ISSN: 2281-1346

Department of Economics and Management

DEM Working Paper Series

Money-Financed versus Debt Financed Fiscal Stimulus with Borrowing Constraints

Chiara Punzo
(Università Cattolica Sacro Cuore, Milano)

Lorenza Rossi
(Università di Pavia)

 # 131 (12-16)

Via San Felice, 5
I-27100 Pavia
http://epmq.unipv.eu/site/home.html

December 2016

Money-Financed versus Debt-Financed Fiscal Stimulus with Borrowing Constraints

Chiara Punzo and Lorenza Rossi *

November 2016

Abstract

We consider a NK-DSGE model with distortive taxation and heterogeneous agents, modeled using a modified version of the mechanism proposed by Bilbiie, Monacelli and Perotti (2012). Following Galì (2014), we study the effects of a shock to government purchases under two alternative financing regimes: (i) monetary financing; (ii) debt financing. Particularly, we focus on the redistributive effects of the two regimes and we find the following. Both regimes imply a redistributive effect from savers to borrowers, measured in terms of the ratio between the consumption of borrowers and that of savers. The redistribution is much greater in the money-financed fiscal stimulus, where the consumption ratio is more than three times higher than the implied one in the debt-financed fiscal stimulus. Borrowers are better off also in terms of their relative labor supply and money demand. Finally, with respect to the representative agent model, the presence of borrowers enhances the impact of the fiscal intervention on aggregate output, when spending is debt financed. Remarkably, with respect to Galì (2014) the same regime implies a reduction of the debt burden instead of an increase.

1 Introduction

This paper contributes to the literature of money-financed fiscal stimulus. This literature has concentrated on the comparison between the Classical and the New Keynesian framework (Galì (2014)), particularly focusing on the effects of a shock to government purchases financed entirely through seigniorage or more conventionally through public debt. However, it abstracts from the role played by borrowing constraints. Furthermore, as for most of the papers with fiscal stimula, it considers lump-sum taxes and do not analyze the interaction between distortive taxes and fiscal stimula. This paper tries to fill this gap, by considering a New-Keynesian Dynamic Stochastic General Equilibrium model -

*Chiara Punzo (Università Cattolica del Sacro Cuore) and Lorenza Rossi (University of Pavia).

henceforth, NK-DSGE model - characterized by distortive taxation and heterogeneous agents. In this respect, the economies are characterized by the presence of savers and borrowers that interact in the credit market. Borrowers and savers are modeled using a modified version of the mechanism proposed by Bilbiie, Monacelli and Perotti (2013 - BMP henceforth). They indeed differ in their degree of impatience: both agents are intertemporal maximizers - since borrowing and lending take place in equilibrium; and, financial markets are imperfect. Differently from them, we introduce real balances in the utility function of both agents, and the budget constraints are also characterized by real money holdings, together with distortive taxes on labor income of both agents. In particular, as in BMP, we assume that the labor income tax follows a simple feedback rule that reacts to stabilize government debt. In this context, we study the dynamics of the model in response to an exogenous increase in government purchases under two alternative financing regimes: (i) monetary financing and (ii) debt financing, with the central bank's decision bound by an interest rate rule in the latter case. The main results of the paper can be summarized as follows.

A key finding from our analysis lies on the redistributive effect of a money-financed fiscal stimulus. The redistributive effect is measured in terms of the ratio between borrower and saver consumption. We show that, in the money-financed fiscal stimulus the consumption ratio is more than three times higher than that implied by the debt-financing regime. Borrowers are also better off in terms of their relative labor supply and money demand. Indeed, the money-financed fiscal stimulus implies that borrowers supply less labor than savers and increase their money demand while savers decrease it.

The intuition for these findings is the following. As in Galì (2014), a government spending shock, financed through money, implies a consumption crowding in, followed by an high and persistent increase in inflation, which is responsible for a long lasting decline in the real debt ratio owned by savers. The increase in consumption and that of inflation is then followed by an increase in the money demand, which leads to an increase in the nominal interest rate. Furthermore, differently from Gali (2014), the reduction in the real public debt implies lower income tax rates for both types of households, due to the fiscal rule considered. This reduces government revenues and partially counteracts the initial reduction of the debt. Both lower revenues and higher interest rates imply an higher debt burden, which is immediately internalized by savers. They indeed fear that an increase in the debt would be followed by an increase in their labor income tax and thus, ceteris paribus, they decide to consume less than borrowers, which do not own any debt and, by construction, cannot internalize the negative effect of the debt.

Another key finding turns out when we compare our model characterized by distortive labor income tax rules with the same model with lump-sum taxes. Remarkably, in the distortive labor income tax model, we find that the debt financed regime implies a reduction in the public debt owned by savers and thus, a reduction in the government debt burden instead of the increase found in Galì (2014). As will be clear in the paper, this counterintuitive result is

due to the presence of a distortive labor income tax rule, while households heterogeneity plays no role in determining the debt reduction. Indeed, with a distortive labor income tax rule, savers internalize the government budget constraint, and recognize that an increase in public expenditure today effectively implies an increase in the debt and thus in their labor income tax, today and in the future. To avoid this, they sell their holdings of government debt to the central bank. In doing this, they reduce their debt beyond the newly issued debt required to finance the fiscal stimulus.

Finally, we find that when the government spending shock is debt-financed and taxes are distortive, the behavior of aggregate variables presents an important departure from that of the representative agent model. In particular, we show that the presence of borrowers enhances the impact of the fiscal intervention on aggregate output, when spending is financed through debt. Furthermore, we find that the reduction in the debt burden is stronger in the two agents model with distortive taxes than in the same model with a representative agent. The extra-reduction in the debt burden, characterizing the model with borrowing constraints, can be explained as follows. Since in our model savers are the single private owners of public debt, ceteris paribus, their percapita internalization of the debt, and consequently the amount of debt sold to the central bank, is higher than in a representative agent economy. This implies a lower debt burden, bringing about lower nominal and real interest rates, which leads to an increase in savers consumption higher than in the single agent economy. Because of the higher increase in the aggregate demand, output increases more than in a representative agent model.

In the recent years, many authors concentrated on the issue of consumers heterogeneity due to the limited asset market participation. They show that the presence of liquidity constrained consumers alters the standard results on the dynamics of the NK-DSGE model. For example, Galì et al. (2007) demonstrate that the presence of liquidity constrained consumers can explain consumption crowding in, which follows an increase in government spending. Bilbiie (2008) shows that limited asset market participation can lead to an inverted aggregate demand logic (the IS curve has a positive slope). Di Bartolomeo and Rossi (2007) show that the effectiveness of monetary policy increases as limited asset market participation becomes more important. Galì et al. (2004) study the determinacy properties in a model with limited asset market participation and capital accumulation under different Taylor rules, showing that the presence of liquidity constrained consumers may alter the determinacy properties of a standard NK model. However, none of these papers compare a money-financed fiscal stimulus with a debt-financed fiscal stimulus. Also they do not consider the dynamic effects of fiscal rules in the presence of public debt and borrowing-constrained agents. One exception is represented by BMP which analyze the effects of two types of fiscal policy rules in a model where a fraction of households are borrowing-constrained. However, this paper does not investigate the role played by distortive labor income tax rules, and does not analyze the effects of a government spending financed through seigniorage.

The academic literature has reacted with a renewed interest in monetary and

fiscal policy interactions (See Woodford (2011) and Kirsanova et al. (2009)). Ascari and Rankin (2013) have analyzed the potentially drastic effect of a Taylor Rule on the effectiveness of fiscal policy in a non-Ricardian model with overlapping generations. However, they do not analyze the effects of distortive labor income taxes and they do not consider monetary policies alternative to the standard Taylor-type rules. Galì (2014) has instead analyzed the effects of an alternative and not conventional monetary policy to recover the economy: a fiscal stimulus, in the form of temporary increase in government purchases, financed entirely through money creation. However, Galì (2014) does not consider the redistributive effects of this policy which is instead the main objective of our paper. Finally, this literature considers lump-sum taxes and the distortive effect of the labor income tax rules is not taken into account.

Money creation to finance the government debt has always been associated with the fears of high inflation and no role was expected by fiscal policies. Also because of the beliefs that the lags in implementing fiscal policies were typically too long to be useful to recover from recessions. However, this long period of crisis has opened a wide spectrum of policy tools, above all because interest rates are already close to zero bound. Nowadays, many money creation policies are considered. The extreme end of this spectrum of possible tools is represented by the over money finance of fiscal deficit - "helicopter money", that is a permanent monetization of government debt (Turner 2013). However, a more moderate example of money creation has already been implemented by central banks: as for example quantitative easing operations. The latter has been accompanied by expansive fiscal policies at least in the US. On this last issue, Giavazzi and Tabellini (2014) argue that measures as quantitative easing should always take place together with fiscal easing. Our paper goes in this direction by considering a more structured fiscal policy than the one considered by Gali (2014) and by also investigating the redistributive effects of money financed spending policies. As we show in the paper the redistributive effects of these policies seem to be important and cannot be neglected by policy makers. Also we point out that when labor income taxes follow a feedback rule, as the one considered in our model, a debt financing fiscal rule is not necessarily so detrimental for the fiscal authority since when the central bank is allowed to buy in the secondary market, private households (consumers or even banks in a more sophisticated financial markets) have the incentive to sell their debt to the monetary policy authority.

The remainder of this paper is organized as follows. Section 2 spells out the model economy, while Section 3 analyzes the effect of a money-financed fiscal stimulus in a NK-DSGE model with savers and borrowers. It then compares the results with those obtained under a debt-financing regime, and then it compares our results with the ones implied by a representative agent model. Section 4 summarizes the main findings and concludes.

2 The model

The model considered is a closed economy composed by four agents: households, firms, the fiscal authority and the monetary authority.

2.1 Households

All households have preferences defined over private consumption, $C_{\iota,t}$, real balances, $M_{\iota,t}/P_t$, and labor services, $N_{\iota,t}$, according to the following utility function:

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta_\iota^t \left[(1-\chi) \ln C_{\iota,t} + \chi \ln \frac{M_{\iota,t}}{P_t} - \psi_\iota \frac{N_{\iota,t}^{1+\varphi}}{1+\varphi} \right], \tag{1}$$

where φ is the inverse of the labour supply elasticity. Following BMP, the agents differ in their discount factors $\beta_\iota \in (0,1)$ and possibly in their preference for leisure ψ_ι. Specifically, there are two types of agents $\iota = s, b$, and $\beta_s > \beta_b$. E_0 denotes expectations conditional on the information available at time 0 and χ measures the weight of real balances relatively to private consumption. Also, χ determines the share of real balances over GDP.

$C_{\iota,t}$ is a CES aggregator of the quantity consumed $C_t(z)$ of any of the infinitely many varieties $z \in [0,1]$ and it is defined as

$$C_{\iota,t} = \left[\int_0^1 C_t(z)^{\frac{\epsilon-1}{\epsilon}} dz \right]^{\frac{\epsilon}{\epsilon-1}}, \tag{2}$$

$\epsilon > 1$ is the elasticity of substitution between varieties.

A $1-\lambda$ share is represented by households who are patient: we label them savers, discounting the future at β_s. Consistent with the equilibrium outcome the patient agents are savers (and hence will hold the bonds issued by impatient agents), we impose that patient agents also hold all the shares in firms. Hence, they have access to three different assets: money, one-period nominally riskless bonds and shareholdings. In each period $t \geq 0$ and under all contingencies each saver chooses consumption, hours worked, money demand asset holdings (bonds and shares), subject to:

$$\begin{aligned} P_t C_{s,t} + B_{s,t}^H + P_t A_{s,t} + M_{s,t} + \Omega_{s,t} P_t V_t \quad \leq \quad & (1+i_{t-1}) B_{s,t-1}^H + (1+i_{t-1}) P_t A_{s,t} \\ & M_{s,t-1} + \Omega_{s,t-1} P_t (V_{t-1} + \Gamma_t) \\ & + W_t N_{s,t} (1-\tau_{s,t}), \end{aligned} \tag{3}$$

where W_t is the nominal wage, $A_{s,t-1}$ is the real value at beginning of period t of total private assets held in period t, a portfolio of one-period bonds issued in $t-1$ on which the household receives the nominal interest i_{t-1}. $V_{t-1}$is the real market value at time t of shares in intermediate good firms, Γ_t are real dividend payoffs of these shares, $\Omega_{s,t}$ are share holdings, $w_t N_{s,t}(1-\tau_{s,t})$ is the after-tax real saver labor income, $B_{s,t}^H$ are the savers' holdings of nominally

riskless one-period government bonds (paying an interest i_t). The nominal debt B_t^H pays one unit in nominal terms in period $t+1$. To prevent Ponzi games, the following condition is assumed to hold at all dates and under all contingencies $\lim_{T\to\infty} E_t\left\{\prod_{k=0}^{T}\left(1+i_{t+k}\right)^{-1} B_{s,t+T}^H\right\} \geq 0$. Given prices, policies and transfers $\left\{P_t\left(z\right), W_t, i_t, G_t, \tau_{s,t}, V_t, \Gamma_t, T_t\right\}_{t\geq 0}$, the saver chooses the set of processes $\left\{C_{s,t}\left(z\right), C_{s,t}, N_{s,t}, M_{s,t}, A_{s,t}, B_{s,t}^H, \Omega_{s,t}\right\}_{t\geq 0}$,so as to maximize (1) subject to $(2), (3)$ and no-Ponzi game condition. After defining the aggregate price level as $P_t = \left[\int_0^1 P_t\left(z\right)^{1-\epsilon} dz\right]^{\frac{1}{1-\epsilon}}$,

as well as real debt as, $b_t^H \equiv B_t/P_t$,optimality is characterized by the first-order conditions:

$$\beta_s E_t\left\{\frac{C_{s,t}\left(1+i_t\right)}{C_{s,t+1}\pi_{t+1}}\right\} = 1, \tag{4}$$

$$\beta_s E_t\left\{\frac{C_{s,t}}{C_{s,t+1}}\frac{V_{t+1}+\Gamma_{t+1}}{V_t}\right\} = 1, \tag{5}$$

$$\frac{\psi_s N_{s,t} C_{s,t}}{1-\chi} = w_t\left(1-\tau_{s,t}\right), \tag{6}$$

$$\frac{M_{s,t}}{P_t} = \left(\frac{\chi}{1-\chi}\right) C_{s,t}\left(1+\frac{1}{i_t}\right). \tag{7}$$

Equation (6) shows that the labor income tax drives a wedge between the marginal rate of substitution between leisure and consumption and the real wage.

In each period $t \geq 0$ and under all contingencies the rest of households on the $[0, \lambda]$ interval are impatient (and will borrow in equilibrium, hence we index them by b for borrowers) faces the following budget constraint:

$$P_t C_{b,t} + P_t A_{b,t} + M_{b,t} \leq \left(1+i_{t-1}\right) P_t A_{b,t-1} + M_{b,t-1} + W_t N_t\left(1-\tau_{b,t}\right), \tag{8}$$

as well as the additional borrowing constraint (on borrowing in real terms) at all times t:

$$-A_{b,t} \leq \bar{D}, \tag{9}$$

Given prices, policies and transfers $\left\{P_t\left(z\right), W_t, \phi_t, i_t, G_t, \tau_{b,t}, T_t\right\}_{t\geq 0}$, the borrower chooses the set of processes $\left\{C_{b,t}\left(z\right), C_{b,t}, N_{b,t}, M_{b,t}, A_{b,t}\right\}_{t\geq 0}$, so as to maximize (1) subject to (2) and (8). Optimality is characterized by the first-order conditions:

$$C_{b,t}^{-1} = \beta_b E_t\left(\frac{1+i_t}{\pi_{t+1}} C_{b,t+1}^{-1}\right) + \phi_t, \tag{10}$$

$$\frac{\psi_b N_{b,t}^{\varphi} C_{b,t}}{1-\chi} = w_t \left(1-\tau_{b,t}\right), \tag{11}$$

$$\frac{M_{b,t}}{P_t} = \left(\frac{\chi}{1-\chi}\right) C_{b,t} \left(1+\frac{1}{i_t}\right). \tag{12}$$

Equation (11) shows that the labor income tax drives a wedge between the marginal rate of substitution between leisure and consumption and the real wage. While, in (10), ϕ_t takes a positive value whenever the constraint is binding. Indeed, because of BMP assumptions on the relative size of the discount factors, the borrowing constraint will bind in steady state.

2.2 Firms

The economy is characterized by an infinite number firms indexed by z on the unit interval $[0,1]$. Each firm produces a differentiated variety with a constant return to scale technology,

$$Y_t(z) = N_t(z), \tag{13}$$

where $N_t(z)$ denotes the quantity of labor hired by firm z in period t. Following Rotemberg (1982), we assume that firms face quadratic price adjustment costs $\frac{\theta}{2}\left(\frac{P_t(z)}{P_{t-1}(z)}-1\right)^2$ expressed in the units of the consumption good defined in (2) and $\gamma \geq 0$. Nominal profits read as:

$$E_t\left\{\sum_{i=0}^{\infty} Q_{t,t+i}(z) \left[\begin{array}{c} P_{t+i}(z) Y_{t+i}(z) - W_{t+i} N_{t+i}(z) \\ -P_{t+i}\frac{\theta}{2}\left(\frac{P_{t+i}(z)}{P_{t+i-1}(z)}-1\right) \end{array}\right]\right\}, \tag{14}$$

where $Q_{t,t+i}$ is the discount factor in period t for nominal profits i periods ahead.

Assuming that firms discount at the same rate as savers implies $Q_{t,t+i} = \beta_s^i \frac{C_{s,t}}{C_{s,t+i}\pi_{t+i}}$, each firm faces the following demand function:

$$Y_t(z) = \left(\frac{P_t(z)}{P_t}\right)^{-\epsilon} Y_t^d, \tag{15}$$

where Y_t^d is aggregate demand and it is taken as given by any firm z. Cost minimization taking the wage as given implied that real marginal cost is w_t. Firms choose processes $\{P_t(z), N_t(z), Y_t(z)\}_{t\geq 0}$ so as to maximize (14) subject to (13) and (15), taking as aggregate prices and quantities $\left\{P_t, W_t, Y_t^d\right\}_{t\geq 0}$. Let the real marginal cost be denoted by

$$mc_t = w_t \tag{16}$$

Then, at a symmetric equilibrium where $P_t(z) = P_t$ for all $z \in [0,1]$, profit maximization and the definition of the discount factor imply:

$$\pi_t(\pi_t - 1) = \beta E_t\left[\frac{C_{s,t}}{C_{s,t+1}}\pi_{t+1}(\pi_{t+1} - 1)\right] + \frac{\epsilon N_t}{\gamma}\left(mc_t - \frac{\epsilon - 1}{\epsilon}\right) \quad (17)$$

(17) is the standard Phillips curve according to which current inflation depends positively on future inflation and current marginal cost. The aggregate real profits are:

$$\Gamma_t = (1 - mc_t) Y_t - \frac{\gamma}{2}(\pi_t - 1)^2. \quad (18)$$

2.3 Fiscal Authority and Monetary Authority

We start by introducing the budget constraints of the fiscal and the monetary authorities, we then describe formally the fiscal intervention that is the focus of our analysis.

The fiscal authority provides the public good $G_t(z)$ for any $z \in [0, 1]$ and aggregating them according to:

$$G_t = \left[\int_0^1 G_t(z)^{\frac{\epsilon-1}{\epsilon}} dz\right]^{\frac{\epsilon}{\epsilon-1}}, \quad (19)$$

so that total government expenditures in nominal terms is $P_t G_t$ and the public demand of any variety is:

$$G_t(z) = \left(\frac{P_t(z)}{P_t}\right)^{-\epsilon} G_t. \quad (20)$$

Expenditures are financed by levying a distortive tax or by issuing one period, risk-free, non state contingent nominal bonds. Hence, the fiscal authority's period budget constraint is given by

$$P_t G_t + B_{t-1}(1 + i_{t-1}) = (1 - \lambda)\tau_{s,t} W_t N_{s,t} + \lambda \tau_{b,t} W_t N_{b,t} + P_t S_t^G + B_t, \quad (21)$$

where G_t and $\tau_{\iota,t}$ denote government purchases and distortive taxes (in real terms), B_t is the stock of one-period nominally riskless government debt issued in period t and yielding a nominal return i_t, and S_t^G denotes a real transfer from the central bank to the fiscal authority. Equivalently, and after letting $b_t = B_t/P_t$ we can write:

$$G_t + b_{t-1}\frac{(1 + i_{t-1})}{\pi_t} = (1 - \lambda)\tau_{s,t} w_t N_{s,t} + \lambda \tau_{b,t} w_t N_{b,t} + S_t^G + b_t. \quad (22)$$

The central bank's budget constraint is given by

$$B_t^M + P_t S_t^G = B_{t-1}^M (1 + i_{t-1}) + \Delta M_t,$$

where B_t^M denotes the central bank's holdings of government debt at the end of period t, and M_t is the quantity of money in circulation[1]. Equivalently, in real terms

$$b_t^M + S_t^G = b_{t-1}^M \frac{(1+i_{t-1})}{\pi_t} + \frac{\Delta M_t}{P_t}, \tag{23}$$

where $b_t^M \equiv B_t^M/P_t$ and $\frac{\Delta M_t}{P_t}$ is the amount of seigniorage generated in period t.

The amount of government debt held by households (expressed in real terms), and denoted by $b_t^H \equiv B_t^H/P_t$, is given by

$$b_t^H = b_t - b_t^M \tag{24}$$

In what follows we often refer to b_t^H as *net* government debt, for short. Combining (22), (23) and (24) one can derive the government's *consolidated* budget constraint

$$G_t + b_{t-1}^H \frac{(1+i_{t-1})}{\pi_t} = (1-\lambda)\,\tau_{s,t} w_t N_{s,t} + \lambda \tau_{b,t} w_t N_{b,t} + b_t^H + \frac{\Delta M_t}{P_t} \tag{25}$$

which may also be interpreted as a difference equation describing the evolution of net government debt over time. Below, following Galì (2014), we consider equilibria near a steady state with zero inflation, no trend growth, and constant government debt b^H, government purchases G, and taxes τ[2]. On the other hand, constancy of real balances requires that $\Delta M = 0$ in the steady state. It follows from (25) that

$$\tau_b = \frac{G + ib^H - (1-\lambda)\,\tau_s w N_s}{\lambda w N_b}, \tag{26}$$

and

$$\tau_s = \frac{G + ib^H - \lambda \tau_b w N_b}{(1-\lambda)\,w N_s}. \tag{27}$$

Note that (23)implies

$$S^G = ib^M, \tag{28}$$

i.e. in that steady state the central bank's transfer to the fiscal authority equals the interest revenue generated by its holdings of government debt. Note

[1] The balance sheet of the central bank is given by

$$B_t^M = M_t$$

[2] The constancy of the net government debt in the steady state implicitly assumes a tax rule designed to stabilize that variable about some target b^H

that in a neighborhood of the zero inflation steady state, the level of seigniorage (expressed as a fraction of steady state output) can be approximated as

$$\begin{aligned}\left(\frac{\Delta M_t}{P_t}\right)\left(\frac{1}{Y}\right) &= \left(\frac{\Delta M_t}{M_{t-1}}\right)\left(\frac{M_{t-1}}{P_{t-1}}\right)\left(\frac{P_{t-1}}{P_t}\right)\left(\frac{1}{Y}\right) \\ &\cong \left(\frac{1}{V}\right)\Delta m_t \end{aligned} \tag{29}$$

where $m_t = \log M_t$ and $V \equiv \frac{PY}{M}$ is the steady state income velocity of money. In words, the level of seigniorage is proportional to money growth.

Let $\hat{b}_t^H \equiv \frac{\left(b_t^H - b^H\right)}{Y}, \hat{g}_t = \frac{(G_t - G)}{Y}$ and $\hat{\tau}_{\iota,t} \equiv \frac{(\tau_{\iota,t} - \tau_\iota)}{Y}$ denote, respectively, deviations of net government debt, government purchases and taxes from their steady state values, expressed as a fraction of output. We assume that the fiscal authority implements the following feedback rule

$$\hat{\tau}_{\iota,t} = \Phi_B \hat{b}_t^H. \tag{30}$$

This tax rule is general enough to allow taxes on each agent to react to stabilize government debt ($\Phi_B = 0.09$ is the debt feedback coefficient). The plan prescribes a tax path that depends on public debt. We think that this is an interesting case, even though it is a simple one, because an endogenous tax response to public debt roughly agrees with the intentions declared by most of public debt-targeting governments.

2.4 Money-Financed vs. Debt-Financed Fiscal Stimulus

In "normal" times government purchases are assumed to be constant and equal to G. The objective of the analysis below is to determine the consequences of deviations of government purchases from that "normal" level, i.e. $\hat{G}_t = G_t - G$. We refer to those deviations as "fiscal stimulus" (or "fiscal contraction", if negative). Below we assume that such fiscal stimulus, expressed as a fraction of steady state output and denoted by $\hat{g}_t \equiv \frac{(G_t - G)}{Y}$, follows the exogenous process

$$\hat{g}_t = \rho_g \hat{g}_{t-1} + \varepsilon_t^g, \tag{31}$$

where $\rho_g \in [0, 1)$ indexes the "persistence" of the fiscal intervention. The baseline policy experiment analyzed below consists of an increase in government purchases financed entirely through seigniorage. Formally,

$$\frac{\Delta M_t}{P_t} = \hat{G}_t, \tag{32}$$

or, equivalently, using (29),

$$\Delta m_t = V \hat{g}_t, \tag{33}$$

i.e., the growth rate of the money supply is proportional to the fiscal stimulus, inheriting the latter's exogeneity. Note that whether the central bank

transfer to the fiscal authority takes the form of a direct transfer of seigniorage (with no counterpart) or a permanent increase in the central bank's holdings of government debt has no bearing on the macroeconomic effects of the fiscal stimulus and is only relevant from an accounting viewpoint.

As an alternative to the fiscal-monetary regime described above, and with the purpose of having a comparison benchmark, we also analyze the effects of a debt-financed fiscal stimulus in a (more conventional) environment in which the central bank follows a simple interest rate rule given by

$$\hat{\imath}_t = \phi_\pi \hat{\pi}_t, \tag{34}$$

where $\hat{\imath}_t = \log \frac{i_t}{i}$, $\hat{\pi}_t = \log \frac{\pi_t}{\pi}$ and $\phi_\pi > 1$ determines the strength of the central bank's response of inflation deviations from the zero long-term target. Notice that, in contrast with the money-financing regime, Δm_t is no longer determined by $\hat{g}_t$.The interest rate rule requires that the central bank injects or withdraws money from circulation by means of open market operations (in exchange for government debt) in order to accommodate whatever money is demanded by households at the targeted interest rate.

As discussed below, an interest rate rule like (34) gives the central bank a tight control over inflation in response to a fiscal stimulus, through its choice of coefficient ϕ_π.Yet, that tighter control comes at the price of a smaller impact of the fiscal stimulus on economic activity (i.e. a smaller "fiscal multiplier").

2.5 Equilibrium

The equilibrium allocation $Y_t = C_t + G_t + \frac{\theta}{2}(\pi_t - 1)^2$ is based on additional markets clearing conditions,

$$C_t = \lambda C_{b,t} + (1-\lambda) C_{s,t}; \tag{35}$$

$$M_t = \lambda M_{b,t} + (1-\lambda) M_{s,t}; \tag{36}$$

$$N_t = \lambda N_{b,t} + (1-\lambda) N_{s,t}; \tag{37}$$

respectively, aggregate consumption, money market clearing condition and labor market clearing condition.

3 Model Dynamics

3.1 Calibration

Before we start showing our results, we briefly describe the baseline calibration of the model's parameters. That calibration is summarized in the top panel of Table (1) . We assume the following settings for the household related parameters: discount factors of borrowers and savers are set respectively $\beta_b = 0.95$ and $\beta_s = 0.99$, values which are in line to those of BMP. Analogously, as in BMP,

	Description	*Value*
NK Model		
φ	Curvature of labor disutility	5
β_b	Borrower's discount factor	0.95
β_s	Saver's discount factor	0.99
$\bar{D}$	Borrowing Constraint	0.05
ψ_b	Borrower's preference for leisure	0.6
ψ_s	Saver's preference for leisure	0.3
π	Inflation	1
χ	Weight of money in utility function	0.08
V	Velocity (quarterly)	4
γ	Government spending share	1/5
ρ_g	Fiscal stimulus persistence	0.9
$\hat{b}^H$	Steady state debt ratio (quarterly)	2.4
ϕ_π	Taylor rule coefficient	1.5
ϵ	Elasticity of substitution (goods)	6
α	Index of price rigidities	0.75
Φ_B	Debt feedback coefficient	0.1

Table 1: Baseline Calibration

we set the borrowing constraint $\bar{D} = 0.05$, borrower and saver preferences for leisure respectively equal to $\psi_b = 0.6$ and $\psi_s = 0.3$. Parameter λ, denoting the share of impatient agents, is set to 0.35, as in BMP, while the debt feedback coefficient in the labor income rule is set to $\Phi_B = 0.1$.

The remaining parameters are kept at their baseline values. We assume that government purchases account for a fraction γ of output in the steady state, i.e. $G/Y = \gamma$. We calibrate the curvature of labor disutility $\varphi = 5$ as in Galì (2014) so as we calibrate the government spending share $\gamma = 0.2$ (steady state share of government purchases in output), the velocity of money $V = 4$, the steady state debt ratio $b^H = 2.4$,and that of inflation $\pi = 1$. The elasticity of substitution among goods is $\epsilon = 6$ and the Taylor rule coefficient is equal to 1.5. The persistence of the government spending shock is set to $\rho_g = 0.9$ and the Calvo price stickiness coefficient used to calibrate the Rotemberg adjustment cost is set to $\alpha = 0.75$, which is in the range of values used in calibration of aggregate sticky price models with exogenous staggering and also consistent with most of the Bayesian estimation of this parameters.

3.2 The Effects of a Money-Financed Fiscal Stimulus

Next we show the impulse response functions (IRFs) of the two-agents model, in face of a government spending shock entirely financed through money creation. Figures 1 and 2 display selected IRFs to a one percent money-financed fiscal stimulus. The dynamics can be described as follows. In particular, Figure 1 shows that the effects of the money-financed fiscal stimulus on inflation are very

large (20 percent on impact). They are, however, extremely short-lived, and concentrated in the first quarter. The real interest rate declines persistently in response to the monetary injection that accompanies the fiscal stimulus. That reduction in the real interest rate induce a large expansion of consumption (almost 20 percent on impact), which contrasts with the crowding out of that variable observed in the classical models (Galì, 2014). Interestingly, the decline in the real interest rate observed in the New Keynesian model in response to the money-financed fiscal stimulus coexists with an increase in the nominal rate, which is brought about a large expansion of money demand due to higher prices and consumption. The gap between the two is, of course, due to a persistently higher rate of inflation, resulting from the gradual adjustment of prices. Gradualism in the price response, implied by staggered price setting, thus seems to play a key role in the transmission mechanism of the money-financed fiscal stimulus in the New Keynesian model. Importantly, as in Galì (2014), the upward response of the nominal interest rate suggests that the existence of a zero lower bound on that variable (whether currently binding or not) should not be an impediment to the implementation and success of a fiscal intervention of the kind considered here. Further, an unambiguous "positive" outcome of the intervention considered pertains to the substantial decrease in the debt ratio (100 percentage points on impact), resulting from erosion of the real value of government debt outstanding at the time the stimulus is initiated, due to the high unanticipated inflation, followed by persistently lower real interest rates (which reduce the government's interest payments and hence the debt issuance requirements).

Figure 2 underlines the redistributive effects of the policy. Notice in particular, that the effects of a money-financed fiscal stimulus on borrower consumption is much greater than the effect on saver consumption. Indeed borrower consumption increases much more than that of savers. Also, borrowers are better off in terms of their relative labor supply, even if the difference is lower with respect to the consumption gap between the two agents. Another important difference concerns the effect of the policy on the agents money demand. Saver money demand declines while borrowers money demand increases. The reason of these responses depends on the fact that, thanks to the tax rules, savers internalize the government budget constraint through their public debt holdings and so recognize that an expansionary monetary and fiscal policy today effectively implies a tax on themselves, today or in the future. For this reason savers consume less than borrowers and overall the public debt works as a mechanism to redistribute wealth among agents.

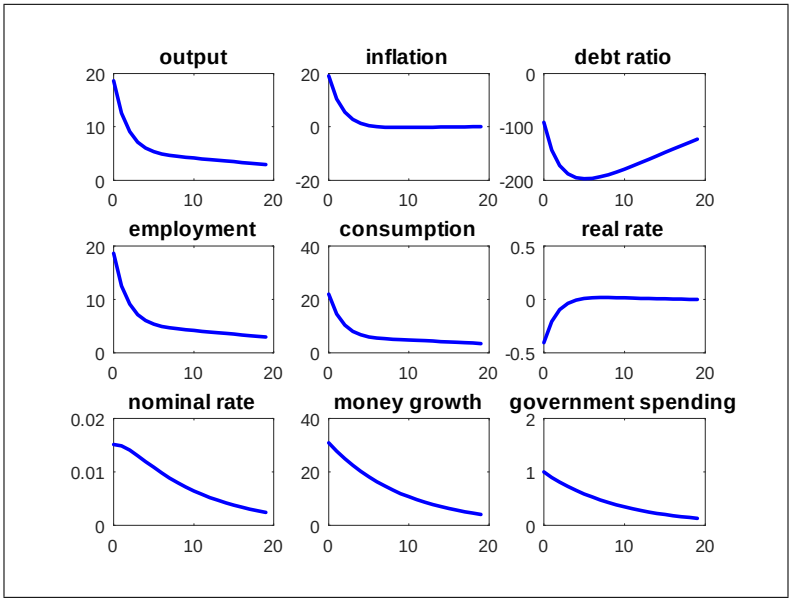

Figure 1: **Money-Financed Fiscal Stimulus in the baseline model**

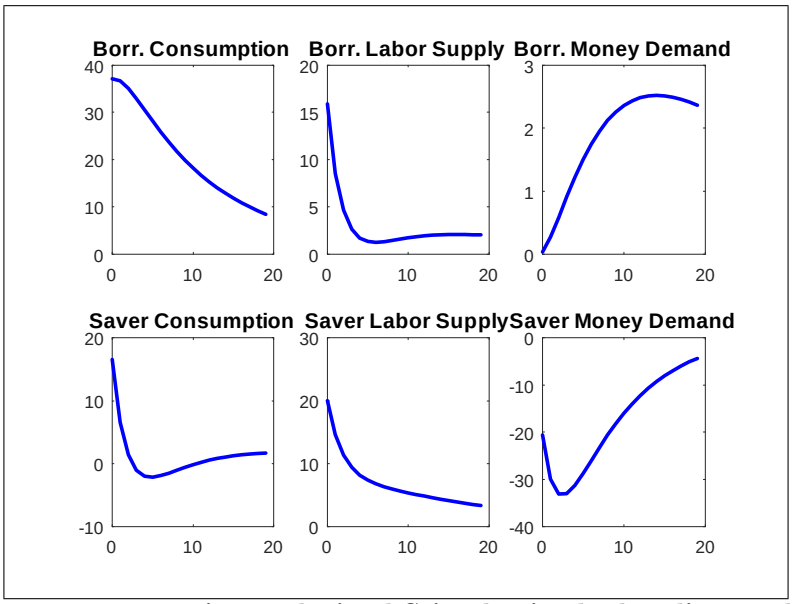

Figure 2: **Money-Financed Fiscal Stimulus in the baseline model: disaggregate effects**

3.3 Money-Financed vs. Debt-Financed Fiscal Stimulus

Consider next the alternative regime of a debt-financed fiscal stimulus, accompanied by a monetary policy described by the simple interest rate Taylor rule (34) .

A central bank that follows a simple rule like (34) can "control", through an appropriate choice of coefficient ϕ_π the extent of the inflationary impact of the fiscal stimulus. In particular, that impact can be made arbitrarily small by having the central bank respond to inflationary pressures sufficiently aggressively, i.e. by choosing a sufficiently large value for ϕ_π. Figure 3 displays the dynamic responses of several macro variables to the fiscal stimulus under a debt-financing regime when the inflation coefficient in rule(34) is $\phi_\pi = 1.5$. This setting corresponds to the value of the inflation coefficient in Taylor's (1993) celebrated rule, and is meant to capture (in a highly stylized way) an empirically plausible policy response. For the sake of comparability, Figure 3 also displays the dynamic responses obtained under a monetary-financing fiscal stimulus. Because of the monetary policy rule considered, we label the debt-financing regime as *Taylor*.

As shown in Figure 3, the difference in the responses of inflation is unambiguous: as in Galì (2014), even a moderate inflation coefficient of 1.5 is enough to stabilize inflation on impact. The decrease in the debt ratio under a debt financing regime is a consequence of distortive taxation, as shown in Appendix. Hence, it leads to a sale of household holdings of government debt in the short run and, hence, a temporary increase in the size of the corresponding central bank holdings above and beyond the newly issued debt required to finance the fiscal stimulus. The money supply increases on impact (more than under money-financing but less persistently), and it leads to a nominal rate decrease. Remarkably, notice that differently from Galì (2014) even though spending is financed through debt, the debt owned by savers reduces on impact as stays below zero for several periods. Even though the debt reduction is lower than that obtained under a money financed fiscal stimulus. As shown in Figure 4, which compares our baseline model with distortive tax rule with the same model characterized by lump-sum taxes, this counterintuitive result is mainly due to the presence of the distortive labor income tax rules.[3] Indeed, savers internalize the government budget constraint through their public debt holdings, and recognize that an increase in public expenditure today effectively implies an increase in the debt and thus of their labor income tax, today and in the future. To avoid this, they sell their holdings of government debt to the central bank, reducing their debt holding beyond the newly issued debt required to finance the fiscal stimulus.[4]

[3] Figure (B.33) in the appendix shows that the same results hold in the representative agent model when lump-sum taxes are substituted with the labor income tax rule considered in our model, which is the same considered in Galì (2014).

[4] This result does not depend on the persistence of the government spending shock, and indeed it is robust also for $\rho_g = 0.5$.

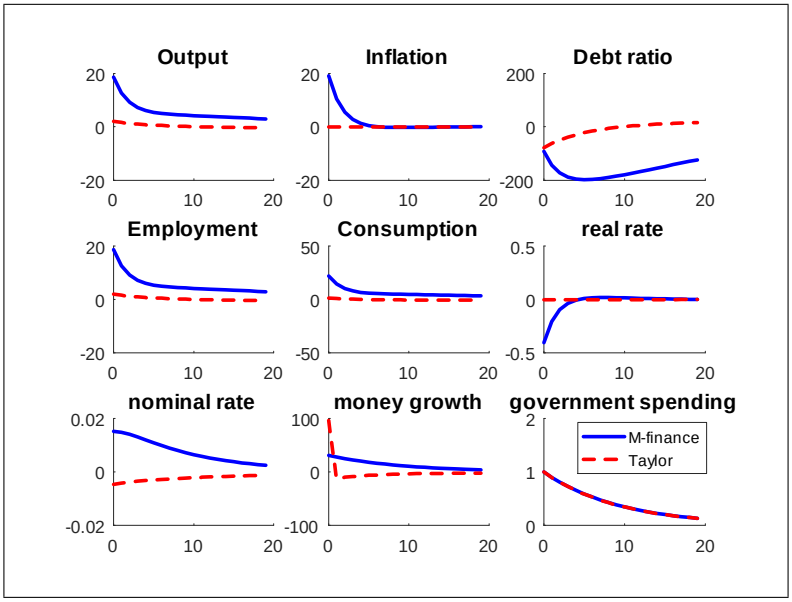

Figure 3: **Fiscal Stimulus in the baseline model**

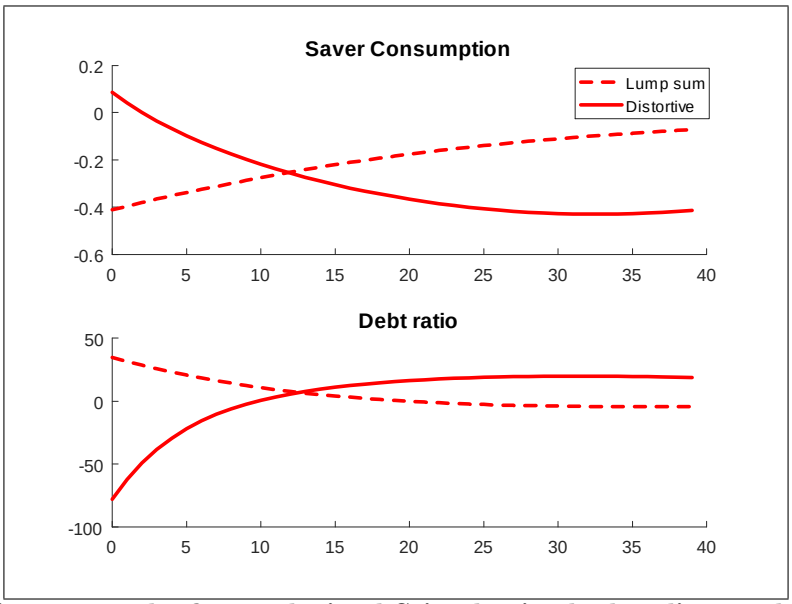

Figure 4: Debt-financed Fiscal Stimulus in the baseline model: distorsive vs lump-sum taxes

Finally, notice the impulse responses of the two agents differ more in the case of a money-financed fiscal stimulus than in the case of a debt-financing regime, as Figure 5 makes clear. In particular, notice that both regimes imply

a redistributive effect from savers to borrowers, measured in terms of the ratio between the consumption of borrowers and that of savers. The redistribution is much greater in the money-financed fiscal stimulus, where as shown in Figure 6, the consumption ratio is more than three times higher than the implied one in the debt-financed fiscal stimulus. Borrowers are better off also in terms of their relative labor supply and money demand.

The intuition for these findings is the following. As in Galì (2014), a government spending shock, financed through money, implies a consumption crowding in, followed by an high and persistent increase in inflation, which is responsible for a long lasting decline of the debt ratio owned by savers. The increase in consumption and that of inflation is then followed by an increase in the money demand, which leads to an increase in the nominal interest rate. Furthermore, differently from Gali (2014), the reduction in the public debt implies lower income tax rates for both types of households, due to the fiscal rule considered. This reduces Government revenues and partially counteracts the initial reduction of the debt. Finally, ceteris paribus, both lower revenues and higher interest rates imply an higher debt burden, which is immediately internalized by savers through their public debt holdings. As a consequence, savers consumption increases much less than that of borrowers, which do not own any debt and, by construction, cannot internalize the negative effect on the government debt burden.

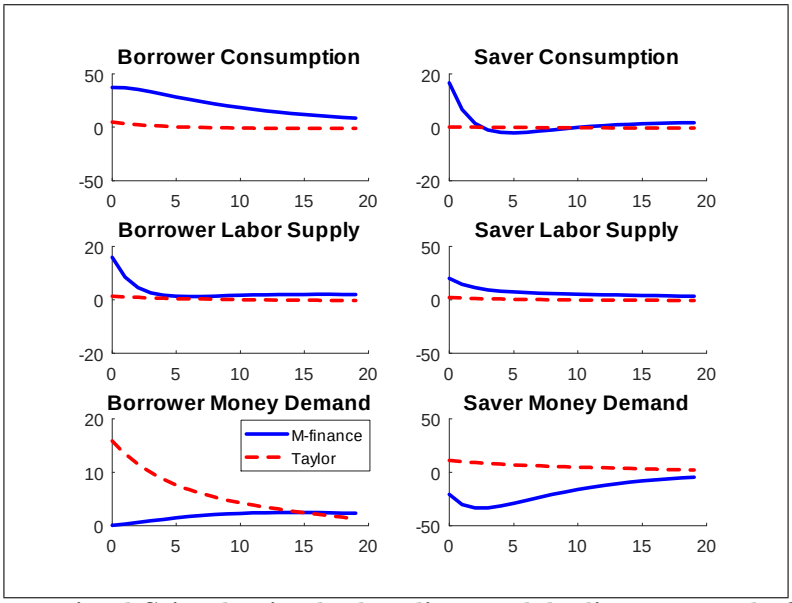

Figure 5: **Fiscal Stimulus in the baseline model: disaggregated effects**

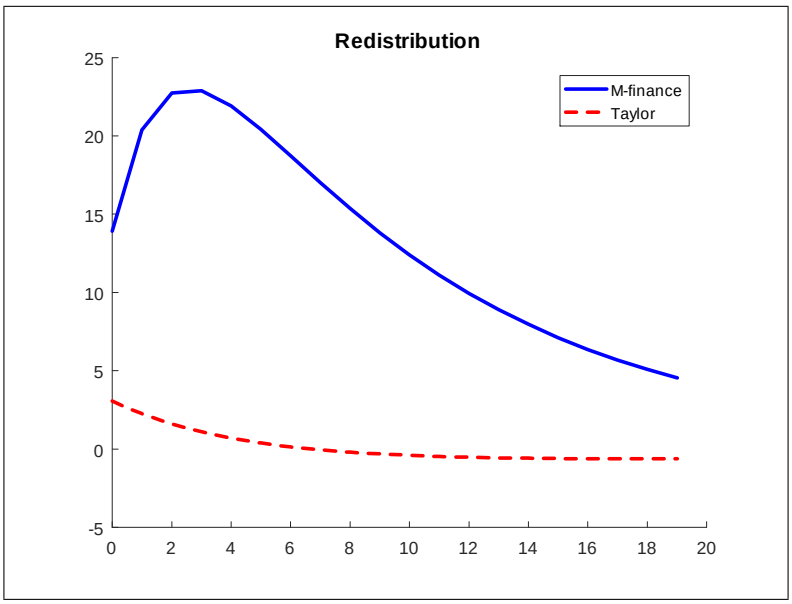

Figure 6: **Consumption ratio: Money-Financed versus Debt-Financed Stimulus**

Over all, our analysis confirms that the effects of a money-financed fiscal stimulus in a New-Keynesian monetary economy supports a strong case for that intervention, due to its effectiveness in stimulating output and employment, despite its large inflationary consequences. While its impact on inflation is very limited, a debt-financed fiscal stimulus, accompanied by a simple interest rate rule has the disadvantage of a null impact on activity. Last but not the least, private debt results in a reduction instead of an increase.

3.4 Representative *vs.* Heterogeneous Agents

Some of the key findings of the previous section regarding the effects of a fiscal stimulus under alternative financing schemes depend likely on the assumption of heterogeneous agents. The assumption of heterogeneous agents is likely to be central to the response of real variables to alternative schemes for the financing of the fiscal stimulus (with their implied differences in monetary policy rules). In the present section we compare our baseline model with the same model with a representative agent. Taxes are distortive as in our baseline model. This allows to analyze to what extent our results on the aggregate macro-variables are due to the presence of borrowing constraints.

3.4.1 Money-Financed Fiscal Stimulus

Next we compare the dynamics of our baseline model with the dynamics of the representative agent model, in response to a spending shock financed through money creation.

Figure 7 displays selected impulse responses to a one percent money-financed fiscal stimulus. As Figure 7 makes clear, the effects of a money-financed fiscal stimulus on output and inflation (as well as on most other macro variables) appear not be affected by the presence of borrowing-constrained households. In contrast with the representative agent economy, in the two agents model the fiscal stimulus requires a sliglthly higher increase in money growth which explains the corresponding higher increase in the response of nominal interest rate.

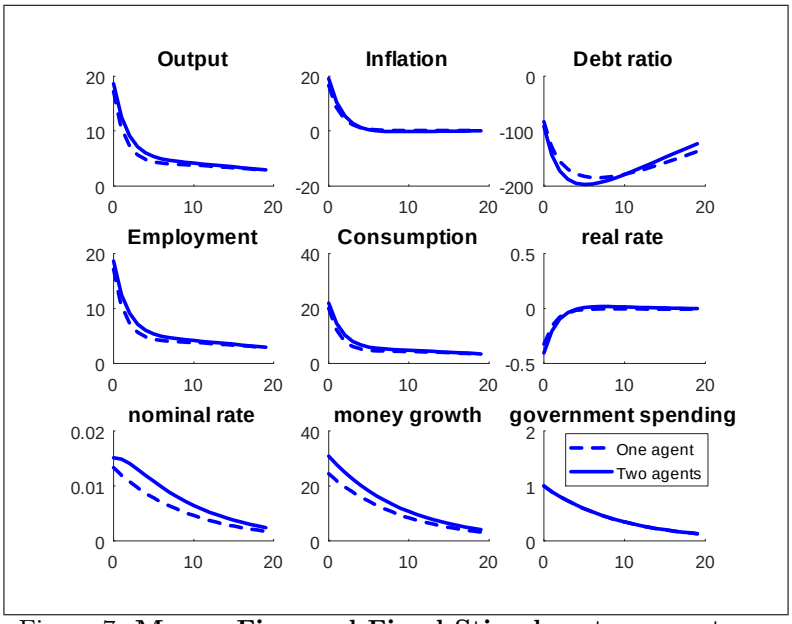

Figure 7: **Money-Financed Fiscal Stimulus: two agents vs representative agent model**

3.4.2 Money-Financed vs. Debt-Financed Fiscal Stimulus

That invariance, resulting in the money-financed fiscal stimulus case, no longer holds in the case of a debt-financed fiscal stimulus, as Figure 8 shows in the resulting IRFs. Notice that, under a Taylor rule, the presence of borrowing-constrained consumers enhances the impact of that fiscal intervention on output due to the increase in overall demand of labor and the increase in overall consumption (due to the crowding in effect of a fiscal stimulus on borrower consumption). Two reasons explain the decrease of public debt held by households: the decrease of overall public debt due to the rise of overall demand of labor and a greater internalization of government budget constraint by the single owners of public debt, the savers. They increase the sale of their public debt holdings with respect to the model with representative agent. The extra-reduction of the debt burden, characterizing the savers-borrowers model, can be explained as follows. When public spending is financed through debt and taxes

are distortive, savers internalize the government budget constraint, because of the fear of higher current and future taxes, and immediately sell their own debt to the Central Bank. Since in our model savers are the single private owners of public debt, ceteris paribus, their percapita internalization of the debt, and consequently the amount of debt sold to the central bank, is higher than in a representative agent economy. This results in a lower debt burden, accompanied by an increase in savers consumption which is higher than in the single agent economy. Because of the higher increase in the aggregate demand, output increases more than in a representative agent model. This also confirms that our result on the reduction of the debt ratio does not depend on the introduction of borrowing constraints but simply on the distortive income tax rule. The appendix shows that in a lump-sum tax representative agent economy debt owned by households increases in debt financed fiscal rules, as found in Galì (2014).

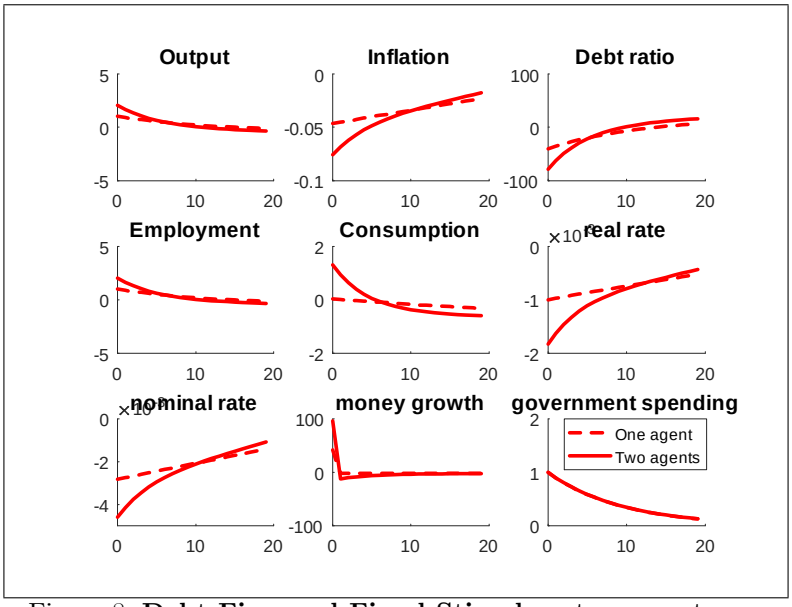

Figure 8: **Debt-Financed Fiscal Stimulus: two agents vs. representative agent model**

4 Conclusions

In the present paper we consider a NK-DSGE model with distortive labor income tax rules and borrowing constrained agents. We analyze the effects of an increase in government purchases financed entirely through seigniorage and compare them with those resulting from a more conventional debt-financed stimulus.

A key finding from our analysis lies on the redistributive effects of a money-financed fiscal stimulus. The redistributive effect of the money-financed fiscal stimulus, measured in terms of the ratio between borrower and saver consumption, is much greater than in the debt-financing regime.

Another key finding turns out when we compare our model with the representative agent model, considered by Galì (2014). While the money-financed fiscal stimulus implies important results in terms of redistribution between the two agents, at aggregate level our model is only slightly different from the same model with representative agent. However, when the government spending shock is debt-financed, the behavior of aggregate variables presents an important departure from the representative agent model. Indeed, in this case, the presence of borrowing-constrained consumers enhances the impact of the fiscal intervention on aggregate output due to the increase in the aggregate consumption (Galì et al. (2007)). In addition, we observe an higher decrease of the public debt held by households. Furthermore, we show that the reduction in the savers debt, following the debt financed stimulus, is only due to the presence of distortive labor income tax rules.

Future research efforts could embed a deeper welfare analysis, including optimal monetary and fiscal policy, under discretion as well as under commitment.

References

[1] Ascari, G. and Rankin, N. (2013). "The Effectiveness of Government Debt for Demand Management: Sensitivity to Monetary Policy Rules", *Journal of Economic Dynamics and Control,* vol.37, pp. 1544-1566.

[2] Bilbiie, F. O. (2008). "Limited asset market participation, monetary policy and (inverted) aggregate demand logic", *Journal of Economic Theory,* vol. 140, pp. 162-196.

[3] Bilbiie, F.O., Monacelli, T. and Perotti, R. (2013). "Public Debt and Redistribution with Borrowing Constraints", *The Economic Journal*, vol. 123, pp. F64-F98.

[4] Di Bartolomeo, G. and Rossi, L. (2007). "Effectiveness of monetary policy and limited asset market participation: Neoclassical versus keynesian effects", *International Journal of Economic Theory,* vol. 3, pp. 213-218.

[5] Galì, J. (2014). "The Effects of a Money-Financed Fiscal Stimulus", mimeo.

[6] Galì, J., Lòpez-Salido, J. D. and Vallés, J. (2004). "Rule-of-thumb consumers and the design of interest rate rules", *Journal of Money, Credit and Banking,*. vol. 36, pp. 739-764.

[7] Galì, J., Lòpez-Salido, J. D. and Vallés, J. (2007). "Understanding the effects of government spending on consumption", *Journal of the European Economic Association,*. vol. 5(1), pp. 227-270.

[8] Giavazzi, F. and Tabellini, G. (2014). "How to Jumpstart the Eurozone Economy", *www.voxeu.org.*

[9] Kirsanova, T., Leith C. and Wren-Lewis, S. (2009). "Monetary and fiscal policy interaction: the current consensus assignment in the light of recent developments", *Economic Journal,* vol. 119(541), pp. 482-496.

[10] Turner, A. (2013). "Debt, Money and Mephistopheles: How do we Get Out of this Mess?" lecture delivered at the Cass Business School.

[11] Woodford, M. (2011). "Simple analytics of the government expenditure multiplier", *American Economic Journal: Macroeconomics,* vol. 3(1), pp. 1-35.

A The Effect of a Money-Financed Fiscal Stimulus: Lump-sum *versus* Distortive Taxes

Some of the key findings of the paper regarding the effects of a fiscal stimulus under alternative financing schemes depend likely on the assumption of distortive taxes. The assumption of distortive taxes is likely to be central to the response of real variables to alternative schemes for the financing of the fiscal stimulus (with their implied differences in monetary policy rules).

In the present section we relax the assumption of distortive taxes on labor income underlying the analysis above. More specifically, we include lump sum taxes into the New Keynesian model with monopolistic competition in goods market and staggered price setting introduced in the paper.

Our objective is to get a sense of the quantitative effects of a money-financed fiscal stimulus on different macro variables, and their differences with those obtained under a more conventional debt-financing scheme, in a model with lump-sum taxes.

Next we describe the key features of the model. We keep all previous assumptions, except for changes we list. Firms sector remains unchanged.

The Model

Households

The household maximizes utility function subject to a sequence of budget constraints

$$P_t C_t + \mathbf{B}_t^H + \mathbf{M}_t = (1 + i_{t-1})\, \mathbf{B}_{t-1}^H + M_{\mathbf{t-1}} + W_t N_t + P_t \Gamma_t - P_t \tau_t, \qquad (38)$$

for $t = 0, 1, 2, ...$where τ_t is a lump-sum tax. Hence, the optimality conditions are given by

$$\frac{W_t}{P_t} = C_t N_t^{\varphi}, \qquad (39)$$

$$1 = \beta(1 + i) E_t \left\{ \left(\frac{C_t}{C_{t+1}} \right) \left(\frac{P_t}{P_{t+1}} \right) \right\}, \qquad (40)$$

$$\frac{M_t}{P_t} = \chi C_t \left(1 + \frac{1}{i_t}\right). \tag{41}$$

Equation (39) shows that there is no wedge, in the case of lump-sum tax, between the marginal rate of substitution between leisure and consumption and the real wage.

Fiscal and Monetary Authorities' Budget Constraints

Expenditures are financed by levying lump-sum taxes or by issuing one period, risk-free, non state contingent nominal bonds. Hence, the fiscal authority's period budget constraint is given by

$$P_t G_t + B_{t-1}(1 + i_{t-1}) = P_t(\tau_t + S_t^G) + B_t, \tag{42}$$

where τ_t denote lump-sum taxes (in real terms). Equivalently we can write:

$$G_t + b_{t-1}\frac{(1 + i_{t-1})}{\pi_t} = \tau_t + S_t^G + b_t. \tag{43}$$

Combining (43) , (23) and (24) one can derive the government's *consolidated* budget constraint with lump-sum taxes

$$G_t + b_{t-1}^H \frac{(1 + i_{t-1})}{\pi_t} = \tau_t + b_t^H + \frac{\Delta M_t}{P_t}. \tag{44}$$

Money-Financed Fiscal Stimulus

Next we report the predictions of the New Keynesian model with lump-sum taxes regarding the effects of a money-financed fiscal stimulus identical to the one analyzed in the paper in the context of a New Keynesian model with distortive taxes.

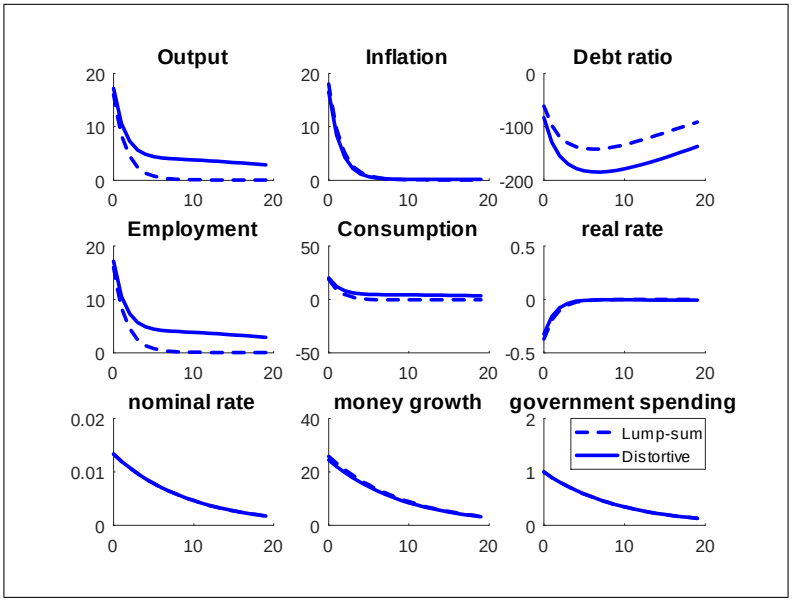

Figure 9: **Money-Financed Fiscal Stimulus in the representative agent model**

Figure 9 displays selected impulse responses to a one percent money-financed fiscal stimulus, under the assumption of $\rho_g = 0.9$. The effect on inflation, money growth, nominal and real interest rate is very similar between the lump-sum tax and the distortive tax context. As Figure 9 makes clear, a substantial difference between the New Keynesian model with lump-sum tax and the New Keynesian model with distortive tax lies in the responses of consumption and employment, and consequently in the responses of output, but also in the response of public debt. In contrast with the lump-sum tax economy, in the distortive tax model employment and consumption increase persistently in response to the monetary injection that accompanies the fiscal stimulus. That increase induces a large and persistent expansion of output (more than 15 percent on impact). The debt ratio declines more fast than in the lump-sum economy. This is due to the increase of employment (and hence a larger increase of public revenues).

Money-Financed vs. Debt-Financed Fiscal Stimulus

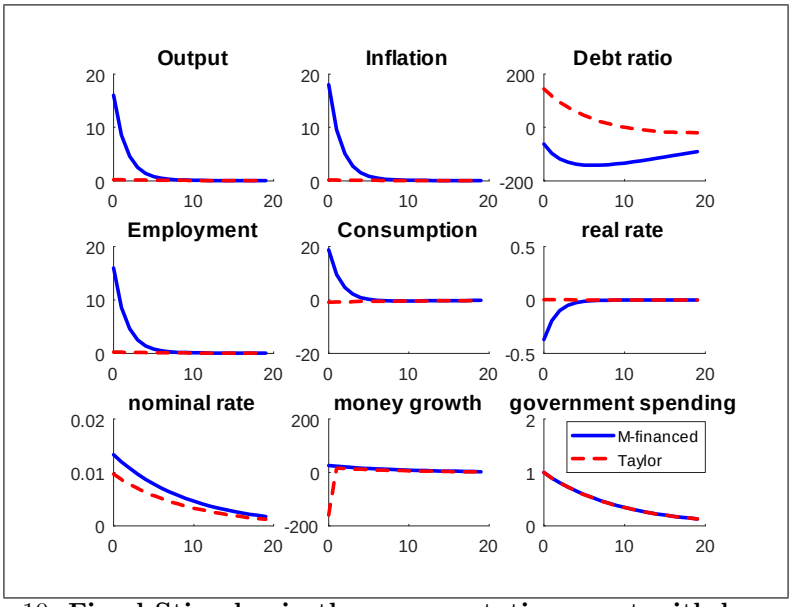

Figure 10: **Fiscal Stimulus in the representative agent with lump-sum taxes**

Figure 10 allows to compare the effects of a money-financed fiscal stimulus to those resulting from a more conventional debt-financed stimulus combined with a monetary policy described by a simple interest rate rule. As in the case of distortive tax, the response of inflation to the fiscal stimulus is much more muted under debt financing, since the central bank has its hands free to counteract the incipient inflation with a more restrictive monetary policy. As shown earlier, a money financed fiscal stimulus is much more effective than a debt-financed one at stimulating economic activity.

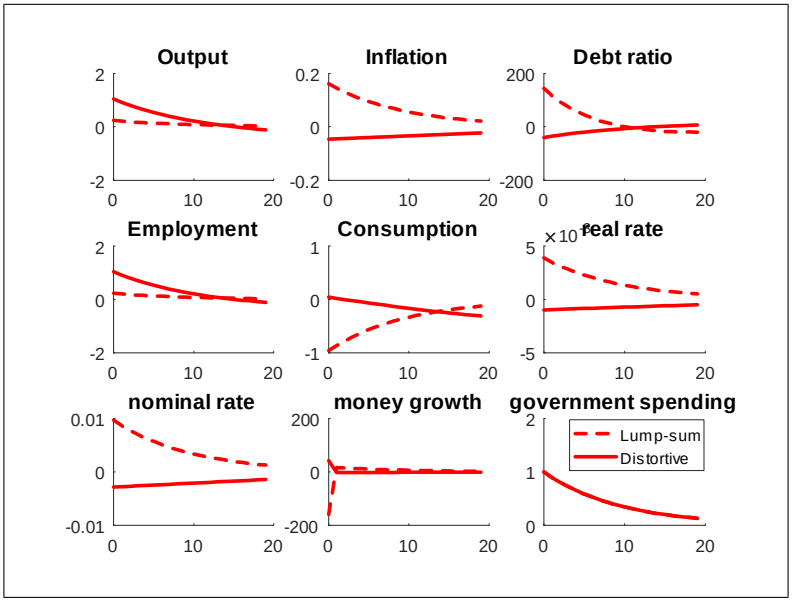

Figure 11: **Debt-Financed Fiscal Stimulus in the representative agent model**

However, if we compare the effects of a debt financed fiscal stimulus between the case of lump-sum taxes and the case of distortive taxes, we notice important differences. The decrease of debt ratio, in the case of distortive taxation, is a consequence of the fact that the representative agent internalizes more the government budget constraint through its public debt holdings due to the tax on its labor income, and recognizes that an increase in public expenditure today effectively implies a tax on its labor income, today or in the future. Hence, it leads to a sale of household holdings of government debt in the short run and, hence, a temporary increase in the size of the corresponding central bank holdings above and beyond the newly issued debt required to finance the fiscal stimulus. The money supply increases on impact, and it leads to a nominal rate decrease, and consequently a real rate decrease.