity for labor supply	5	Galí (2020a)
β Household's discount factor	0.995	Galí (2020a)
ρ Household's discount rate	$(1-\beta)/\beta$	Galí (2020a)
α Labor share in Cobb Douglas function	0.25	Galí (2020a)
θ Calvo parameter of price stickyness	0.75	Galí (2020a)
ϵ Elasticity of substitution	9	Galí (2020a)
ν Inverse elasticity of substitution consumption to money	0	Galí (2020a)
χ Inverse velocity of money supply	0.33	Galí (2020a)
η Interest semi-elasticity of money demand	7	Galí (2020a)
ψ_bTransfers adjustment parameter	0.02	Galí (2020a)

4 Estimation results

Table 2 and table 3 show exogenous parameters estimated with Bayesian estimation in the monetary-financing scenario, of an increase in government transfers and an increase in government spending.

Table 2: Estimated parameters - money-financed government transfers

	Prior			Posterior		
Parameter	Distribution	Mean	St. Dev	Mean	HPD interval	
σ_z Preference shock standard error	Inv. gamma	0.1	2	8.64	7.79	9.51
σ_t Government transfers standard error	Inv. gamma	0.1	2	7.23	6.72	7.75
ρ_z Persistence parameter preference shock	Beta	0.75	0.15	0.35	0.26	0.45
δ_t Persistence parameter government transfers	Beta	0.75	0.15	0.05	0.02	0.08

Table 3: Estimated parameters - money-financed government spending

	Prior			Posterior		
Parameter	Distribution	Mean	St. Dev	Mean	HPD interval	
σ_z Preference shock standard error	Inv. gamma	0.1	2	4.07	3.55	4.57
σ_g Government spending standard error	Inv. gamma	0.1	2	2.72	2.52	2.92
ρ_z Persistence parameter preference shock	Beta	0.75	0.15	0.57	0.49	0.66
δ_g Persistence parameter government spending	Beta	0.75	0.15	0.41	0.33	0.49

Figure 1: Prior and posterior values of estimated exogenous parameters for the money-financed increase in government transfers. The black dotted line represents the prior value of the parameter. The blue line is the posterior estimate.

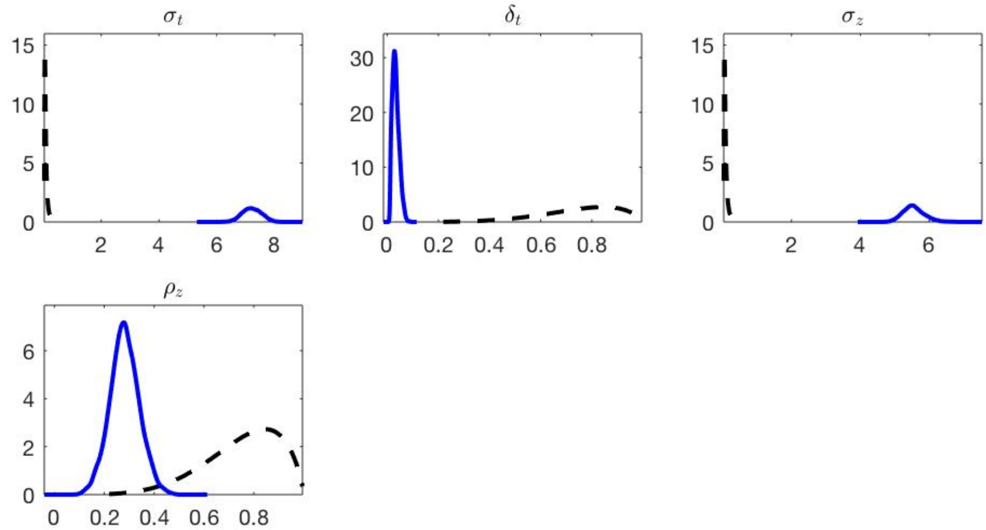


Figure 2: Prior and posterior values of estimated exogenous parameters for the money-financed increase in government spending. The black dotted line represents the prior value of the parameter. The blue line shows the posterior estimate.

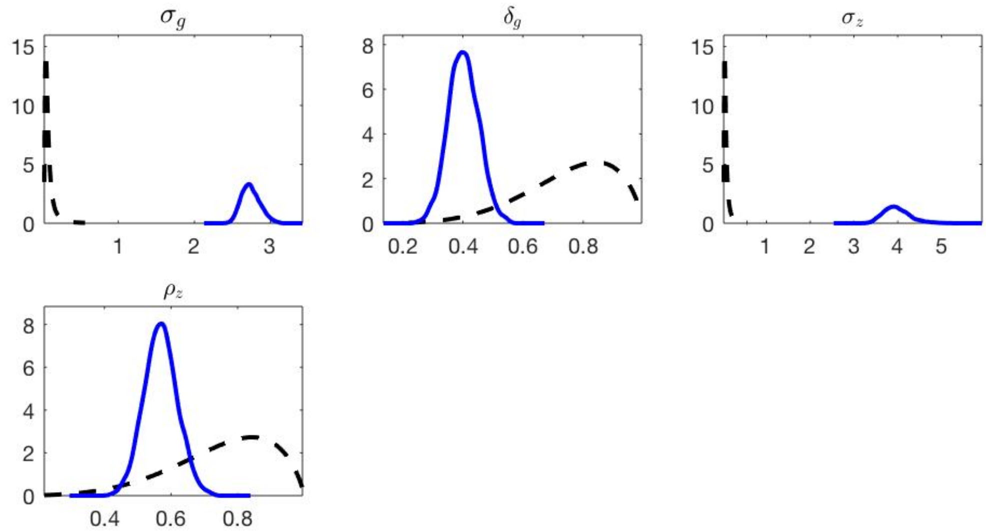
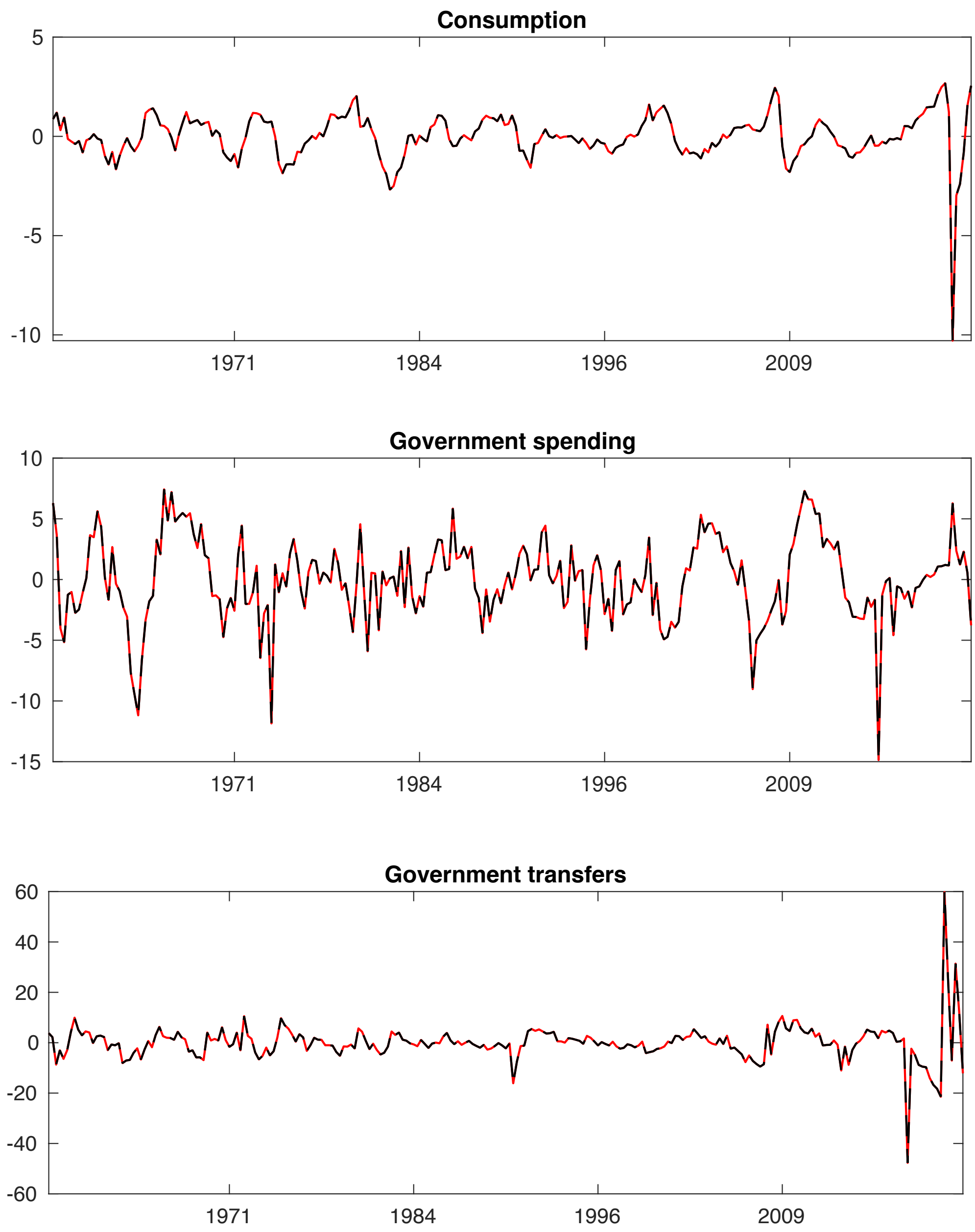


Figure 3: Historical and smoothed variables in a money-financed scenario. The dotted black line describes the observed data. The red line shows the estimate of the smoothed variable, derived from the Kalman smoother at the posterior mean.



5 Impact of a monetary-financed vs a debt financed increase in government transfers and government spending

In the next section we analyze two scenarios in which the government and monetary authorities implement 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. Each of them are placed in a scenario where the financing occurs through issuance of debt and subsequently in a scenario where financing occurs through an increase in money growth. In the first scenario, i.e. when the fiscal stimulus is financed by debt, the fiscal authorities pursue an inflation targeting policy with

$$\pi_t = 0 \tag{58}$$

In the opposite scenario, i.e. when the fiscal stimulus is financed by money growth, the fiscal and monetary authorities increase money growth 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, from equation (45), we obtain:

$$\Delta m_t = (1/\chi)\left(\hat{g}_t - t_t^* + b(1+\rho)\left(\hat{i}_{t-1} - \pi_t\right)\right) \tag{59}$$

which describes the money growth rule in the money-financing scenario. An increase in government transfers occurs through an exogenous shock to the AR(1) process of $\hat{t}_t^*$ following:

$$\hat{t}_t^* = \delta \hat{t}_{t-1}^* + \epsilon_t \tag{60}$$

where ϵ_t is the exogenous shock. In this case, the increase in transfers does not have to be adjusted by government spending, therefore in (59) $\hat{g}_t = 0$ and the money growth rule becomes:

$$\Delta m_t = (1/\chi)\left(-\hat{t}_t^* + b(1+\rho)\left(\hat{i}_{t-1} - \pi_t\right)\right) \tag{61}$$

A government purchase increase occurs through a positive exogenous shock to the AR(1) of $\hat{g}_t$:

$$\hat{g}_t = \delta \hat{g}_{t-1} + \epsilon_g \tag{62}$$

where ϵ_g is the exogenous government spending shock. In the money-financing scenario, the government spending increase does not have to be adjusted by a cut in trasfers, therefore in (59) $\hat{t}_t^* = 0$ and the money growth rule becomes:

$$\Delta m_t = (1/\chi)\left(\hat{g}_t + b(1+\rho)\left(\hat{i}_{t-1} - \pi_t\right)\right) \tag{63}$$

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 debt (blue line) and when the increase in transfers is financed by money (red line). The figure shows that economic variables are only impacted in the second scenario. The increase in transfers financed by debt only has an impact on debt and on the debt-to-output ratio.

In the first scenario, no impact on economic variables is explained by the effect of the Ricardian equivalence. When the fiscal stimulus is debt-financed, the monetary authority pursues a monetary policy to control inflation $\pi = 0$. This is the same as having flexible prices. A debt-financed increase in transfers combined with flexible prices has no or very little impact on economic variables, as consumers understand that a debt increase means 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.

The increase in transfers financed by money on the other hand, has an expansionary impact on output and consumption, because as shown by Galí (2020a), increase in transfers are perceived by households as an increase in disposable income. After the increase in money supply, the nominal interest rate is cut, so that households are more willing to hold money. Consequently, also real interest rates decrease. This has a positive impact on spending and consumption, which brings about an increase in output. The increase in output lowers the debt-to-output ratio, while debt stays constant. Inflation expectations increase, and this accordingly leads to an increase in quarterly inflation. Year-on-year inflation reaches its peak after about 4 periods from the fiscal stimulus shock. After one period the nominal interest rate starts raising. This causes consumption, output, and inflation to reduce until returning to the equilibrium level. The money growth initially increases due to the monetary policy, and becomes negative after about one-two periods because now the price level is higher than the nominal money amount in the economy.

Figure 5 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 (blue line) and when the government spending increase is financed by money (red line). In this case, output increases in both scenarios, though the increase is much higher in the money-financing scenario. To understand the smaller increase of output in the debt-financing scenario with respect to the monetary-financed scenario, consider the economy under flexible prices and separability in real balances. This implies that the mark-up $\hat{\mu}_t = 0$ and $\nu_t = 0$. A relation between $\hat{y}_t$ and $\hat{g}_t$ can be derived from equations (23), (29), (33) (as in Gali 2020)

$$\hat{y}_t = \hat{g}_t \frac{(1-\alpha)\,\sigma}{(1-\alpha)\,\sigma + \alpha + \varphi} \tag{64}$$

The equation shows that the government spending multiplier is less than one. This applies to the scenario in which a government spending increase is financed by debt, as this scenario is similar to a flexible price economy, where Ricardian equivalence holds[4]. After an increase in government spending, besides the increase in nominal interest rates due to financing of government spending through debt, inflation needs to be stabilized. This is done through an additional increase in the nominal interest rate, a decrease in money supply and higher future taxes. As a result, consumption is crowded out and output increases only by a small amount. Money supply initially decrease consistently to keep inflation to zero, but shortly after increases above the equilibrium level. This is led by the increase in government spending, which increases demand for goods, the money demand and therefore the money supply.

A money-financed government spending increase leaves transfers, debt and debt-to-output ratio unchanged. The policy has an expansionary impact on output. In this case the multiplier is higher than 1, and this is an effect of the increase in consumption. In this case, the govern-

[4]This is because in this scenario fiscal and monetary authorities pursue an inflation targeting strategy as in eq. (58) with $\pi = 0$.

ment and monetary authorities do not intervene to stabilize inflation, therefore the increase in consumption 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 and therefore a positive shift in the consumption response. The nominal interest rate this time is increased by a smaller amount, as the government spending is not financed by debt. (The nominal interest rate increase only in response to an adjustment process inside the government budget constraint).

Figure 6 shows the difference between the two fiscal stimuli when the financing occurs with money. The blue line shows the impact of a money-financed increase in government transfers, while the red line shows the impact of a money-financed increase in government spending. As described in the previous 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. The output multiplier is greater than 1, due to the increase in consumption.The impact on consumption in the debt-financed scenario is the common result obtained in New Keynesian literature after an increase in government spending.(Figure 5). As mentioned above, this is due to the decrease in the real interest rate. Finally, the increase in money growth needed is much higher in the case of an increase in transfers than in the case of an increase in government spending.

Figure 4: Impact of an exogenous increase in government transfers on endogenous variables. The blue line describes the impact of a debt-financed transfer increase, while the red line describes the impact of a money-financed transfer increase.

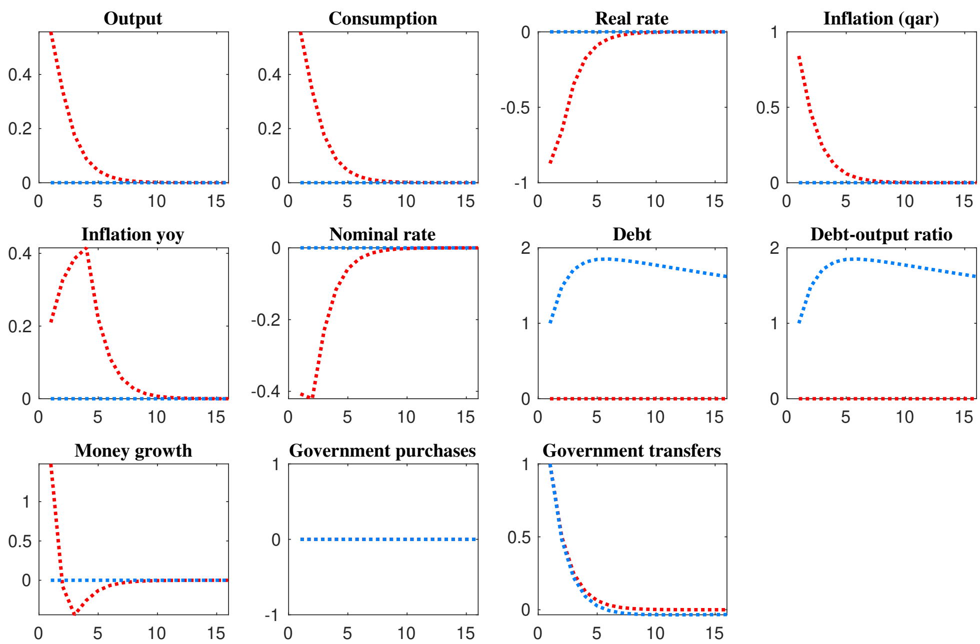


Figure 5: Impact of an exogenous government spending increase on endogenous variables. The blue line describes the impact of a debt-financed government spending, while the red line describes the impact of a money-financed government spending.

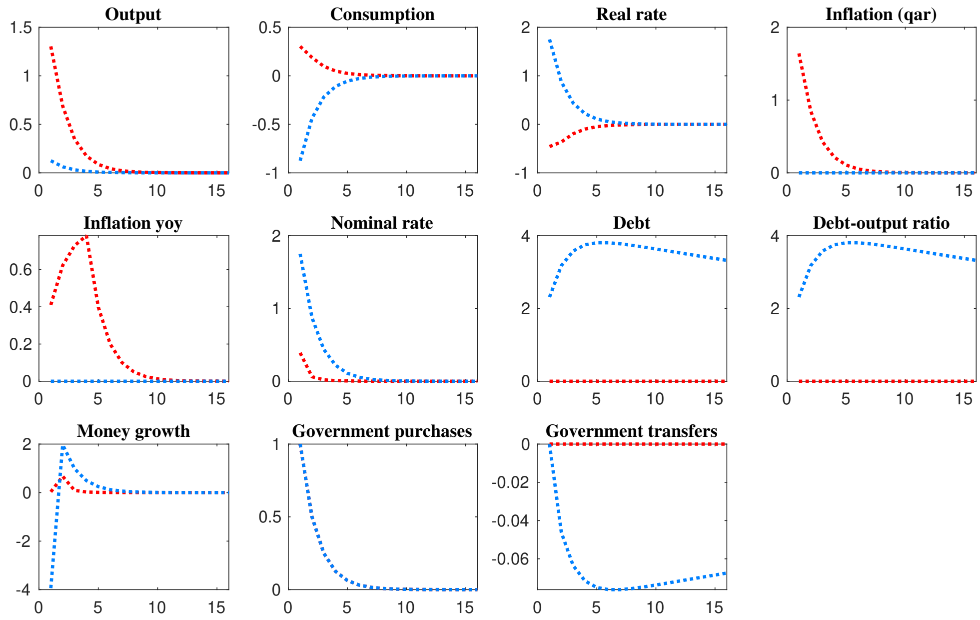
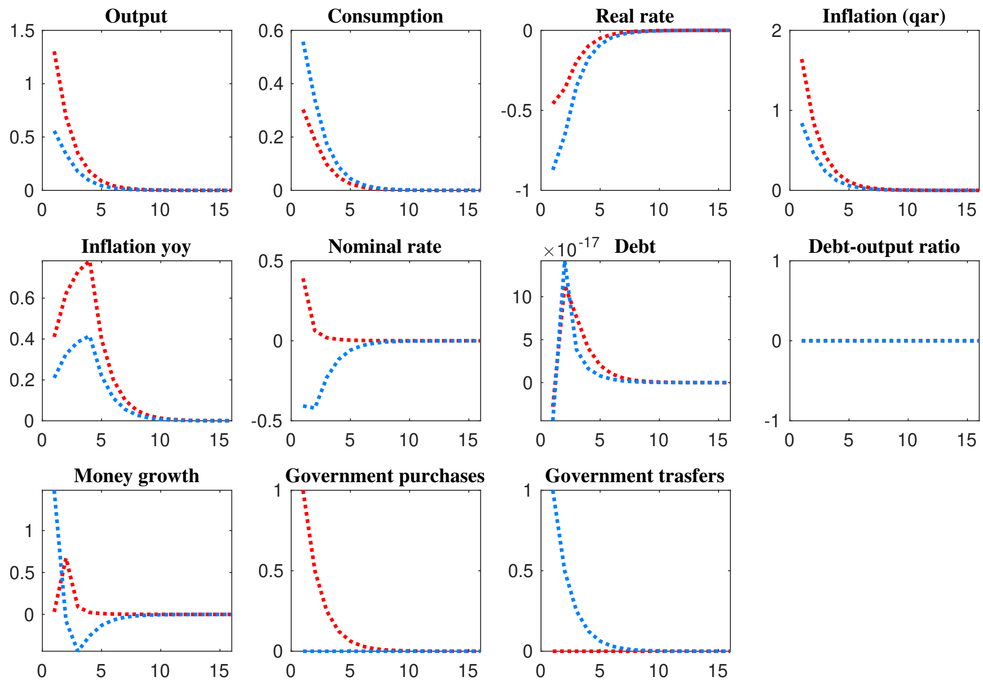


Figure 6: Comparison between a money-financed government transfers increase and a money-financed government spending increase. The blue line describes the impact of a money-financed increase in government transfers, while the red line describes the impact of a money-financed increase in government spending.



Appendix

Figure 7: Impulse response functions of a orthogonalized shock to a monetary-financed government spending produced from the Bayesian estimation. The grey shaded areas provide highest posterior density (HPD) intervals.

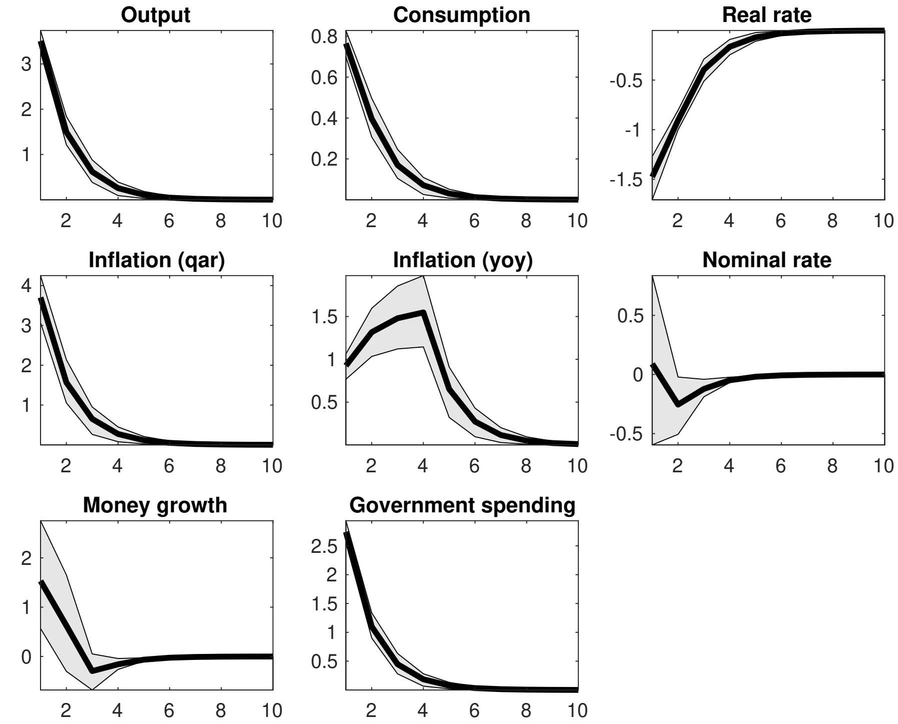
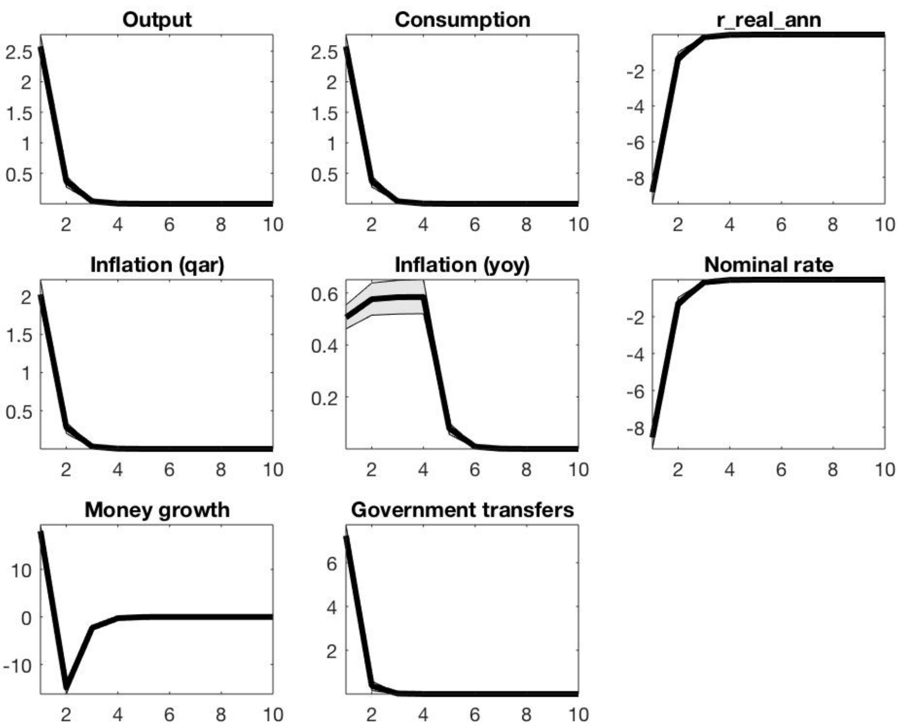


Figure 8: Impulse response functions of a orthogonalized shock to a monetary-financed government transfers produced from the Bayesian estimation. The grey shaded areas provide highest posterior density (HPD) intervals.



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