Monetary-Fiscal Interaction and the Liquidity of Government Debt*

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Abstract

How does the monetary and fiscal policy mix alter households' saving incentives? And what are the resulting implications on the evolution and stabilization of the economy? To answer these questions, we build a heterogenous agents New Keynesian model where 3 different types of agents can save in assets with different liquidity profiles to insure against idiosyncratic risk. Policy mixes affect saving incentives differently according to their effect on the liquidity premium- the return difference between less liquid assets and public debt. We derive an intuitive analytical expression linking the liquidity premium with consumption differentials amongst different types of agents. Our analysis highlights the presence of two competing forces on the liquidity premium: a *self-insurance-driven demand channel* and a *policy-driven supply channel*. We show that the relative strength of the two is tightly linked to the policy mix in place and the type of business cycle shock hitting the economy.

Keywords: monetary-fiscal interaction, liquidity, government debt, HANK

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1 Introduction

A burgeoning research agenda has highlighted the empirical differences in portfolios across the distribution of wealth and its relevance in terms of policy effectiveness and macroeconomic dynamics. In a seminal contribution, Kaplan *et al.* (2018) distinguish types of households by the prevalence of liquid or illiquid assets in their portfolios and describe the implications of different types of households for the transmission of monetary policy. Bayer *et al.* (2023) point to the importance of the liquidity channel of fiscal policy for its overall effect: the issuance of liquid government debt to finance discretionary government spending leads to a fall in the liquidity premium, thereby inducing the households to save more in liquid assets that improve their ability to smooth consumption after negative shocks. We analyze a novel transmission mechanism through which the interaction of monetary and fiscal policy shapes economic stability, i.e., via its effect on the portfolio choice of private agents. The purpose of this paper is to study how different combinations of active and passive policies affect the liquidity properties of the portfolios of different types of agents in the economy, and, through this, the aggregate response and stabilization of the economy.

For this, we use a New-Keynesian model with limited household heterogeneity in which three types of agents differ in their ability to trade in financial assets, in the spirit of Bilbiie (2021). The model features incomplete financial markets, on which agents can only trade liquid, nominal government bonds and an illiquid, real physical asset, i.e., capital. Leaving a more detailed treatment of the characteristics of each agent in the model for later, we briefly introduce them here for intuition. Our economy is made of *capitalists*, who can trade in both markets; *savers*, who can only adjust their liquid asset portfolio and cannot access the return from capital investments for consumption purposes; and *hand-to-mouth* households, who cannot engage in the purchase of any asset, therefore relying on their labor income and previously accumulated government bonds for their consumption. Households are subject to idiosyncratic shocks that make them switch types according to an exogenous transition probability. When moving across types, households may only carry with them their government bonds. This characteristic defines the liquidity of this asset contrary to capital.

Additionally, the presence of a fiscal authority that chooses the quantity of nominal tax revenues in a model with idiosyncratic uncertainty serves the further purpose of extending the range of policy mixes that we can consider in our analysis. In particular, this modeling choice makes the price level always determinate in our model (Hagedorn, 2021).[1] When fiscal policy is specified in nominal terms, shifts in the price level affect the real value of debt and thus affect real aggregate demand.[2]

By considering the monetary-fiscal regime together with the portfolio choice, we can identify and quantify two different channels. First, due to the liquidity friction, government bonds are the preferred asset to build up a buffer stock of savings to partially insure against idiosyncratic uncertainty. Therefore, policy regimes that worsen the consumption ability of the hand-to-mouth by lowering their labor income or their bond income from previous states would increase the demand for self-insurance of the capitalist type, leading to a shift in their portfolios towards more liquid assets, *ceteris paribus.* This is what we will label the "self-insurance" channel, and it works through asset demand. In the analysis, we highlight the importance of this "self-insurance" channel for the dynamics of the liquidity premium, taken as encompassing the trade-off between investing in liquid and illiquid assets, deriving an equation that relates it directly to consumption differentials across types. To the best of our knowledge, we are the first to derive such an intuitive relation linking the liquidity premium to household consumption differentials in a HANK model. Secondly, the policy regime will also determine the change in the supply of nominal government debt, due to the change in the interest payment on its stock and the strength through which the government will curb the movement in debt. This is the "supply" channel and it will have a further effect on the liquidity premium as the asset returns will have to adjust for markets to clear. Different policy mixes will affect the relative strength of these two channels and therefore provide different results in terms of the relationship between the liquidity premium and the portfolio choice of households.

We then use the model to answer questions regarding the aggregate implications of the

[1]Differently from here, Hagedorn (2021) and Bilbiie (2021) have a set up where the fiscal authority chooses the quantity of nominal debt, and fiscal revenues are then pinned down as a residual from the government budget constraint. From a price level determinacy perspective, this is equivalent to what we have here.

[2]See Bilbiie (2021) and Cantore and Dhamija (2024) for a detailed stability analysis of two-agent models with idiosyncratic risk, and nominal fiscal policy as in Hagedorn (2021) but without capital.

combination of these two novel portfolio channels under different monetary and fiscal regimes. In our first experiment, we simulate and explore the implications of technology shock. Our objective is two-fold. On the one hand, we want to gauge the relative strength of the two channels highlighted above under different policy regimes. On the other hand, we want to explore the relative strength of the trade-off between the "self-insurance" channel via government bonds and the alternative "insurance-through-investment" channel. The latter comes from the fact that whilst a decline in liquid assets has a negative effect in principle because of the lower ability of agents to smooth consumption, a concomitant increase in capital investment may represent an indirect, general equilibrium, form of insurance, by potentially increasing the demand for labor and therefore the income of the hand-to-mouth type.

Through this experiment, we show first that in regimes in which there is a large change in government debt, as when the monetary policy changes the interest rate strongly and the fiscal policy does not intervene through taxes (active monetary, active fiscal regime), the supply channel reinforces the gap in the liquidity premium, inducing the profit motive of the capitalist to prevail. In this case, an increase in the liquidity premium leads capitalists to move towards less liquid assets, spurring an increase in investment. Regimes for which the change in government debt is more tamed, however, see a dominance of the self-insurance mechanism, whereby a worsening of the risky state induces a shift of capitalists towards the more liquid asset. Then, we show that in our model, in which we adopt a standard Cobb-Douglas production function, the "investment-through-insurance" channel discussed above is very weak, due to the poor complementarity between the two productive assets. This implies that the building of more capital stock does not represent a viable substitute for liquid savings for agents in the hand-to-mouth state.

In our second experiment, we look at the effects of a fiscal stimulus with different combinations of the monetary/fiscal policy mix. An increase in government spending that produces a strong income effect for the hand-to-mouth agents reduces the "self-insurance" channel and induces capitalists to swap bonds for capital. At the same time, the fiscal stimulus increases the bond supply. We show that, once again, the relative strength of these two effects depends on the policy mix.

When monetary policy is active the supply channel dominates independently from the actions put in place by the fiscal authority. Whereas a more active fiscal policy generates a larger cumulative fiscal multiplier, capitalists keep investing in bonds at the expense of capital. However, with passive monetary policy a different picture emerges. The fiscal stimulus now induces a larger income effect on the hand-to-mouth which pushes the liquidity premium further down and makes the "self-insurance" channel stronger. Under both fiscal policy scenarios, capitalists now substitute bonds with capital, which generates substantially larger fiscal multipliers compared to the active monetary policy simulations.

1.1 Literature review

Understanding monetary-fiscal policy dynamics is crucial to the formulation and implementation of effective policy measures aimed at promoting economic growth and stability. We see our paper contributing and merging two streams of the existing literature, i.e., the study of monetary and fiscal interactions, and the aggregate consequences of households' portfolio choices, both of which are extremely prolific.

First, we delve into the evolving discourse surrounding the interplay between monetary and fiscal policies. Initially, Sargent and Wallace (1981) introduced the notion of "unpleasant monetarist arithmetic," illustrating the quandary faced by a central bank dedicated to curbing inflation while needing to accommodate inherently inflationary fiscal policies. Building upon this, Sargent (1984) extended the discussion to show how shifts in fiscal policy could undermine a central bank's commitment to maintaining low inflation. This research underscored the significance of fiscal policy expectations in influencing the efficacy of monetary policy, adding a crucial dimension to the discourse on the interaction of fiscal and monetary policies. Subsequently, Leeper (1991) introduced the concepts of "active" and "passive" monetary and fiscal policies, and illustrated how both monetary and fiscal policies are endogenously determined within a model. Leeper's analysis highlighted the pivotal role of the chosen policy regime, whether fiscal or monetary policy is active or passive, in shaping the economy's response to shocks.

Building upon these foundations, a further series of studies explored the implications of policy rules and regime switching in the context of monetary and fiscal policy interactions (Davig and Leeper, 2006, 2011; Bianchi and Melosi, 2019; Bianchi *et al.*, 2020).

Instead of going down the route of regime switching models, our first contribution to this literature, leveraging the work of Hagedorn (2021), consists of extending the static exploration of policy interactions beyond the traditional set of parameters' space. As discussed above, allowing the government to set fiscal policy in nominal terms induces price level determinacy in the model even with passive monetary policy.

Then, our study adds to the dialogue on the aggregate consequences of households' portfolio decisions in the presence of assets varying by their liquidity attributes. The role of government debt as liquidity, previously addressed by Woodford (1990), has recently gained renewed attention, as evidenced by studies such as Bayer *et al.* (2023), Bilbiie *et al.* (2022) and Bilbiie (2021). While Bayer *et al.* (2023) strive to quantitatively identify the liquidity channel's influence on the effectiveness of fiscal policy using a model with a fully heterogeneous population of households, our study adopts an approach more closely aligned with that of Bilbiie *et al.* (2022) and Bilbiie (2021), focusing on limited heterogeneity among household types. This method allows us to retain key elements of the larger, more complex models while clearly illustrating the proposed novel mechanism of transmission. In doing so we also offer a methodological contribution by extending the Bilbiie (2021)'s set-up to a 3-agent setting. This gives us the possibility to derive an intuitive and analytical expression linking the liquidity premium to the consumption risk of agents.

The paper is structured as follows. In Section 2 we outline the model. Then, in Section 3 we explore the results of our experiments. In particular, we first look at a technology shock to answer the question of which of the channels outlined above prevails under different regimes, and then we move to the transmission of a fiscal shock, to study what the addition of the portfolio choice implies for the transmission of fiscal policy given different monetary policy stances. We conclude by outlining how this analysis could be extended in future works.

2 The benchmark model

In this section, we present the model economy. As the main action takes place on the household side of the economy, we will be mainly focusing on detailing this. The production side follows the standard New-Keynesian specification (see Galí, 2015), with CES final good producers and monopolistically competitive, Rotemberg-pricing intermediate good firms. The government side will be modelled as a fiscal authority that chooses the quantity of nominal government debt and tax revenues, as in Hagedorn (2021), to finance exogenous government spending.

2.1 Households

The household's side is modeled in a way that can be defined as Luetticke (2020) meets Bilbiie *et al.* (2022). Meaning that we are going to borrow the infrequent capital trading friction from the former and introduce it into the latter model of limited heterogeneity. In particular, we are going to focus on a three-agent model, in which households will switch between three states with exogenous transition probabilities governed by the matrix Λ with generic component $\lambda_{i,j}$ for $(i, j) \in \{H, S, K\}^2$ as the transition probability of moving from state i to state j. The difference among the three agents is going to be in their ability to access financial markets to insure against future income shocks. In particular, capitalists (indexed by K) can access capital markets in a way that allows them to adjust both their bond and capital holdings, whereas savers (indexed by S) will only be able to adjust and ripe the returns from government bonds. Furthermore, we assume that only capitalists are the firm's shareholders and receive their profits. Finally, hand-to-mouth agents (H) will consume their labor income every period, as well as their accumulated savings income from bonds before transitioning to the hand-to-mouth state. It is in this sense that we define government bonds as a liquid asset and capital as an illiquid one, i.e., in terms of their consumption-smoothing insurance value to households.

We think of each type of agent as living on an island populated by their own type. Bonds can be carried across such islands, though they can only be adjusted on islands K and S, and, as such, forward-looking agents will consider the consumption risk moving forward in their portfolio decisions. The benefits from holding capital, instead, can only be enjoyed on the K island, therefore presenting a trade-off between the higher return commanded by its illiquidity and the desire to smooth consumption across states. Given our tractable set-up, we will be able to highlight analytically the link between consumption risk and the liquidity premium in this economy.

2.1.1 Population and financial accounting

We can think about the three types of consumers as inhabiting three distinct islands. We normalize the total population in the economy to 1 and denote with $\Pi_{i,t}$ for $i \in \{H, S, K\}$ the share of the population on each of the islands. Given our normalization, we have that $\Pi_{H,t} = 1 - \Pi_{S,t} - \Pi_{K,t}$. The evolution of each of these two shares follows the following laws of motion:

$$\Pi_{K,t+1} = \lambda_{K,K}\Pi_{K,t} + \lambda_{S,K}\Pi_{S,t} + \lambda_{H,K}(1 - \Pi_{K,t} - \Pi_{S,t}) \tag{1}$$

$$\Pi_{S,t+1} = \lambda_{K,S}\Pi_{K,t} + \lambda_{S,S}\Pi_{S,t} + \lambda_{H,S}(1 - \Pi_{K,t} - \Pi_{S,t}). \tag{2}$$

We look for the stationary distribution by setting $\Pi_{i,t+1} = \Pi_{i,t} = \Pi_i$ in the system above which can be solved for the stationary shares as a function of the exogenous transition probabilities. From now onward, when referring to population shares we mean the stationary ones, therefore omitting time subscripts.

We follow the notation in Bilbiie *et al.* (2022) and call B^j_{t+1}, for $j \in \{K, S\}$, the beginning-of-period $t+1$ holdings, with a "bold" letter $\mathbb{B}$ denoting island-wide stocks, and Z^j_{t+1} the end-of-period t per-capita holdings of bonds of agent j, which the agents can choose before they learn about their type. The former evolves given the latter as follows:

$$\mathbb{B}^K_{t+1} = \Pi_K B^K_{t+1} = \lambda_{K,K}\Pi_K Z^K_{t+1} + \lambda_{S,K}\Pi_S Z^S_{t+1} \tag{3}$$

$$\mathbb{B}^S_{t+1} = \Pi_S B^S_{t+1} = \lambda_{K,S}\Pi_K Z^K_{t+1} + \lambda_{S,S}\Pi_S Z^S_{t+1} \tag{4}$$

$$\mathbb{B}^H_{t+1} = (1 - \Pi_K - \Pi_S) B^H_{t+1} = \lambda_{K,H}\Pi_K Z^K_{t+1} + \lambda_{S,H}\Pi_S Z^S_{t+1}. \tag{5}$$

2.1.2 Household problem

Each of the agent types will maximize the discounted sum of lifetime utility depending on the same specification as a function of the final consumption good and disutility from labor. Following the literature on the topic, we assume that there is a union that centralizes the wage-setting decision by pooling the labor supply of both types and allocates the hours equally across types, i.e. $N_t^K = N_t^S = N_t^H = N_t$.

Therefore, agents will choose a path of consumption and, when possible, asset holdings to maximize the following period utility function

$$\mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{j\,1-\sigma}}{1-\sigma} - \psi \frac{N_t^{j\,1+\varphi}}{1+\varphi} \right) \tag{6}$$

for $j \in \{H, S, K\}$ subject to their respective flow of resources. For capitalists, that is

$$P_t C_t^K + Z_{t+1}^K + P_t I_t^K = P_t W_t N_t^K + (1 + R_{t-1}^b) \frac{\mathbb{B}_t^K}{\Pi_K} + R_t^k P_t \frac{K_t^K}{\Pi_K} + P_t \frac{D_t}{\Pi_K} - \frac{T_t^K}{\Pi_K} - \frac{\tau^K}{\Pi_K}, \tag{7}$$

and similar for the purely bond savers ("Savers") is

$$P_t C_t^S + Z_{t+1}^S = P_t W_t N_t^S + (1 + R_{t-1}^b) \frac{\mathbb{B}_t^S}{\Pi_S} - \frac{T_t^S}{\Pi_S} - \frac{\tau^S}{\Pi_S}. \tag{8}$$

Finally, as hand-to-mouth agents will not be able to trade bonds, their budget constraint will define their consumption as follows

$$P_t C_t^H = P_t W_t N_t^H + (1 + R_{t-1}^b) \frac{\mathbb{B}_t^H}{\Pi_H} - \frac{T_t^H}{\Pi_H} - \frac{\tau^H}{\Pi_H}. \tag{9}$$

C_t^j is nominal consumption, N_t^j hours of work, K_t^K is capitalists capital stock, I_t^K is investment in capital, W_t nominal wages, R_t^b the risk free net nominal interest rate on bonds, R_t^K the gross real rental rate of capital, $\mathbb{B}_t^j$ is the island-wide beginning of period nominal bond holdings, Z_t^j is the per-capita end of period nominal bond holdings, D_t are economy-wide firms profits, T_t^j are lump sum taxes, τ^j are steady state transfers to equate agents consumption, σ the inverse of the intertermporal elasticity of substitution, φ the inverse of the Frish elasticity, ψ the disutility weight of labor and δ is capital depreciation.

We assume equal redistribution of the total tax revenue needed by the government. Note that, although type-H agents cannot trade in bonds, there will be a certain stock of this asset on the island as agents can carry these with them across type switches.

We also assume that capital investment is subject to a convex adjustment cost ι so that capital accumulation reads:

$$K_t^K = I_t^K \left(1 - \iota \left(\frac{I_t^K}{I_{t-1}^K} - 1\right)^2\right) + K_{t-1}^K \ (1 - \delta) \,. \tag{10}$$

Since one of our focuses is fiscal policy, we introduce this adjustment cost to obtain fiscal multipliers in line with what is found in the literature, e.g., (Cantore and Freund, 2021; Hagedorn *et al.*, 2019), under the active monetary policy regime, thereby making our analysis more realistic.

2.2 Firms

Since our model enriches the household side of the economy, we model firms according to a standard New Keynesian model with Rotemberg (1982) adjustment costs. A continuum of monopolistically competitive firms indexed by $i \in [0, 1]$ produce differentiated intermediate goods $Y_t(i)$ using labor $N_t(i)$ and capital $K_t(i)$ according to the following production function:

$$F(A_t, N_t, K_t) = (A_t N_t(i))^{1-\alpha} + K_t(i)^{\alpha}, \tag{11}$$

where A_t is a technology shock and α is the capital share of income. Firms seeks to maximize their profits by optimally choosing their prices $P_t(i)$ subject to the demand they face and price adjustment costs. The firm's problem is represented by the following dynamic optimization problem:

$$
\begin{aligned}
&\max_{\{P_t(i)\}} E_0 \sum_{t=0}^{\infty} \Psi_{0,t}^K \left[P_t(i)Y_t(i) - W_t N_t(i) - R_t^K K_t(i) - AC_t \right] \\
&\text{s.t. } Y_t(i) = \left(\frac{P_t(i)}{P_t} \right)^{-\epsilon} Y_t, \\
&\quad Y_t(i) = (A_t N_t(i))^{1-\alpha} + K_t(i)^{\alpha} - F,
\end{aligned}
$$

where $\Psi_{0,t}^K = \beta^t \left(\frac{C_t^K}{C_0^K} \right)^{-\sigma}$ is the marginal rate of intertemporal substitution of capitalists, $\epsilon > 1$ is the elasticity of substitution between different varieties of goods and F are fixed costs in production to ensure 0 profits in steady state. We specify Rotemberg adjustment costs AC_t according to the standard quadratic representation:

$$
AC_t = \frac{\xi}{2} \left(\frac{P_t(i)}{P_{t-1}(i)} - 1 \right)^2 Y_t,
$$

where ξ is a positive parameter that dictates the cost of adjusting prices.

By optimizing this symmetric problem, the firms set the price to equate the real marginal cost (MC_t) to a markup over price, subject to adjustment costs. The first-order conditions for this problem generate the New Keynesian Phillips curve, providing the connection between inflation and output:

$$
(1-\epsilon) + \epsilon MC_t - \Pi_t \xi (\Pi_t - 1) + \beta \Psi_{t,t+1}^K \Pi_{t+1} \xi (\Pi_{t+1} - 1) \frac{Y_{t+1}}{Y_t} = 0. \tag{12}
$$

2.3 Aggregation

Aggregation of consumption and labor supply between the three types of households gives:

$$
C_t = \Pi_K C_t^K + \Pi_S C_t^S + \Pi_H C_t^H, \tag{13}
$$

$$
N_t = \Pi_K N_t^K + \Pi_S N_t^S + \Pi_H N_t^H. \tag{14}
$$

Aggregate capital and investment are given by:

$$K_t = \Pi_K K_t^K, \tag{15}$$

$$I_t = \Pi_K I_t^K. \tag{16}$$

Total nominal government debt is:

$$B_t = \Pi_K Z_t^K + \Pi_S Z_t^S. \tag{17}$$

Finally the weighted sum of the three budget constraints (7), (8) and (9) gives the aggregate resource constraint.

2.4 Policy block

The Central Bank operates according to a standard Taylor rule of the form:

$$\frac{1+R_t^b}{1+R_b^*} = \left(\frac{1+R_{t-1}^b}{1+R_b^*}\right)^{\rho_{R^b}} \left(\frac{\Pi_t}{\Pi^*}\right)^{(1-\rho_{R^b})\phi_\pi} \epsilon_{m,t}, \tag{18}$$

where ϵ_m is a standard monetary policy shock. Variables with a * denote steady state values.

The government is in charge of fiscal policy. In particular, it responds to a shock to nominal government expenditures, which follows a standard AR(1) process:

$$\frac{G_t}{G^*} = \left(\frac{G_{t-1}}{G^*}\right)^{\rho_g} \epsilon_{g,t}, \tag{19}$$

by raising nominal lump sum taxes following a fiscal rule of the form

$$\frac{T_t}{T^*} = \left(\frac{T_{t-1}}{T^*}\right)^{\rho_T} \left(\frac{B_{t-1}}{B^*}\right)^{(1-\rho_T)\gamma_T} \left(\frac{G_t}{G^*}\right)^{(1-\rho_T)\gamma_{TG}}. \tag{20}$$

Government nominal debt is therefore a residual pinned down by the inter-temporal government budget constraint:

$$G_t + B_{t+1} = (1 + R^B_{t-1})B_t + T_t. \tag{21}$$

2.5 Calibration

Table 1 summarizes the calibration of the model. The value of the discount factor and capital depreciation are standard in quarterly models. We assume log-utility ($\sigma = 1$) to highlight the precautionary savings coming purely from the liquidity channel while we set $\varphi = 0.5$ in line with the estimates in Chetty *et al.* (2011). Investment adjustment costs are set to 2.5. Hours in steady state assume that each agent works 1/3 of their time. We calibrate the steady-state share of government spending in output (20%) and the annual debt-to-output ratio (57%) to match the average for the US economy from 1984 to 2018. Rotemberg price adjustment costs are calibrated to match a frequency of price adjustment of 3.5 quarters. For cleaner intuition of the impulse responses, we assume no smoothing in the interest rate and taxes. In all simulations, taxes response to government spending will remain fixed to $\gamma_{GT} = 0.1$ as in Galí *et al.* (2007). The rest of the parameters of the monetary and fiscal policy rules will vary across exercises. Passive fiscal policy will imply $\gamma_T = 1$ while active $\gamma = 0.5$ which is the lower variable that ensures stability under all the scenarios analyzed below. Active monetary policy uses $\psi_\pi = 1.2$ while passive $\psi_\pi = 0.8$. Reducing further the response to inflation will generate much larger effects of fiscal policy.

Transition probabilities are calibrated such that capitalists remain in the K island with probability $\lambda_{K,K} = 0.8$ or move the H one with probability $\lambda_{K,H} = 0.02$. Hand-to-mouth instead have $\lambda_{H,K} = 0.0541$ probability to become capitalists and savers $\lambda_{S,S} = 0.95$ to stay savers. In line with data from the Survey of Consumer Finance we calibrate to 20% of the population live hand-to-mouth, 10% capitalists while the rest is made of savers.[3],[4]

[3]These population weights are also in line with calibrations in Cantore and Freund (2021), Bilbiie *et al.* (2023) and Orchard *et al.* (2023).

[4]The calibration of the population weights together with the 4 transition probabilities mentioned above implies the rest of the transition probabilities: $\lambda_{S,K} = 0.0131$, $\lambda_{K,S} = 0.18$, $\lambda_{H,S} = 0.085$, $\lambda_{S,H} = 0.0369$ and $\lambda_{H,H} = 0.8609$.

Parameter	**Value**	**Description**
β	0.99	Discount factor
σ	1	Intertemporal elasticity of substitution
δ	0.025	Capital depreciation rate
φ	0.5	Inverse of Frisch elasticity
ι	2.5	Investment adjustment cost parameter
Π_K	0.1	Share of K-type households
Π_H	0.2	Share of hand-to-mouth households
$\lambda_{K,K}$	0.8	Probability of a K-type staying K
$\lambda_{K,H}$	0.02	Probability of a K-type moving to H-type
$\lambda_{H,K}$	0.0541	Probability of an H-type moving to K-type
$\lambda_{S,S}$	0.95	Probability of an S-type staying S
ρ_{R^b}	0	Interest-rate smoothing parameter
ϕ_π	0.8 or 1	Taylor rule parameter
ρ_g	0.9	Government spending persistence parameter
ρ_T	0	Tax persistence parameter
γ_T	0.4 or 1	Tax response to debt
γ_{TG}	0.1	Tax response to government spending
γ_G	0	Government spending response to debt
ζ	6	Elasticity of substitution between goods varieties
ξ	42.7	Rotemberg price adjustment cost parameter
ρ_a	0.75	Technology shock persistence parameter
N^*	0.33	Steady-state labor supply
Π^*	1	Steady-state inflation rate
$\frac{G^*}{Y^*}$	0.2	Steady-state government spending-to-output ratio
$\frac{B^*}{Y^*4}$	0.57	Annualized steady-state debt-to-output ratio

Table 1: Calibration

2.6 The dynamics of the liquidity premium

Before moving on to the model simulations in the following sections, we believe it is helpful to provide a characterization of the dynamics of the liquidity premium to understand better the determinants of the portfolio choice of the capitalists. The liquidity premium in this economy is given by the expected return premium to hold the less liquid asset (capital) relative to the more liquid one (public debt). Therefore we can write it as the ratio between the expected real gross return on capital and the expected real return on government bonds:

$$LP_t = \mathbb{E}_t \frac{(R^K_{t+1} + (1-\delta)Q_{t+1})\frac{1}{Q_t}}{(1+R^B_t)\frac{1}{\Pi_{t+1}}}, \tag{22}$$

where, due to the presence of investment adjustment costs, Q_t is the price of capital goods relative to consumption goods. For ease of exposition we call the real gross return of the two assets: $\mathcal{R}^K_{t+1} = \frac{R^K_{t+1}+(1-\delta)Q_{t+1}}{Q_t}$ and $\mathcal{R}^B_{t+1} = \frac{1+R^B_t}{\Pi_{t+1}}$. As a result the liquidity premium can be written as $LP_t = \mathbb{E}_t \frac{\mathcal{R}^K_{t+1}}{\mathcal{R}^B_{t+1}}$.

Proposition 1. *The dynamics of the liquidity premium can be characterized up to the first order as follows:*

$$\mathbb{E}_t \left[\tilde{R}^K_{t+1} - \tilde{R}^B_{t+1}\right] = -\sigma \mathbb{E}_t \left[\lambda_{K,S}(\hat{C}^S_{t+1} - \hat{C}^K_{t+1}) + \lambda_{K,H}(\hat{C}^H_{t+1} - \hat{C}^K_{t+1})\right]. \tag{23}$$

In the above expression "$\tilde{(\cdot)}$" denotes that the variable has been linearized, as opposed to log-linearized (denoted by "$\hat{(\cdot)}$"), in line with how the literature treats variables that are already expressed as percentages. The proof of this proposition, as well as further details on the analytics of the model, can be found in Appendix A3.

Equation (23) helps us underpin in higher analytical details the mechanism that generates variations in the liquidity premium as related to self-insurance. The main mechanism is driven by the difference between the consumption of the capitalists and that of the other two types. The intuition behind this is that what determines the liquidity premium is the poor insurance quality of the capital asset. If the change in the consumption of the three agents is identical in every period, then the liquidity premium is neutralized, as there is no need for self-insurance to begin with. This will make the two assets perfect substitutes. In fact, in this case, the change in consumption will always be the same, regardless of which type the current capitalist will be in the next period. By contrast, if we consider a shock that induces a stronger response of the consumption of the non-hand-to-mouth type vis-à-vis those hand-to-mouth, we see that the last term in the equation above is likely to dominate. Assuming further that such deviation is positive, we see that it will generate a fall in the liquidity premium. Intuitively, such a shock makes the perspective of the risky hand-to-mouth state not as undesirable and, therefore, reduces the need for self-insurance. For this reason, the willingness to hold government bonds falls and the real interest rate must increase for the market to clear. Through this mechanism, we see the importance of the interplay between monetary and fiscal policies in shaping the portfolio choice of agents with access to both capital and bond markets. Changes in the supply of government bonds, coupled with a change in their remuneration induced through monetary policy, will generate consumption inequality across the different categories, thereby affecting the need for insurance of the capitalist. This is what we will now study in the rest of the paper.

3 The portfolio channel of monetary and fiscal policy interaction

In this section, we report the dynamics of the model following a supply (*technology*) and a demand (*fiscal*) shock with a focus on different combinations of the monetary-fiscal policy mix.

Following Leeper (1991), for each of these shocks, we consider two scenarios for monetary policy: *passive* ($\phi_\pi = 0.8$) when the nominal interest rate responds less than one to one to inflation; *active* ($\phi_\pi = 1.2$) when the Taylor principle is satisfied. For each of these cases, we consider two scenarios for fiscal policy: *passive* ($\gamma_T = 1$) when nominal taxes respond one to one to the increase in nominal debt; *active* ($\gamma_T = 0.5$) when the reaction in taxes is more muted (ie. fiscal policy *actively* decides not to increase taxes to stimulate the economy).

3.1 Technology shock

First, in Figure 1 and Figure 2, we analyze the consequences of the portfolio channel on the transmission of a standard supply shock analysed in the literature, i.e., a persistent ($\rho_a = 0.75$) technology shock. In particular, each figure plots different fiscal regimes for the same monetary regime.

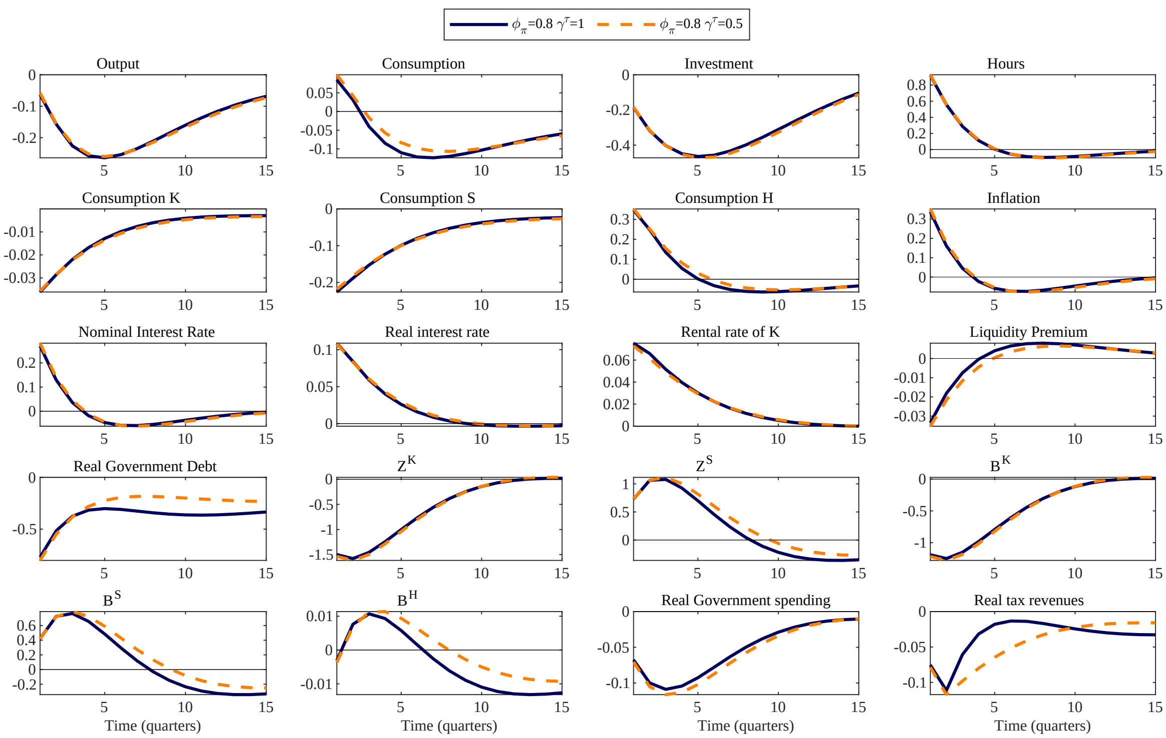

Figure 1: Impulse responses to a temporary 1% decrease in A for active and passive fiscal policy when monetary policy is passive ($\phi_\pi = 0.8$).

The general transmission mechanism is the one established in the New Keynesian literature for this type of shock. A negative technology shock increases the real marginal costs, which determines an increase in inflation. Furthermore, it also generates a decrease in investments and a rise in labor hours. Importantly we can see that a negative TFP shock relaxes the self-insurance mechanism we highlight in this paper. In particular, the rise in hours determines an increase in the consumption of hand-to-mouth, which decreases the desirability of liquid government bonds for self-insurance purposes (becoming hand-to-mouth becomes less undesirable). This can be seen from the portfolio

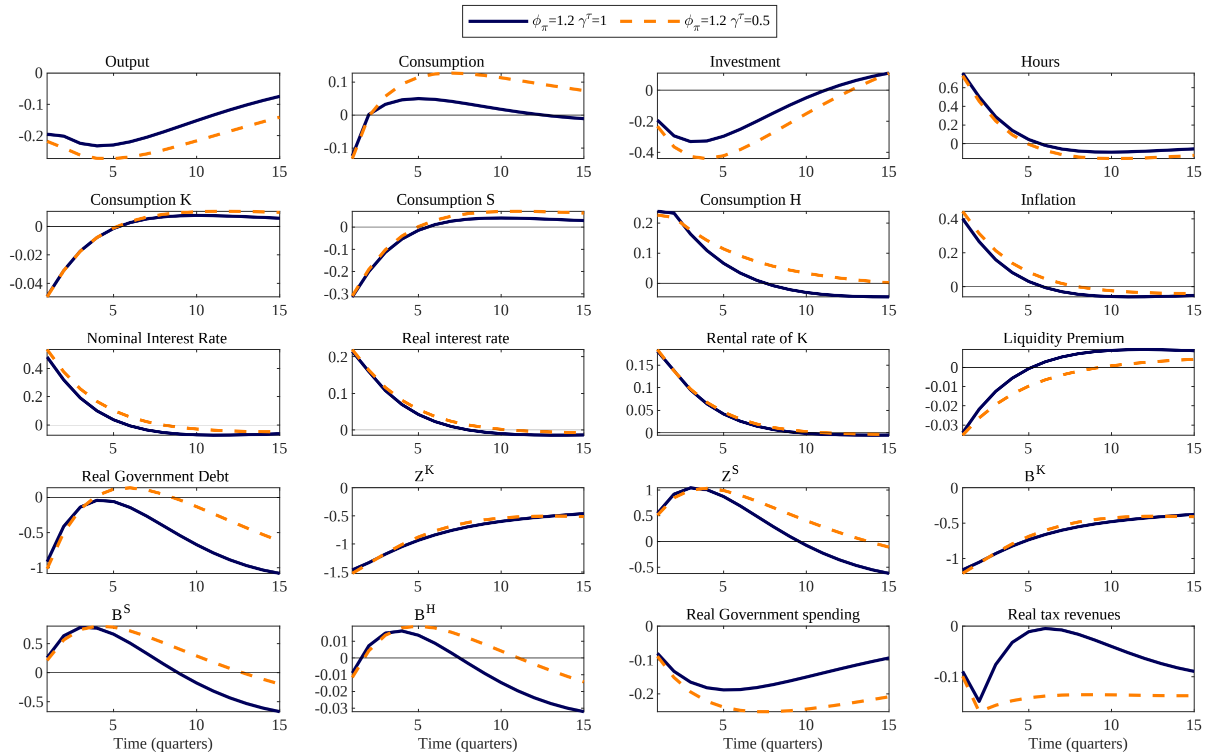

Figure 2: Impulse responses to a temporary 1% decrease in A for active and passive fiscal policy when monetary policy is active ($\phi_\pi = 1.2$).

choice of capitalists, who reduce their holdings of this type of asset. On the other hand, for savers, who only have access to the bond markets, the standard interest rate channel is dominant and they respond to the rise in interest rate by investing more and consuming less. Given the current calibration, we see that the bond holdings of hand-to-mouth follow a similar path as that of savers, which further improves the rise in consumption of the former. In line with the lower demand for self-insurance of the capitalists, the liquidity premium, which quantifies the insurance value of government bonds as pointed out in Proposition 1, decreases.

By moving to a comparative analysis across regimes, we can see how different combinations affect the portfolio channel and, therefore, the aggregate dynamics in the economy. In particular, a comparison across Figures 1 and 2 shows how a more active monetary policy in response to an inflationary technology shock induces stronger and more persistent movements in output, and consequently a smaller increase in hours. Importantly, this logic is not peculiar to technology shocks but will hold for all supply shocks that move inflation and output in opposite directions in the context of a monetary policymaker that does pure inflation targeting, such as a cost-push shock: a stronger monetary policy response to tame inflation is going to have a destabilizing effect on output which will limit the response of hours. This translates in general into a lower increase in hand-to-mouth consumption and a lower decline in capitalist consumption. As a consequence, the decline in the liquidity premium, on impact, is similar to the one of Figure 1. However, its persistence is much higher now when active fiscal policy is at play.

This is because the interaction of monetary and fiscal policy brings a further mechanism at play which was not evident for the case of passive monetary policy. After an initial decrease, due to the shift in capitalists' portfolios and counterbalanced by a decrease in taxes for government budget constraint to hold, real government debt experiences a rise for two reasons, i.e., the increasing demand of capitalists and the increased interest payments on the existing stock. The strength of this rise is driven by the monetary reaction as well as how strongly the government tries to stabilize it through taxes. In particular, if the fiscal policy does not react strongly to the change in debt, i.e., in the active fiscal regime in Leeper (1991) terminology, the stock of government debt is going to follow a more strongly increasing path, coupled with an active monetary policymaker that changes rates aggressively and rises the interest payments on government debt. This is evident in Figure 2. This strong increase in the supply of real government debt has a feedback effect on the liquidity premium, which takes longer to recover.

Furthermore, we can see how different fiscal policy stances affect the liquidity premium and consequently capital investment and ultimately output. When monetary policy is active a passive fiscal policy delivers a lower decline in investment and output. This supply effect is largely non-present in Figure 1, where we see that with passive monetary policy, the fiscal stance does not affect the macroeconomic variables. Finally, for a supply shock, we see that the trade-off between self-insurance and "insurance-through-investment" is resolved in favor of the former. In fact, following a negative TFP shock, a decrease in investment increases the demand for labor and creates a substitution effect that improves the position of the hand-to-mouth. This might be overturned in the presence of a more general production function, e.g. of the CES form, which would allow for complementarity between capital and labor.

In appendix B we provide simulations of the two-agent version of the model (by setting $\Pi_S = 0$, and $\lambda_{K,K} = 0.98$ as in Bilbiie *et al.* (2022) and Bilbiie *et al.* (2023)) where there are no savers and therefore there is no meaningful portfolio choices of capitalists affecting the demand for Government debt. Results show that in the 2-agent economy, the dynamics are mainly driven by the monetary authority independently of the fiscal stance. This is because the self-insurance channel is not present in this economy and therefore the liquidity premium barely moves.

3.2 Fiscal Shock

How does fiscal policy transmit with different combinations of the monetary/fiscal policy mix? We answer this question by looking at the shock to government spending and focusing our attention on the effect on real public debt when different combinations of monetary and fiscal policy lead to different behaviors of inflation.

Figure 3 shows the responses of key variables to a persistent ($\rho_g = 0.9$) increase in G of 1% in terms of output for the case of active monetary policy. The increase in government purchases raises the level of aggregate demand in the economy. Following the standard New Keynesian narrative, firms operating under monopolistic competition raise their prices, however, given nominal rigidities this change is insufficient to fully restore the original equilibrium. The labor demand curve shifts outwards, hours worked and output rise; this implies an increase in the real wage (not shown). In contrast to the representative-agent paradigm, the presence of a high marginal propensity to consume agents (H) means that they will see a boost in their disposable income and raise their consumption. In contrast capitalists and savers, who have access to financial markets, will reduce their consumption. As a result, aggregate consumption is slightly crowded out on impact but it quickly turns positive and its magnitude depends on the fiscal policy stance. Capital investment, instead, is persistently crowed out in line with the standard transmission mechanism in the presence of investment adjustment costs.

The effect on real debt can be decomposed into demand and supply-side effects. From the demand side, the strong income effect that pushes up consumption of the hand-to-mouth makes the H state less undesirable and therefore lowers the liquidity premium making bond and capital closer substitutes. This induces a shift of the capitalists out of the bond market and into the capital market as their demand for *insurance* via bonds is reduced (Z^K declines for the first couple of quarters and the initial drop in investment is contained). However, there is a contrasting supply-side effect on capital vs bond investment. This is due to the increase in nominal debt issuance generated by the increase in government spending and by the increase in real debt due to the jump in inflation and the real interest rate. This standard "interest rate" channel makes bonds more attractive with respect to capital.

The relative strength of these two effects depends on the policy mix. When monetary policy is active the supply side effect dominates (Figure 3). When fiscal policy is passive (solid blue line) the rise in tax revenues corresponds to a smaller increase in inflation which translates smaller decline and faster recovery in the liquidity premium compared with the active fiscal policy case (dashed orange line). If the self-insurance motive of capitalists dominates we would observe a smaller drop in investment in the active fiscal policy case while our simulations show the opposite. This is evidence that the supply-side effect is driving the response of real debt to the fiscal shock.

The different behavior of inflation and the liquidity premium explain also the different fiscal multipliers under the two fiscal policy scenarios. On impact, the fiscal multiplier is slightly larger under active fiscal policy but the difference widens when looking at the cumulative effect.

Figure 4 shows the responses for the case of passive monetary policy. Compared to the case of active monetary, the impact of the shock is qualitatively similar for many variables as the standard New-Keynesian narrative also applies in this case. Quantitatively however we observe a substantially larger fiscal multiplier, a larger increase in inflation, and a smaller rise in the real rate. When the central bank lets inflation increase by a larger amount the demand effect of the fiscal shock is magnified. This induces a stronger income effect on the hand-to-mouth which reduces even further the self-insurance motive of capitalists. Their shift away from the bond market is much

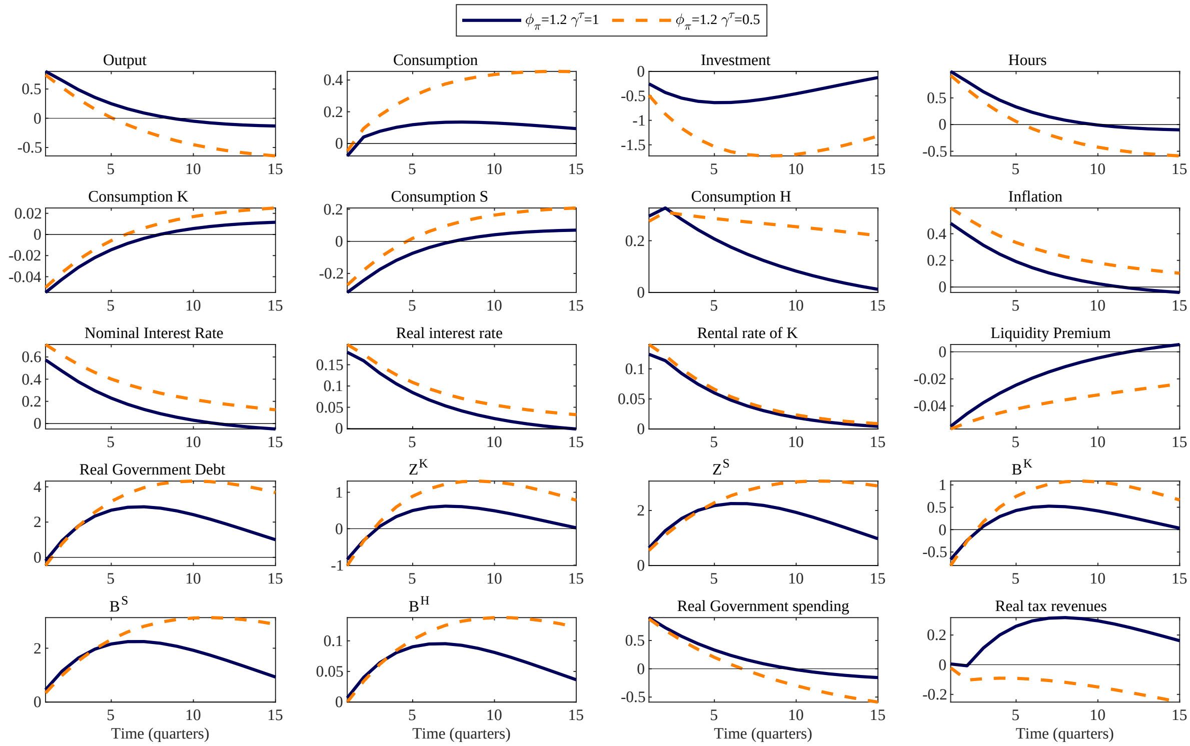

Figure 3: Impulse responses to a temporary 1% increase in G for active and passive fiscal policy when monetary policy is active ($\phi_\pi = 1.2$).

Note: All variables are expressed in real terms except for Hours, Inflation and Nominal interest rate. All variables related to fiscal policy are in % deviation from the steady state of output. The remaining variables are in % deviations from their own steady state. We plot the next period realized rental rate of capital (R^K_{t+1}). Consumption, Z's and B's are island-wide figures (multiplied by the population sizes Π's).

more pronounced and persistent. Therefore in this case the demand effect now dominates over the supply of new public debt. Under both fiscal policy scenarios, capitalists substitute bonds for capital (Z^K is negative and persistent). When fiscal policy is active we even observe a decline in real government debt for a few quarters and a small increase in investment on impact following the fiscal expansion. Finally we also notice how under active fiscal policy the increase in inflation is so large that generates a substantial decline in real tax revenues which frees up disposable income and generates an increase in consumption for both capitalists and savers.

Another way to highlight the importance of the demand side effect coming from the reduced insurance motive of capitalists is to look at the same impulse responses in the two-agent version of the model where only the supply side effect is at play. In Appendix B we show that, as it was for

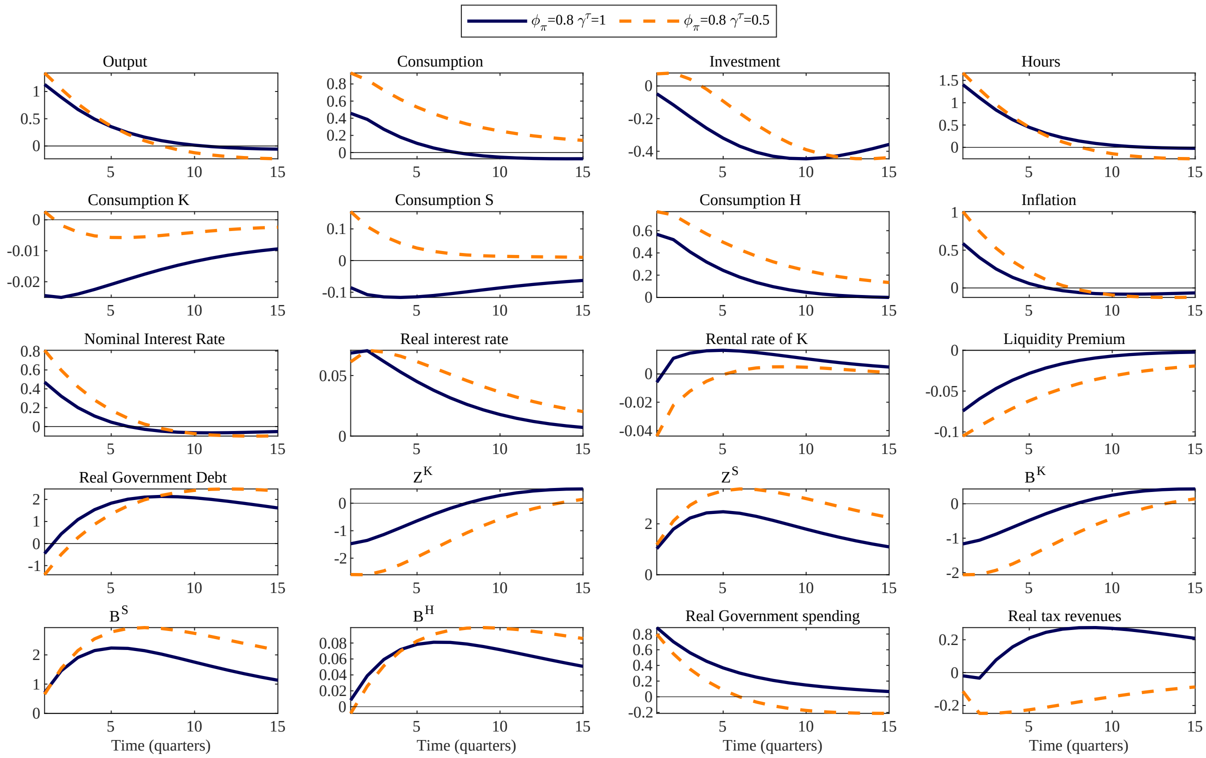

Figure 4: Impulse responses to a temporary 1% increase in G for active and passive fiscal policy when monetary policy is passive ($\phi_\pi = 0.8$).

Note: All variables are expressed in real terms except for Hours, Inflation and Nominal interest rate. All variables related to fiscal policy are in % deviation from the steady state of output. The remaining variables are in % deviations from their own steady state. We plot the next period realized rental rate of capital (R^K_{t+1}). Consumption, Z's and B's are island-wide figures (multiplied by the population sizes Π's).

the case of the technology shock, given the monetary policy stance, fiscal policy has not a visible impact on macroeconomic variables. Let's consider the passive monetary policy scenario in Figure B4 for example. In this two-agent world capital and bonds are perfect substitutes and therefore the capitalists do not substitute bonds for capital, as in the three-agent economy. This leads to a larger decline in investment compared to the active fiscal policy case in the three-agent economy. Note also the standard decline in the consumption of capitalists which further contributes to generating a smaller fiscal multiplier in the two-agents set up.

4 Conclusions

This paper has provided an investigation into the reciprocal interplay of fiscal and monetary policy and its impact on the liquidity properties of the portfolios of various types of agents within an economy. In doing so, we built upon the burgeoning research agenda focusing on the empirical differences in portfolios across the wealth distribution and its impact on policy effectiveness and macroeconomic dynamics.

Utilizing a New-Keynesian model with limited household heterogeneity, we considered a novel transmission mechanism through which monetary and fiscal policy interact with the portfolio choices of private agents. This analysis revealed two crucial forces, the "self-insurance" and the "supply" channels, that determine the liquidity premium in different policy regimes and shape the relationship between this premium and the portfolio choices of households.

Our first experiment illustrated how these channels manifest and interact in response to a standard technology shock. We found that when there is a large change in government debt, the supply channel enhances the gap in the liquidity premium. On the contrary, in regimes where changes in government debt are more tempered, the "self-insurance" mechanism dominates. Moreover, our model suggested that the "insurance-through-investment" motive is weak due to the poor complementarity between the two productive assets, indicating that the building of more capital stock, via its general equilibrium effect on labor income, does not serve as a viable substitute for liquid savings for agents in the hand-to-mouth state.

In our second experiment, we explored the effects of a fiscal stimulus within different combinations of the monetary/fiscal policy mix. The relative strength of the self-insurance and supply channels was found to be dependent on the policy mix. Under an active monetary policy, the supply effect dominated, while under a passive monetary policy, a larger income effect on hand-to-mouth agents made the "self-insurance" channel stronger.

This study provides interesting insights into the complex dynamics between fiscal and monetary policy and their influence on the portfolio choices of different types of agents. We showed how policy regimes impact both the liquidity properties of agent portfolios and the stabilization and aggregate response of the economy.

Future work could extend the analysis presented here along several dimensions. For example, the model economy could be modified to allow for a CES production function with complementarity between capital and labor to check if the relative strength of the “insurance-through-investment” channel changes. It would also be interesting to allow for endogenous regime switching in the fiscal policy mix. Other extensions could include a detailed stability analysis of the model, as well as the responses to different types of shocks.

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Appendix

A Model details

A1 Solution

The solution of the model is obtained by writing down the Bellman equations for capitalists and savers

$$
\begin{aligned}
V^K(\mathbb{B}_t^K, K_t^K) = \max_{\{N_t^K, Z_{t+1}, K_{t+1}^K\}_{t=0}^{\infty}} & \left\{ \frac{C_t^{K\,1-\sigma}}{1-\sigma} - \psi \frac{N_t^{K\,1+\varphi}}{1+\varphi} \right. \\
& \left. + \beta \mathbb{E}_t \left[V^K(\mathbb{B}_{t+1}^K, K_{t+1}^K) + \frac{\Pi_S}{\Pi_K} V^S(\mathbb{B}_{t+1}^S) + \frac{\Pi_H}{\Pi_K} V\left(\mathbb{B}_{t+1}^H\right) \right] \right\} \\
\text{s.t. } & (7), (9), (10), (3), (4), (5)
\end{aligned}
$$

and similarly,

$$
\begin{aligned}
V^S(\mathbb{B}_t^S) = \max_{\{N_t^S, Z_{t+1},\}_{t=0}^{\infty}} & \left\{ \frac{C_t^{S\,1-\sigma}}{1-\sigma} - \psi \frac{N_t^{S\,1+\varphi}}{1+\varphi} \right. \\
& \left. + \beta \mathbb{E}_t \left[\frac{\Pi_K}{\Pi_S} V^K(\mathbb{B}_{t+1}^K, K_{t+1}^K) + V^S(\mathbb{B}_{t+1}^S) + \frac{\Pi_H}{\Pi_S} V\left(\mathbb{B}_{t+1}^H\right) \right] \right\} \\
\text{s.t. } & (8), (9), (3), (4), (5).
\end{aligned}
$$

Moreover, hand-to-mouth agents will not consume on their Euler equation, but will choose the amount of labor hours optimally, giving rise to a standard intra-temporal condition detailed below.

Using dynamic programming techniques, we can show that the optimality conditions to these programs can be expressed in terms of three Euler equations,

$$C_t^{K-\sigma} = \beta\mathbb{E}_t\left[\frac{\left(R_{t+1}^K + (1-\delta)Q_{t+1}\right) C_{t+1}^{K\ -\sigma}}{Q_t}\right] \tag{A1}$$

$$C_t^{K-\sigma} = \beta\mathbb{E}_t\left[\frac{1+R_t^B}{\Pi_{t+1}}\left(\lambda_{K,K}C_{t+1}^{K\ -\sigma} + \lambda_{K,S}C_{t+1}^{S\ -\sigma} + \lambda_{K,H}C_{t+1}^{H\ -\sigma}\right)\right] \tag{A2}$$

$$C_t^{S-\sigma} = \beta\mathbb{E}_t\left[\frac{1+R_t^B}{\Pi_{t+1}}\left(\lambda_{S,K}C_{t+1}^{K\ -\sigma} + \lambda_{S,S}C_{t+1}^{S\ -\sigma} + \lambda_{S,H}C_{t+1}^{H\ -\sigma}\right)\right], \tag{A3}$$

and three intra-temporal conditions

$$\psi\frac{N_t^{K\varphi}}{C_t^{K-\sigma}} = W_t \tag{A4}$$

$$\psi\frac{N_t^{S\varphi}}{C_t^{S-\sigma}} = W_t \tag{A5}$$

$$\psi\frac{N_t^{H\varphi}}{C_t^{H-\sigma}} = W_t. \tag{A6}$$

A2 labor union

Following much of the literature on models with limited heterogeneity, we assume the existence of a labor union that pools the labor supplies of the different types, sets the wage and redistributes labor hours equally among agents ($N_t^K = N_t^S = N_t^H$). Hence the total labor supply in the economy is given by

$$\psi N_t^{\varphi} = W_t C_t^{-\sigma}, \tag{A7}$$

where ψ can be calibrated in order to ensure that the number of aggregate hours worked in steady state is 0.33.

A3 Proofs

Proof of Proposition 1

Proof. Consider the two Euler equations for the capitalist type,

$$C_t^{K^{-\sigma}} = \beta \mathbb{E}_t \left[\mathcal{R}_{t+1}^K {C_{t+1}^K}^{-\sigma} \right] \tag{A8}$$

$$C_t^{K^{-\sigma}} = \beta \mathbb{E}_t \left[\mathcal{R}_{t+1}^B \left(\lambda_{KK} {C_{t+1}^K}^{-\sigma} + \lambda_{KS} {C_{t+1}^S}^{-\sigma} + \lambda_{KH} {C_{t+1}^H}^{-\sigma} \right) \right] \tag{A9}$$

where we have now used the definitions of the gross real return on capital $\left(\mathcal{R}_{t+1}^K = \frac{\left(R_{t+1}^K + (1-\delta) Q_{t+1}\right)}{Q_t} \right)$ and of the gross real return on bonds $\left(\mathcal{R}_{t+1}^B = \frac{1+R_t^B}{\Pi_{t+1}} \right)$ respectively.

Then, by taking a first-order approximation of the two around the deterministic steady state and combining them we obtain

$$\beta \mathbb{E}_t \left[\tilde{\mathcal{R}}_{t+1}^K - \tilde{\mathcal{R}}_{t+1}^B \right] = -\sigma \mathbb{E}_t \left[\lambda_{KS} (\hat{C}_{t+1}^S - \hat{C}_{t+1}^K) + \lambda_{KH} (\hat{C}_{t+1}^H - \hat{C}_{t+1}^K) \right] \tag{A10}$$

where "$\tilde{(\cdot)}$" denotes that the variable has been linearized, as opposed to log-linearized (denoted by '$\hat{(\cdot)}$"), in line with how the literature treats variables that are already expressed as percentages.

Finally, we conclude the proof by recognizing that the left-hand side of equation (A10) is the approximation to the first order of the liquidity premium as defined in the main text. □

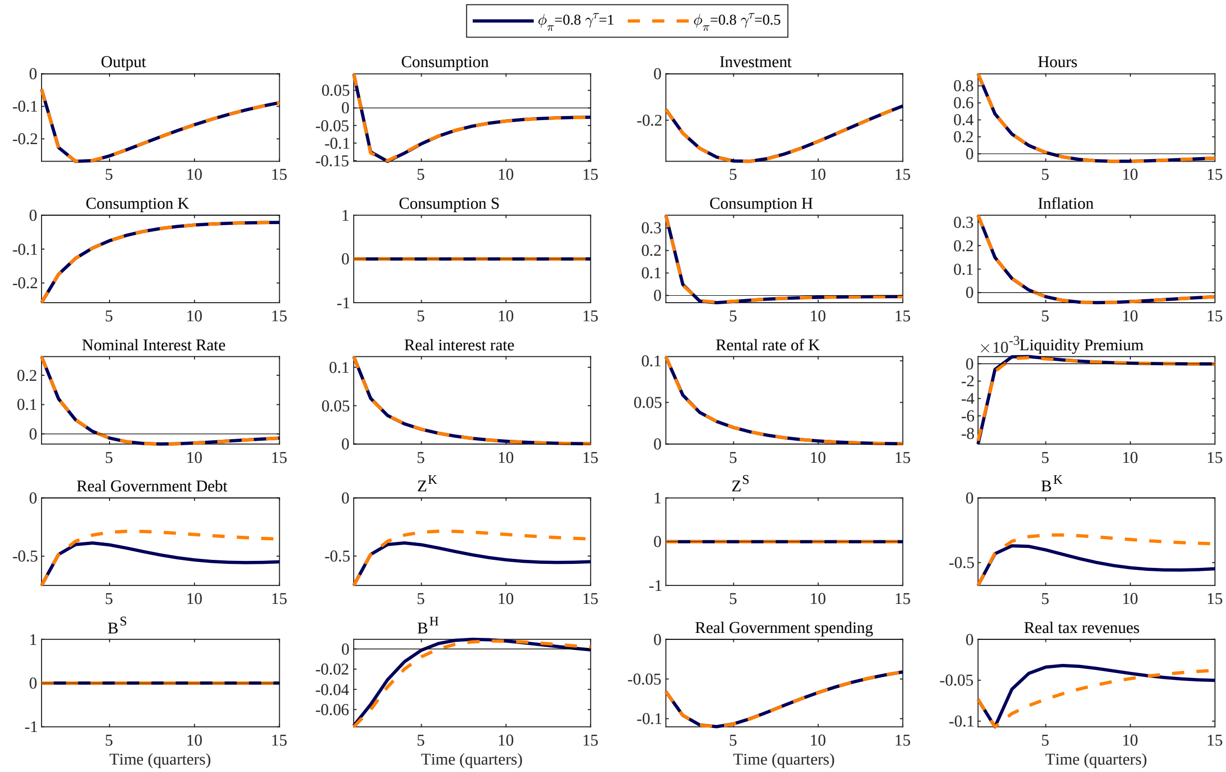

Figure B1: THANK: Impulse responses to a temporary 1% increase in A for active and passive fiscal policy when monetary policy is passive ($\phi_\pi = 0.8$).

Note: All variables are expressed in real terms except for Hours, Inflation and Nominal interest rate. All variables related to fiscal policy are in % deviation from the steady state of output. The remaining variables are in % deviations from their own steady state. We plot the next period realized rental rate of capital (R^K_{t+1}). Consumption, Z's and B's are island-wide figures (multiplied by the population sizes Π's).

B Comparison with 2-agent model

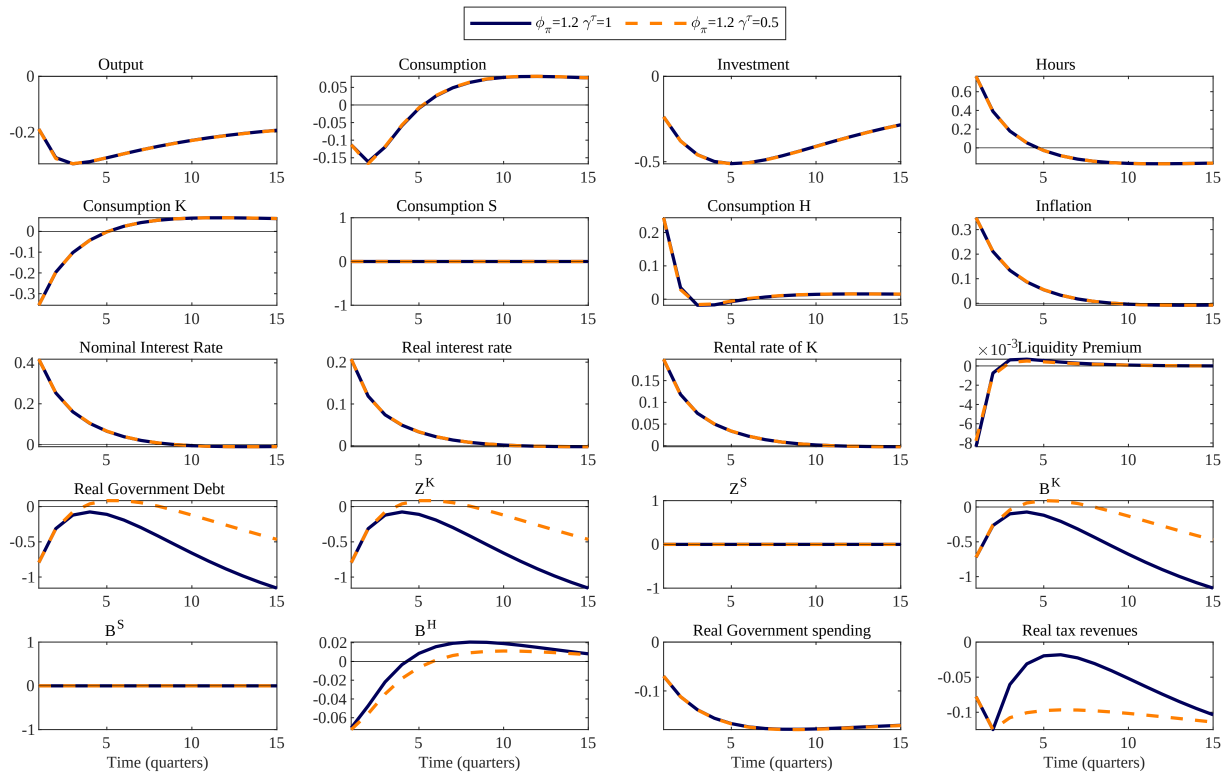

Figure B2: THANK: Impulse responses to a temporary 1% increase in A for active and passive fiscal policy when monetary policy is active ($\phi_\pi = 1.2$).

Note: All variables are expressed in real terms except for Hours, Inflation and Nominal interest rate. All variables related to fiscal policy are in % deviation from the steady state of output. The remaining variables are in % deviations from their own steady state. We plot the next period realized rental rate of capital (R^K_{t+1}). Consumption, Z's and B's are island-wide figures (multiplied by the population sizes Π's).

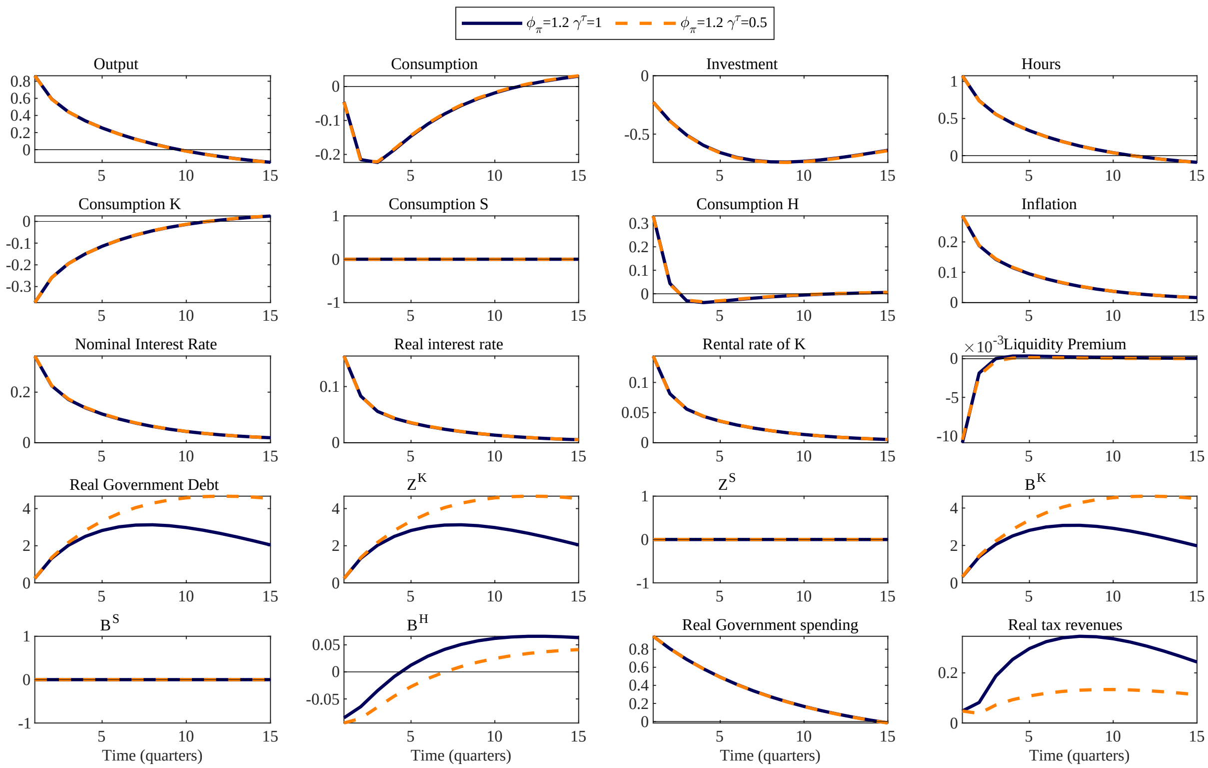

Figure B3: THANK: Impulse responses to a temporary 1% increase in G for active and passive fiscal policy when monetary policy is active ($\phi_\pi = 1.2$).

Note: All variables are expressed in real terms except for Hours, Inflation and Nominal interest rate. All variables related to fiscal policy are in % deviation from the steady state of output. The remaining variables are in % deviations from their own steady state. We plot the next period realized rental rate of capital (R^K_{t+1}). Consumption, Z's and B's are island-wide figures (multiplied by the population sizes Π's).

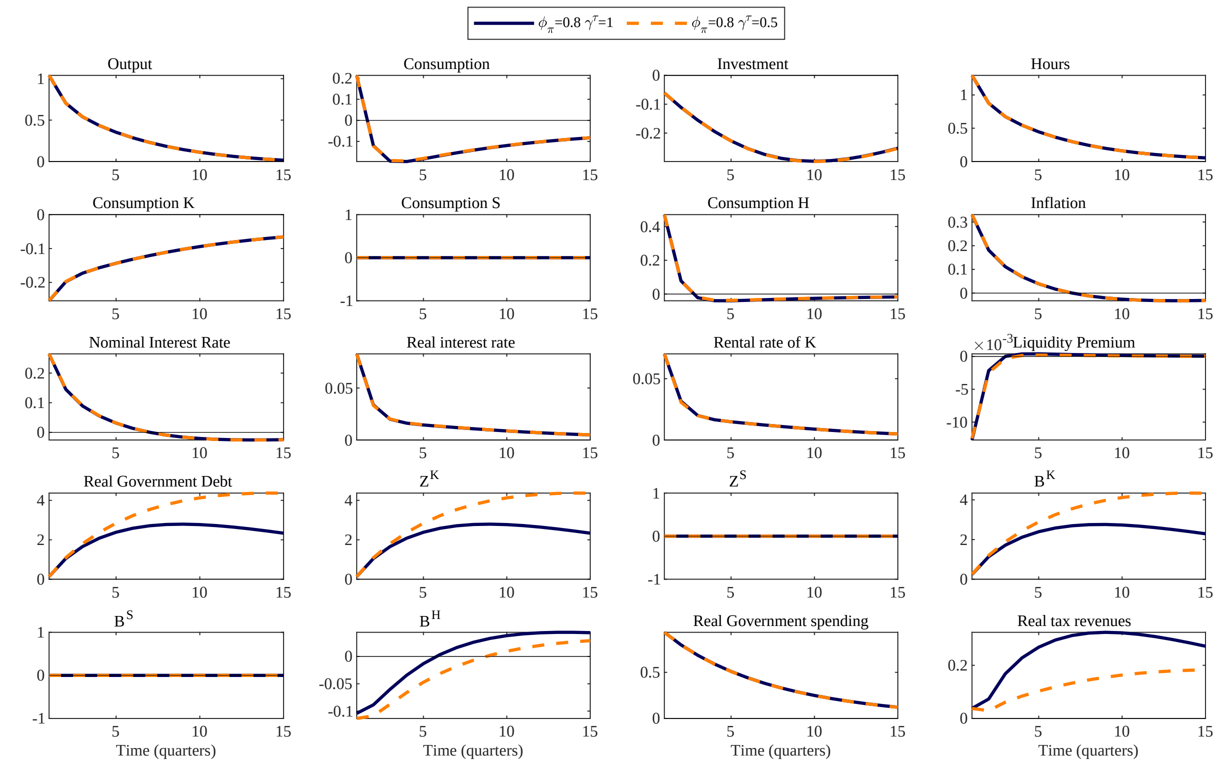

Figure B4: THANK: Impulse responses to a temporary 1% increase in G for active and passive fiscal policy when monetary policy is passive ($\phi_\pi = 0.8$).

Note: All variables are expressed in real terms except for Hours, Inflation and Nominal interest rate. All variables related to fiscal policy are in % deviation from the steady state of output. The remaining variables are in % deviations from their own steady state. We plot the next period realized rental rate of capital (R^K_{t+1}). Consumption, Z's and B's are island-wide figures (multiplied by the population sizes Π's).