Debt Maturity and Government Spending Multipliers*

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Abstract

Government spending effectiveness depends critically on how it is financed. Using state-dependent SVAR models and local projections on post-war US data, we show that fiscal expansions financed with short-term debt generate significantly larger output multipliers than those financed with long-term debt. This difference mainly stems from private consumption responses: short-term financing crowds in consumption while long-term financing does not. To rationalize this finding, we construct an incomplete markets model in which households invest in short-term and long-term assets. Short assets provide liquidity/safety services; households can (more readily) use them to cover sudden idiosyncratic spending needs. An increase in the supply of these assets, through a short-term debt-financed government expenditure shock, boosts private consumption. We first show this mechanism analytically in a simplified model, and then quantify it in a carefully calibrated New Keynesian model. We find that fiscal multipliers differ substantially across financing modes, with short-term-financed shocks typically exceeding unity while long-term-financed shocks typically fall below unity. We show these differences persist across monetary and fiscal policy regimes, with important implications for optimal debt management and stimulus design.

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1 Introduction

Understanding fiscal multipliers—how much additional output results from each dollar of government spending—remains central to macroeconomic policy design. A large empirical and theoretical literature investigates this question because government spending represents a primary tool for countering recessions and stabilizing business cycles.[1]

Recent research shows that fiscal multipliers vary significantly depending on economic and policy conditions. Multipliers differ according to whether spending increases or decreases (e.g., Barnichon et al., 2022), the progressivity of the tax system (Ferriere and Navarro, 2025), exchange rate regimes (e.g., Born, Juessen, and Müller, 2013; Ilzetzki, Mendoza, and Végh, 2013) and whether governments finance spending through external versus domestic debt (e.g., Priftis and Zimic, 2021; Broner et al., 2022).

This paper shows that debt maturity is a crucial determinant of the size of the fiscal multiplier. Employing two widely-used macroeconometric approaches, state-dependent SVARs and local projections, we find that short-term debt financing generates substantially larger multipliers—typically exceeding unity—while long-term debt financing produces multipliers below one. Accounting for this difference in the output multipliers is the significant difference in the responses of private consumption to spending shocks: Short-term financing crowds in consumption, whereas long-term financing does not.

We develop a theoretical model to explain these empirical patterns. At the heart of our model is the notion that short-term bonds provide liquidity/safety services to households facing idiosyncratic consumption risk. We first derive analytical results in a simplified New Keynesian model, showing that short-term debt financing increases private consumption. We then demonstrate this result in an otherwise standard New Keynesian model. Calibrated carefully to US data, our model can explain a large part of the differences in the fiscal multipliers that we document empirically.

Our empirical analysis is presented in Section 2 and relies on two complementary methods to show that multipliers depend on the debt maturity used to finance spending shocks. Our first approach uses a proxy-SVAR following Ramey and Zubairy (2018) instrumenting government spending with military spending news. To identify the impact of the maturity choice, we condition on the movements of the ratio of short-term (maturity less than one year) to long-term debt in the US. We define short-term financed shocks as those occurring when this ratio increases, and long-term financed shocks as those occurring when it decreases.

Our second empirical strategy uses local projections (Jordà, 2005). Rather than conditioning on contemporaneous changes in the debt maturity ratio, we interact spending shocks with the lagged ratio of short-term to long-term debt. This strategy, which follows Broner et al. (2022), exploits the fact that the share of short over long term debt is highly persistent and a good proxy for the

[1]See Blanchard and Perotti (2002); Hall (2009); Alesina and Ardagna (2010); Mertens and Ravn (2013); Uhlig (2010); Parker (2011); Ramey (2011a,b); Auerbach and Gorodnichenko (2012); Ramey and Zubairy (2018); Barnichon, Debortoli, and Matthes (2022); Priftis and Zimic (2021); Broner, Clancy, Erce, and Martin (2022); Bouakez, Rachedi, and Santoro (2023) for examples of the empirical papers written on this topic. See below for extensive references to the theoretical work in this literature.

new issues of government debt. Like Broner et al. (2022), our estimates draw on both narrative identification of spending shocks and the structural VAR approach of Blanchard and Perotti (2002).

Both the proxy-SVAR and local projection approaches show that short-term financed shocks yield larger fiscal multipliers due to consumption crowding-in. This finding is robust to controlling for relevant variables including private sector wages, the debt-to-GDP ratio, and short- and long-term interest rates (capturing the response of monetary policy and of the term premium to spending shocks). The results hold regardless of sample period—whether using post-1980s observations (when US monetary policy arguably targeted inflation more actively) or data since the 1960s, and whether including or excluding the Great Recession. We consistently find multipliers exceeding unity under short-term financing and below unity under long-term financing.

These findings reveal that debt maturity choice represents an important fiscal transmission channel. In Sections 3 and 4 of the paper we develop a theoretical framework that can account for these maturity-dependent multiplier differences.

Our model features an incomplete markets economy where households save in short-term and long-term assets while facing heterogeneous spending needs. Short-term bonds provide liquidity/safety services, enabling households to finance *urgent consumption needs* subject to a 'bonds in advance constraint' that limits expenditure to the real value of short-term holdings. In equilibrium, short-term bonds earn lower returns, reflecting the premium for the services they provide. The model embeds these features in a standard New Keynesian framework with monopolistic competition, sticky prices, and a government that issues debt and levies taxes to finance exogenous spending shocks. To maintain tractability, we abstract from investment, as our empirical analysis shows that debt maturity affects primarily consumption rather than investment.

We then investigate the fiscal multipliers in this model. Our baseline is an economy in which monetary policy is set according to a rule targeting inflation and the lagged interest rate, while fiscal policy adjusts tax rates in response to lagged debt. A spending shock financed through short-term debt crowds in consumption, generating a multiplier considerably above one. Long-term financed shocks work in reverse— dampening consumption, leading to a multiplier well below one.

This stark difference between the two modes of financing can be traced to the Euler equation that prices the short-term asset in the model. The supply of short-term debt appears like a standard demand shock in the Euler equation. When the government increases the quantity of this debt, it engineers a demand expansion. Aggregate consumption increases through two channels: the immediate impact of alleviating the financial friction today, but also through an inter-temporal effect, through inducing households to save less anticipating that future constraints become less likely to bind. In contrast, a long-term financed shock may lead to a lower real value of short bonds in the economy (through the inflation channel), and thus reverse the effect on consumption. To build this intuition we leverage a simple version of the model that we can solve analytically.

While an inertial monetary policy rule magnifies the differences between short- and long-term financed shocks, these differences persist under a standard Taylor rule. As long as monetary policy does not completely offset the demand shock—for instance, through a stochastic intercept that tracks the real rate of interest—we continue finding a significant gap between the two financing modes.

The differences also persist under alternative policy regimes. When taxes remain constant and monetary policy responds weakly to inflation (passive monetary/active fiscal regime, see Leeper, 1991), the multiplier gap remains as large as under our baseline inertial rule. In this fiscally dominated equilibrium, demand shocks impact inflation not only through the Euler equation but also through the government budget constraint, amplifying macroeconomic volatility (e.g., Bianchi and Ilut, 2017).

This paper is related to several strands of literature. First, our empirical finding that debt maturity affects fiscal multipliers cannot be explained by standard macroeconomic asset pricing models, where bond yields reflect only intertemporal consumption substitution. Instead, our theoretical model draws on recent finance and macroeconomics literature showing that the relative supply of short versus long bonds affects interest rates. (see, e.g., Vayanos and Vila, 2021; Greenwood and Vayanos, 2014; Greenwood, Hanson, and Stein, 2015; Guibaud, Nosbusch, and Vayanos, 2013; Chen, Cúrdia, and Ferrero, 2012; Ray, Droste, and Gorodnichenko, 2024; Challe, Le Grand, and Ragot, 2013; Geromichalos, Herrenbrueck, and Salyer, 2016; Williamson, 2016).

We review this literature in detail below, explaining the various modeling assumptions and channels through which debt supply affects yields and allocations. Our framework draws on both (i) liquidity-based mechanisms emphasizing the special role of short-term debt (e.g., Geromichalos et al., 2016; Williamson, 2016) and models with transaction costs in long-term bond trades (Chen et al., 2012), and (ii) safety-based mechanisms where short-term bonds provide better hedging for heterogeneous agents facing idiosyncratic income or liquidation risk (Challe et al., 2013). However, to investigate fiscal multipliers in a tractable, partially analytical setting, we focus on a simpler and more stylized mechanism for modeling short-term debt's special role.

Greenwood et al. (2015) provide crucial empirical foundations for our analysis. They document that short-term US Treasury debt functions like money, providing liquidity to the private sector beyond what long-term debt offers. Our quantitative exercise builds on their estimates, which exploit exogenous movements in short bond supply to identify effects on the yield curve. By matching these estimates, we ensure our model captures the empirical relationship between debt supply and interest rates.

We are thus confident our findings would persist under model extensions including private sector provision of liquid assets or partial liquidity services from long-term debt. To demonstrate this robustness, we investigate alternative specifications allowing long bonds to partially complement short bonds in providing liquidity/safety services. As long as we match the empirical relationships in Greenwood et al. (2015), we continue finding sizable differences in spending multipliers.

Moroever, our empirical evidence complements Greenwood et al. (2015) by exploring the macroeconomic implications of short-term debt's money-like properties. Whereas Greenwood et al. document the special role of short-term debt for bond yields, we show how this translates into larger fiscal multipliers when spending is financed with short-term debt. This mechanism parallels how money-financed fiscal shocks amplify their macroeconomic effects (see, for example, Galí, 2020).

Our empirical approach builds methodologically on Priftis and Zimic (2021) and Broner et al. (2022), who examine how fiscal multipliers depend on external versus domestic debt financing. Priftis and Zimic use a proxy SVAR identifying financing through contemporaneous changes in the external/domestic debt ratio, while Broner et al. employ local projections conditioning on the lagged ratio. We adapt these methods to investigate an entirely different policy dimension: the debt maturity used to finance spending shocks rather than debt ownership. Thus, while our methodological contribution is limited, our analysis investigates a crucial and previously unexplored margin for US fiscal and debt management policy.

Relatedly, our findings also contribute to the literature on optimal public debt composition in macroeconomic models.[2] In this literature, the objective of debt issuance policy is to minimize distortions from financing government deficits through taxes or inflation. A common finding is that governments should issue long-term debt and save in short-term assets to exploit the negative covariance between long bond prices and deficits.[3]

Our empirical results add a new dimension to this trade-off. Since short-term financed spending shocks generate higher cumulative output increases, they produce smaller deficits and require smaller tax increases. This tax smoothing benefit of short-term bonds has been overlooked in existing literature. Testing its quantitative importance requires solving for optimal Ramsey policies with endogenous taxes and debt portfolios—a computationally challenging task. In companion work (Mankart, Priftis, and Oikonomou, 2024), we use our tractable framework to study these optimal policy questions.

Finally, our work contributes to the broader literature on fiscal shock propagation in macroeconomic models. (see, for example, Gali, Lopez-Salido, and Valles, 2007; Woodford, 2011; Christiano, Eichenbaum, and Rebelo, 2011; Bilbiie, 2011; Hagedorn, 2018a; Hagedorn, Manovskii, and Mitman, 2019; Auclert, Bardóczy, and Rognlie, 2023; Rannenberg, 2021; Bayer, Born, and Luetticke, 2023; Ferriere, Grübener, Navarro, and Vardishvili, 2021).

Most closely related are papers studying fiscal multipliers in models where government debt provides net wealth to households—that is, where debt's value exceeds future tax liabilities. A rapidly growing literature examines multipliers in heterogeneous agent models with incomplete financial markets (for example, Bayer et al., 2023; Auclert and Rognlie, 2020; Hagedorn et al., 2019; Hagedorn, 2018a; Auclert, Rognlie, and Straub, 2024). In these models, government debt is valuable to households for its safety and liquidity, enabling them to accumulate precautionary savings and buffer consumption against labor income shocks.

Another stream of papers takes a shortcut, considering simpler models in which government

[2] See, for example, Angeletos (2002); Buera and Nicolini (2004); Debortoli, Nunes, and Yared (2017); Nosbusch (2008); Lustig, Sleet, and Yeltekin (2008); Faraglia, Marcet, and Scott (2010); Faraglia, Marcet, Oikonomou, and Scott (2016, 2019); Canzoneri, Collard, Dellas, and Diba (2016); Greenwood et al. (2015); Aparisi de Lannoy, Bhandari, Evans, Golosov, and Sargent (2022); Passadore, Nuno, Bigio, et al. (2017) among others.

Close to our paper are Greenwood et al. (2015) who set up a three period model in which short bonds enter the utility function, giving rise to a money-like demand function for this asset. They use their model to study the optimal policy of a government that needs to refinance its debt in the face of exogenous interest rate shocks. Bonds in the utility may be considered a more brute force way of modeling the demand for short-term debt but ultimately, it is not that dissimilar to our more microfounded setting. However, unlike Greenwood et al. (2015), we consider a fully fledged New Keynesian model with infinitely lived agents and focus on the propagation of spending shocks.

[3] More precisely the seminal papers of Angeletos (2002) and Buera and Nicolini (2004) were the first to point out that optimal debt is long term. Since them, a few papers have extended the canonical real business cycle model with realistic frictions to find reasons for governments to issue short-term debt (e.g., Faraglia et al., 2019; Debortoli et al., 2017; Aparisi de Lannoy et al., 2022; Greenwood et al., 2015).

debt enters in the utility function directly (Rannenberg, 2021; Caramp and Singh, 2023), or affects consumption through providing liquidity and facilitating transactions (as in, e.g., Hagedorn, 2018a). Recent work shows that these simpler models can approximate the shock propagation properties of more complex heterogeneous agent models (Hagedorn, 2018a; Auclert et al., 2024). This insight suggests our findings would likely persist in richer heterogeneous agent frameworks that cannot be solved analytically. Our model extends Hagedorn (2018a) to a two-asset economy where short-term debt provides safety and liquidity services to households.

Finally, Rannenberg (2021) shows that fiscal multipliers are larger when government debt enters the household's utility function in a standard New Keynesian model. Our empirical evidence and theory demonstrates that debt maturity matters crucially: short-term debt generates larger multipliers than long-term debt when households can arbitrage between the two and short-term bonds provide superior liquidity/safety services.

2 Empirical Analysis

This section examines whether fiscal multipliers depend on government debt maturity financing. In Section 2.1, we use a proxy-SVAR approach that instruments government spending with defense news and conditions on contemporaneous changes in the debt maturity structure. In Section 2.2, we employ local projections that interact spending shocks with the lagged debt maturity ratio. Both approaches indicate that short-term debt financing generates larger fiscal multipliers than long-term financing.

Throughout this section, we evaluate the effects of fiscal shocks on economic variables over multiple periods, defining the *cumulative* fiscal multiplier as:[4]

$$m_{t+h} = \frac{\sum_{q=t}^{t+h} \Delta X_q}{\sum_{q=t}^{t+h} \Delta G_q} \left(\frac{\overline{X}}{\overline{G}}\right) \tag{1}$$

where m_{t+h} measures the cumulative change of the endogenous variable X (GDP, consumption, investment) per unit of additional government spending G, from the impulse at time t, up to the horizon h. $\left(\frac{\overline{X}}{\overline{G}}\right)$ is the sample average of the endogenous variable over spending.

2.1 Proxy-SVAR

2.1.1 Econometric methodology

Our first identification approach employs a proxy-SVAR framework and conditions on debt maturity movements to distinguish financing regimes. Following Stock and Watson (2012) and Mertens and Ravn (2013), we obtain a proxy for the government spending shock, whose exogenous variation is included in the VAR system. The proxy is assumed to be correlated with the structural spending shock but orthogonal to other shocks. Our choice of the proxy follows Ramey and Zubairy (2018),

[4] See, for example, Ilzetzki et al. (2013).

who derive a *defense news* series, based on movements of spending related to political and military events.

To distinguish between short-term and long-term financed spending shocks, we condition the defense news instrument on movements in the debt maturity ratio. Specifically, we classify defense news shocks occurring during periods when the ratio increases as short-term financed (STF) shocks. Conversely, we classify defense news shocks occurring when the ratio decreases as long-term financed (LTF) shocks. Notably, this approach resembles the identification of domestic- and foreign-debt-financed spending employed by Priftis and Zimic (2021). We now formalize this approach.

Our objective is to estimate the following system of equations:

$$\mathbf{A}\mathbf{Y}_t = \sum_{i=1}^{p} \mathbf{C}_i \mathbf{Y}_{t-i} + \varepsilon_t \tag{2}$$

where $\mathbf{Y}_t$ is an $n \times 1$ vector of endogenous variables in quarter t. $\mathbf{C}_i, i = 1, ..., p$ are $n \times n$ coefficient matrices of the own- and cross-effects of the i^{th} lag of the variables, and ε_t is an $n \times 1$ vector of orthogonal i.i.d. shocks with $E\left[\varepsilon_t\right] = 0$ and $E\left[\varepsilon_t \varepsilon_t^{'}\right] = I$. $\mathbf{A}$ is an $n \times n$, matrix capturing contemporaneous interactions between the elements of $\mathbf{Y}_t$.

An equivalent representation of the above system is:

$$\mathbf{Y}_t = \sum_{i=1}^{p} \delta_i \mathbf{Y}_{t-i} + \mathbf{B}\epsilon_t \tag{3}$$

where $\mathbf{B} = \mathbf{A}^{-1}$, $\delta_i = \mathbf{A}^{-1}\mathbf{C}_i$ and let $\mathbf{u}_t = \mathbf{B}\varepsilon_t$ denote the vector of reduced form residuals. As is well known, the estimate of the covariance matrix of $\mathbf{u}_t$ provides $n\left(n+1\right)/2$ independent restrictions, less than the number required for identification of $\mathbf{B}$. As in Mertens and Ravn (2013) we use covariance restrictions from the proxy of the true (latent) exogenous variable.

Formally, let $\widetilde{p}_t$ be a $k \times 1$ vector of proxy variables satisfying $E\left(\widetilde{p}_t\right) = 0$, and which are correlated with the k structural shocks of interest $(\varepsilon_{g,t})$ but orthogonal to other shocks $(\varepsilon_{x,t})$. The proxy variables can be used to identify $\mathbf{B}$ provided the following conditions hold:

$$\begin{aligned} E\left[\widetilde{p}_t \varepsilon_{g,t}^{'}\right] &= \Psi \\ E\left[\widetilde{p}_t \varepsilon_{x,t}^{'}\right] &= 0 \end{aligned}$$

where Ψ is a non-singular $k \times k$ matrix. Given these conditions hold, we can identify the elements of $\mathbf{B}$ which are relevant for the innovations in $\varepsilon_{g,t}$.[5]

In turn, disentangling STF spending shocks from LTF shocks is obtained by defining $\widetilde{p}_t$ with

$$\widetilde{p}_t = \begin{cases} \widetilde{p}_{\text{STF},t}, & \text{if } R_t \text{ increases} \\ \widetilde{p}_{\text{LTF},t}, & \text{if } R_t \text{ decreases} \end{cases}$$

[5]In our specification, $k = 1$ since we have one instrument (defense news) and $\varepsilon_{g,t}$ represents the government spending shock.

and where R_t denotes the ratio of short-term debt to long-term debt.

Finally, estimation proceeds following the standard two-step procedure for proxy-SVARs. First, we run a two-stage least squares estimation of non-government spending residuals on the residuals of government spending using $\widetilde{p}_t$ as an instrument, and second, we impose covariance restrictions to identify the relevant elements in $\mathbf{B}$.

2.1.2 SVAR results

Our benchmark estimates are based on a VAR with four variables: $Y_t = [G_t, GDP_t, C_t, I_t]$, where G_t denotes government expenditures, GDP_t is real gross domestic product, C_t is private consumption, and I_t is private investment. The sample consists of quarterly observations for the period 1954Q3-2015Q4.[6] The baseline specification estimates the system in (2) in log differences.[7] We employ four lags of the endogenous variables applying the Hannan-Quinn criterion. We report median estimates for the impacts of government spending shocks on output, consumption, and investment, along with one standard deviation confidence bands computed using Goncalves and Kilian (2004).

Figures 1 and 2 plot the cumulative impulse responses and the cumulative multipliers of consumption, investment and output, following a 1% government spending shock. The top panels show these responses under STF and LTF separately, and in the bottom panels we plot the differences in responses between the two.[8] Table 1 complements the exposition reporting the point estimates of the cumulative multipliers and the confidence intervals at various horizons.

As is evident from Figure 1, financing the spending shock with short-term debt leads to a much stronger reaction of aggregate output. Output increases on impact by more in the STF case (blue dashed line, left panel), and moreover, it continues to increase during the 12 quarters shown in the graph. The difference in terms of the median responses between short- and long-term financing (blue and red lines, respectively) grows throughout this horizon and it remains statistically significant.[9]

This difference can be more clearly stated in terms of the implied values of the fiscal multipliers (Figure 2 and Table 1). When spending is financed short-term, the impact multiplier is 1.48 and it remains above 1 after 12 quarters. On the other hand, if the shock is financed with long-term debt, the impact output multiplier is 1.08 but it drops to 0.42 after 4 quarters and becomes statistically insignificant.

The middle and right panels in the figures and the middle and bottom panels in Table 1, show

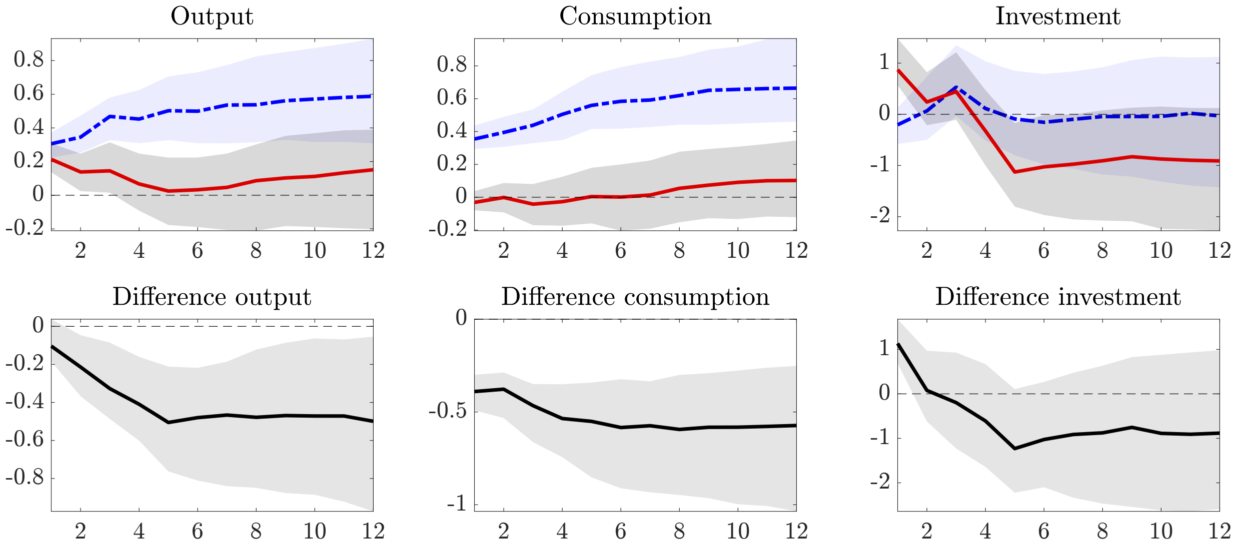
[6]Details on data sources and the construction of all variables used in this empirical section are, for brevity, provided in the online appendix.

[7]Running the model in log levels instead of differences gave us very similar results.

[8]The difference is defined as the LTF responses minus the STF responses. It has been calculated for each draw of the simulated distribution of the models that satisfy the sign restrictions.

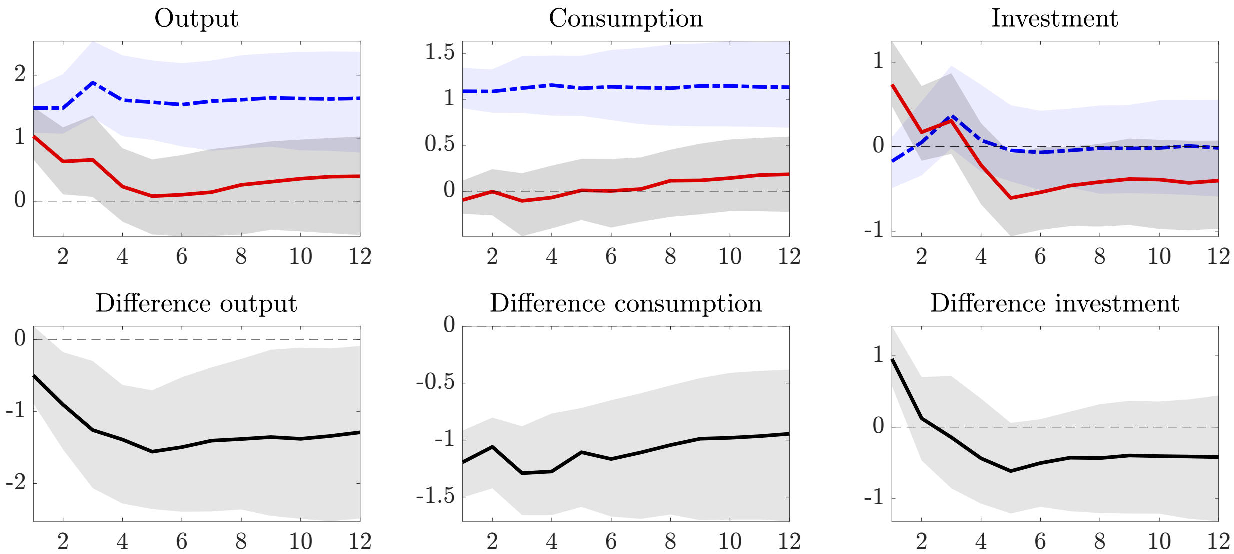
[9]In the online appendix we show the (cumulative) responses of spending following STF and LTF shocks. The paths are very similar, both in terms of the magnitude of the responses and their persistence. This indicates that the differential responses on output and consumption that we obtain under STF and LTF shocks are not driven by a different spending process. We also looked at the relation between the government consumption and investment series and the ratio of short over long debt. We did not find any positive correlation of the ratio of government consumption to investment with R, that could suggest that investment is more likely to be financed long term and consumption shocks with short-term debt. In the appendix we present results from VARs using the government consumption (investment) series and show that our results go through.

Figure 1: Proxy-SVAR: Cumulative impulse response functions



Notes: Top panel: Impulse response functions following a shock to short-term (blue, dash-dotted) and long-term debt-financed (red, solid) government expenditures. Lines correspond to median responses. Bottom panel: The difference in the impulse response functions between long-term and short-term debt financed government expenditures. Shaded areas correspond to confidence bands of one standard deviation.

Figure 2: Proxy-SVAR: Cumulative multipliers



Notes: Top panel: Cumulative multipliers following a shock to short-term (blue, dash-dotted) and long-term debt-financed (red, solid) government expenditures. Cumulative multipliers are calculated as in equation (1). Lines correspond to median responses. Bottom panel: The difference in the cumulative multipliers between long-term and short-term debt financed government expenditures. Shaded areas correspond to confidence bands of one standard deviation.

Table 1: Proxy-SVAR: Cumulative multipliers

	horizon	"Long-G shock"		"Short-G shock"		difference	
Output							
	1	**1.08**	[0.68 , 1.51]	**1.48**	[1.03 , 1.86]	-0.42	[-1.06 , 0.19]
	4	**0.42**	[-0.38 , 0.99]	**1.85**	[1.23 , 2.51]	-1.44	[-2.70 , -0.62]
	12	**0.55**	[-0.29 , 1.11]	**1.91**	[1.12 , 2.85]	-1.42	[-2.80 , -0.21]
Consumption							
	1	**-0.03**	[-0.28 , 0.16]	**1.16**	[0.96 , 1.40]	-1.21	[-1.55 , -0.89]
	4	**0.00**	[-0.40 , 0.34]	**1.31**	[0.93 , 1.68]	-1.24	[-1.98 , -0.82]
	12	**0.33**	[-0.21 , 0.62]	**1.35**	[0.85 , 1.92]	-1.08	[-2.00 , -0.46]
Investment							
	1	**0.80**	[0.44 , 1.14]	**-0.17**	[-0.55 , 0.17]	0.96	[0.55 , 1.50]
	4	**-0.12**	[-0.68 , 0.41]	**0.17**	[-0.30 , 0.72]	-0.31	[-1.34 , 0.35]
	12	**-0.33**	[-0.82 , 0.14]	**0.15**	[-0.34 , 0.78]	-0.42	[-1.40 , 0.30]

Notes: The table reports cumulative multipliers for output, consumption, and investment at different horizons for short-term debt-financed and long-term debt-financed government spending shocks, as well as the difference in multipliers, defined as Long-Short. Confidence bands of one standard deviation are denoted inside the brackets.

where the differences in the responses of output to spending derive from. Notice that the differences are clearly driven by the responses of consumption. The short-term debt-financed spending shock produces a strong crowding-in of consumption (the consumption multiplier is 1.16 on impact and remains around that level throughout the horizon). However, when spending is financed with long-term debt, private consumption does not increase. In contrast to consumption, aggregate investment shows no statistically significant response to spending shocks under either financing regime. The difference between the two investment responses is also statistically insignificant.

This baseline exercise confirms that the way the US government finances its spending matters for the effects of the shock on the paths of aggregate consumption and output. We next test the robustness of our baseline results by adding further controls in estimation and examining different sample periods.

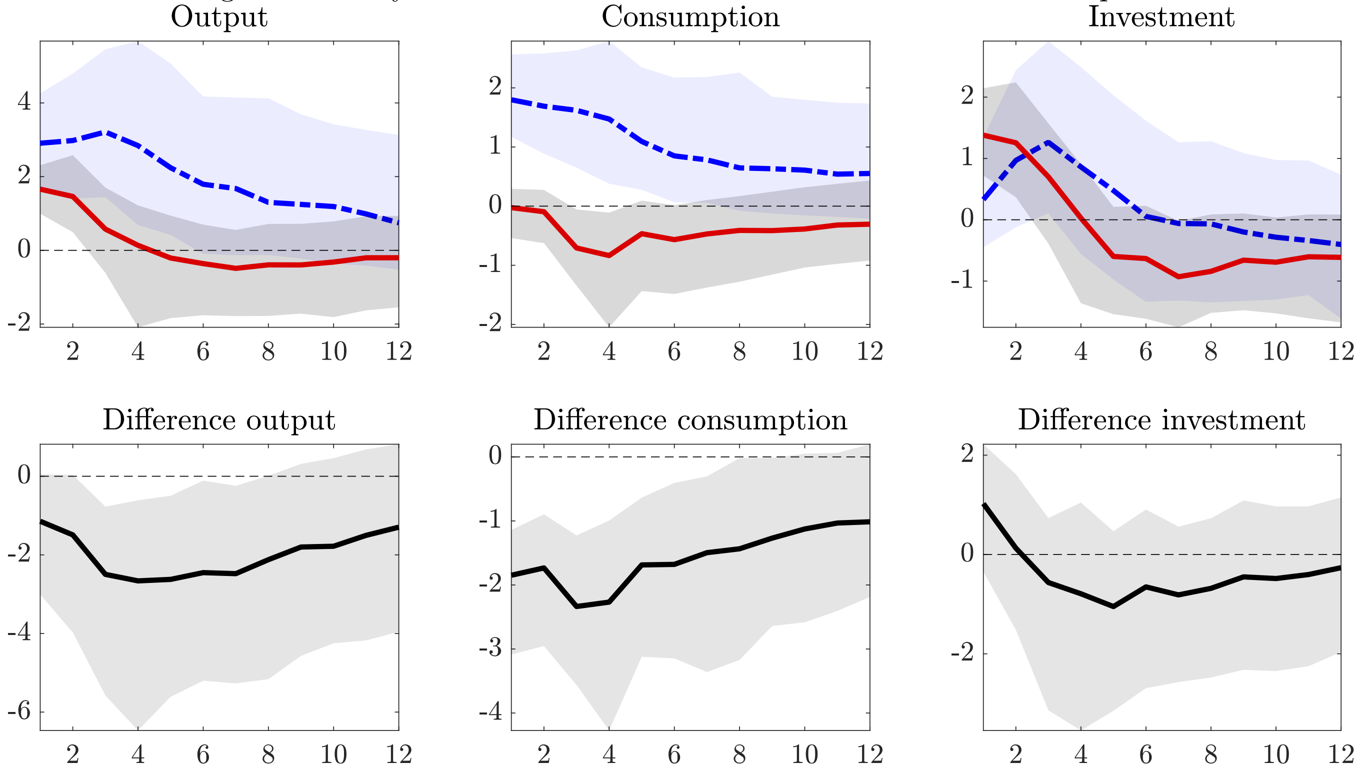
2.1.3 Robustness tests and extensions

Adding macroeconomic variables.

We first show the robustness of our findings to including additional macroeconomic variables in the VAR. In particular, we repeat the estimation of system (2) controlling for real wages of the private sector, the yields on short- and long-term government debt, the overnight interest rate, and the GDP deflator. We do so to treat possible endogeneity issues that may have contaminated our baseline estimates, using the standard approach of adding variables to the VAR and showing that the results do not change significantly. To motivate the experiments that we conduct in this paragraph let us briefly discuss the types of biases and endogeneity issues that we believe might matter in the context of our exercise.

First, the endogeneity of the decision of the Treasury to finance with short or long-term debt. It is well known that debt management decisions are influenced by the interest rate costs of financing. Thus, debt managers are more likely to issue short-term debt when yield curves are upward sloping (making short-term debt cheaper) than when curves are downward sloping (making long-term debt cheaper). Moreover, downward sloping yield curves predict recessions. The lower multipliers for long-term financing could reflect that the economy is set on a recessionary path.[10] We control for this possibility by adding the short-term rate and the term premium in our VAR (to capture both the level and the slope of the yield curve).

Figure 3: Proxy-SVAR with additional controls: Cumulative multipliers



Notes: Top panel: Cumulative multipliers following a shock to short-term (blue, dash-dotted) and long-term debt-financed (red, solid) government expenditures. Cumulative multipliers are calculated as in eq. 1. Lines correspond to median responses. Bottom panel: The difference in cumulative multipliers between long-term and short-term debt financed government expenditures. Shaded areas correspond to confidence bands of one standard deviation. Controls are the term premium, real wages, overnight rate, and the GDP deflator.

Second, adding wages as well as interest rates to the VAR also enables us to control for possible differential impacts of the STF and LTF shocks on these variables which may be relevant if the shocks are of a different nature and thus affect the macroeconomy differently. For example, a STF shock may put more upward pressure on wages when the government is hiring in certain sectors. This could then result in a larger increase in the consumption of hand-to-mouth households and thus in a stronger effect on aggregate output. Though our shocks have been identified using military spending news, and both STF and LTF shocks lead to similar cumulative spending responses (see appendix),

[10] Arguably, the opposite could also be true, if fiscal multipliers are higher during economic recessions (see, for example, Auerbach and Gorodnichenko, 2012).

demonstrating robustness to these concerns is valuable. Finally, we control for the (endogenous) response of monetary policy by adding the overnight interest rate in the VAR.[11]

Figure 3 shows the cumulative multipliers we obtain when we include all of these variables together in the VAR.[12] As is evident from the Figure, the cumulative output multiplier in the case of short-term financing continues being larger; once again the difference is driven by the differential responses of private consumption to the spending shock under short- and long-term financing. Our previous findings thus continue to hold.

Table 2 shows a breakdown of this exercise, reporting the consumption and output multipliers from five separate VARs, when we include one variable at a time. The top panel shows the results from a VAR run with wages as an additional control, then the short-term interest rate is the additional variable in the second panel, the long-term rate in the third panel, the 'yield curve' (short rate and the term premium) in the fourth panel, and lastly, the GDP deflator in the bottom panel. We focus on the consumption and output responses, the multipliers for investment were found insignificant in most of these specifications and we left those outside the table. Moreover, to conserve space, we report the point estimates at horizons of 1, 4 and 12 quarters.

Across all specifications, significant differences emerge between STF and LTF multipliers, particularly at the 4- and 12-quarter horizons. While LTF multipliers can be substantial on impact in some specifications, they decline rapidly and often become statistically insignificant by the fourth quarter. In contrast, STF multipliers remain persistently above unity throughout the horizon.

[11] In separate experiments in the online appendix we considered adding taxes in the VAR. Our results did not change.

[12] The term premium has been defined as the difference between the yield of the 10 year Treasury note and the overnight rate. Our results are almost identical when we define the term premium as the difference between the 10 year and the 3 month yields. Moreover, for brevity, the responses of the interest rates, wages and prices to the spending shock are shown in the online appendix. These responses are (by and large) what we expect them to be and in line with the theoretical model that we develop in Sections 3 and 4 of the paper. For example, a STF shock increases the short-term interest rate and reduces the term premium. In contrast, an LTF shock increases the term premium without affecting the short-term rate. Moreover, the STF shock increases the price level persistently, whereas the effect of the LTF shock on prices is nearly 0. See appendix for further details and discussion.

Table 2: Proxy-SVAR: Multipliers with additional controls

		horizon	"LTF shock"		"STF shock"		difference	
Wages	Y	1	**0.46**	[-0.12 , 0.93]	**1.72**	[0.96 , 2.33]	-1.24	[-2.22 , -0.51]
		4	**-0.64**	[-1.71 , -0.01]	**1.55**	[0.64 , 2.83]	-2.57	[-3.88 , -0.84]
		12	**-0.28**	[-1.30 , 0.58]	**1.47**	[0.50 , 2.65]	-1.95	[-3.23 , -0.44]
	C	1	**-0.31**	[-0.65 , -0.11]	**1.10**	[0.78 , 1.45]	-1.43	[-1.96 , -1.09]
		4	**-0.51**	[-1.11 , -0.18]	**0.88**	[0.37 , 1.56]	-1.53	[-2.33 , -0.82]
		12	**-0.10**	[-0.58 , 0.37]	**0.94**	[0.41 , 1.58]	-1.18	[-1.66 , -0.38]
Short rate	Y	1	**1.32**	[0.86 , 1.58]	**1.72**	[1.20 , 2.22]	-0.48	[-1.12 , 0.18]
		4	**0.59**	[-0.23 , 1.31]	**1.66**	[0.88 , 2.53]	-1.09	[-2.26 , 0.02]
		12	**0.40**	[-0.40 , 1.15]	**1.39**	[0.73 , 2.43]	-1.02	[-2.56 , 0.16]
	C	1	**0.23**	[0.02 , 0.45]	**1.57**	[1.26 , 1.78]	-1.31	[-1.65 , -0.98]
		4	**0.16**	[-0.21 , 0.50]	**1.26**	[0.92 , 1.73]	-1.13	[-1.90 , -0.55]
		12	**0.25**	[-0.17 , 0.65]	**1.06**	[0.61 , 1.70]	-0.86	[-1.78 , -0.17]
Long rate	Y	1	**1.26**	[0.60 , 1.88]	**1.49**	[1.00 , 2.01]	-0.22	[-1.08 , 0.49]
		4	**-0.83**	[-2.71 , 0.37]	**2.11**	[1.38 , 3.32]	-2.95	[-5.30 , -1.72]
		12	**-0.97**	[-2.39 , -0.13]	**2.20**	[1.18 , 3.43]	-3.26	[-5.43 , -1.79]
	C	1	**0.03**	[-0.30 , 0.29]	**1.45**	[1.19 , 1.78]	-1.36	[-1.97 , -1.06]
		4	**-1.10**	[-2.02 , -0.54]	**1.60**	[1.13 , 2.22]	-2.72	[-3.83 , -2.02]
		12	**-0.75**	[-1.42 , -0.25]	**1.58**	[1.00 , 2.34]	-2.37	[-3.63 , -1.54]
Short rate; term premium	Y	1	**1.79**	[1.00 , 2.58]	**1.46**	[0.99 , 1.90]	0.36	[-0.51 , 1.14]
		4	**0.82**	[-0.49 , 1.80]	**1.75**	[0.93 , 2.57]	-1.05	[-2.65 , 0.67]
		12	**0.11**	[-1.16 , 0.96]	**1.71**	[0.99 , 2.52]	-1.57	[-3.73 , -0.59]
	C	1	**0.20**	[-0.08 , 0.52]	**1.51**	[1.28 , 1.82]	-1.38	[-1.71 , -0.92]
		4	**-0.27**	[-1.22 , 0.21]	**1.42**	[1.02 , 1.92]	-1.80	[-2.91 , -1.11]
		12	**-0.11**	[-0.95 , 0.37]	**1.34**	[0.92 , 1.92]	-1.54	[-2.80 , -0.86]
GDP deflator	Y	**1**	**1.12**	[0.78 , 1.54]	**2.35**	[1.84 , 2.89]	-1.08	[-1.88 , -0.51]
		4	**0.24**	[-0.35 , 0.87]	**2.78**	[1.90 , 3.61]	-2.54	[-3.38 , -1.46]
		12	**0.42**	[-0.15 , 1.30]	**2.25**	[1.35 , 3.17]	-1.73	[-3.12 , -0.58]
	C	**1**	**-0.02**	[-0.24 , 0.14]	**1.46**	[1.14 , 1.90]	-1.54	[-1.93 , -1.16]
		4	**-0.00**	[-0.36 , 0.30]	**1.59**	[1.15 , 2.14]	-1.61	[-2.27 , -1.10]
		12	**0.23**	[-0.09 , 0.70]	**1.29**	[0.83 , 2.05]	-1.20	[-2.13 , -0.49]

Notes: The table reports cumulative multipliers for Y and C for short-term and long-term debt-financed government spending shocks, as well as the difference in multipliers, defined as Long-Short, for different proxy-SVAR specifications. Each specification augments the system in 2.1.2 with the variables in the first column. Confidence bands of one standard deviation are denoted inside the brackets.

Additional experiments: High vs. low debt and monetary policy regimes.

We now conduct two additional experiments to further condition our estimates on the macroeconomic policy environment, specifically focusing on the influence of the debt-to-GDP ratio and of the monetary policy regime.

A well-known feature of US debt management is that the Treasury has typically tilted its issuance towards long-term debt, when the debt-to-GDP ratio was high (Greenwood et al., 2015).[13] At high debt levels, the response of output to a fiscal shock may be weaker if, for example, the private sector expects that distortionary taxes are more likely to increase significantly, or if high debt implies political controversies about how to manage government liabilities.

To explore whether this is a crucial dimension we re-estimated the baseline system in (2) using 'a high debt sample', that is focusing on periods where the debt-to-GDP ratio was above the median of the full sample of observations. Our results were unaffected. We continued to find a large difference in the fiscal multipliers of output and consumption in this sub-sample (see online appendix).

Moreover, we also run the model using only observations from the post 1980 period. It has been documented, that US monetary policy did not react strongly to inflation during the 1960s and 1970s but it satisfied the 'Taylor principle' after the early 1980s.[14] We therefore examine whether this policy change affects fiscal multipliers under alternative financing modes. Results in the online appendix show that differences between STF and LTF persist, with consumption multipliers remaining significant only under short-term financing.

Lastly, we run our sample dropping observations from the financial crisis and the years the Fed kept the short-term nominal interest at its effective lower bound. Again we found no significant change in our estimates when we run the model with this subsample. For brevity, we show these results in the online appendix.[15]

2.2 Local Projections

We now employ local projections as an alternative method to investigate the effect of debt maturity on fiscal multipliers. We follow an approach similar to Broner et al. (2022) interacting government spending shocks with the lagged ratio of short-term to long-term debt. We leverage the high persistence of this ratio to argue that the first order lag is a good proxy for the contemporaneous financing

[13] The explanation is that when overall debt rises the refinancing risk increases and debt managers face a trade off between issuing more expensive and less risky debt, long-term, or cheaper and riskier debt, short-term. In general they prefer to issue long-term debt to reduce overall refinancing risks of government portfolios.

[14] See, for example, Bianchi and Ilut (2017) for recent work on this.

[15] It is perhaps necessary to add a couple of lines to discuss what we expect (in theory) the fiscal multipliers to be in a liquidity trap. As discussed previously, one important source of the differences in the fiscal multipliers could be the money-like services of short bonds. During a liquidity trap episode, however, the economy is 'satiated' with money (and close substitutes to money) and so we should find smaller differences between the STF and LTF multipliers. However, other forces, besides liquidity provision, may give rise to differences in fiscal multipliers; most notably the types of forces that can rationalize why quantitative easing works in a liquidity trap (see, for example, Chen et al. (2012) and the considerable literature on QE.).

Unfortunately, the short time span of the liquidity trap episode in the US, coupled with our identification assumption for spending shocks, precludes us from using the 2008-2015 observations to estimate the differences in fiscal multipliers in this regime. We thus consider only what dropping these observations does to our estimates.

of spending shocks.

2.2.1 Econometric methodology

Our empirical specification in this subsection is

(4)

$$\sum_{j=0}^{h} Y_{t+j} = \beta_h \sum_{j=0}^{h} \widetilde{G_{t+j}} + \gamma_h R_{t-1} \sum_{j=0}^{h} \widetilde{G_{t+j}} + \sum_{k=1}^{4} \Theta_{k,h} \mathrm{X}_{t-k} + \sum_{k=1}^{4} \Delta_{k,h} R_{t-1} \mathrm{X}_{t-k} + \zeta_h R_{t-1} + \mathrm{Trend}^2 + \varepsilon_{t+h}$$

where the dependent variable Y_t is consumption, investment or GDP and $\sum_{j=0}^{h} Y_{t+j}$ denotes the cumulative sum of Y over h quarters. The variable $\widetilde{\sum_{j=0}^{h} G_{t+j}}$ is an instrumented measure of the cumulative sum of government spending.[16] As Broner et al. (2022), we obtain $\widetilde{\sum_{j=0}^{h} G_{t+j}}$ through a first stage regression of the sum $\sum_{j=0}^{h} G_{t+j}$ on the news variable and the government spending level in period t, controlling for the lags of macroeconomic variables (including GDP and spending).[17]

Equation (4) distinguishes between short-term and long-term financed shocks, through conditioning on the lagged value of the R ratio (short over long debt). Thus, a shock that is financed through short-term debt is one that has occurred in periods when the ratio R is high. Conversely, an LTF shock corresponds to one that has occurred when R was low. The coefficients of interest are β_h and γ_h. Estimating these objects allows us to plot cumulative fiscal multipliers for different values of $\beta_h + \gamma_h R_{t-1}$ and interpret the resulting responses over the horizon h as STF and LTF multipliers.

Unlike the SVAR model in the previous subsection, where we obtained estimates by conditioning on contemporaneous changes in R, here we utilize debt stocks for identification. Though this may appear to capture different channels through which debt maturity influences fiscal multipliers, the distinction may matter little in practice: The share of short-term debt is highly persistent in US data, so outstanding stocks strongly correlate with new issues. Thus, the stock serves as a good proxy for the issuance.[18]

Broner et al. (2022) argue that identification based on the stock variable is likely to yield estimates that are not contaminated by potential biases (i.e., when shocks besides spending can drive new issuance). Our robustness exercises in the previous paragraph, were carried out in light of this possibility. The alternative identification strategy we employ in this section will further strengthen the robustness of our findings.

Finally, the control variables in X include the lagged values of the main variables (output, consumption, investment and spending) as well as further controls for wages, interest rates etc (the

[16] See (Jordà, 2005; Ramey and Zubairy, 2018)

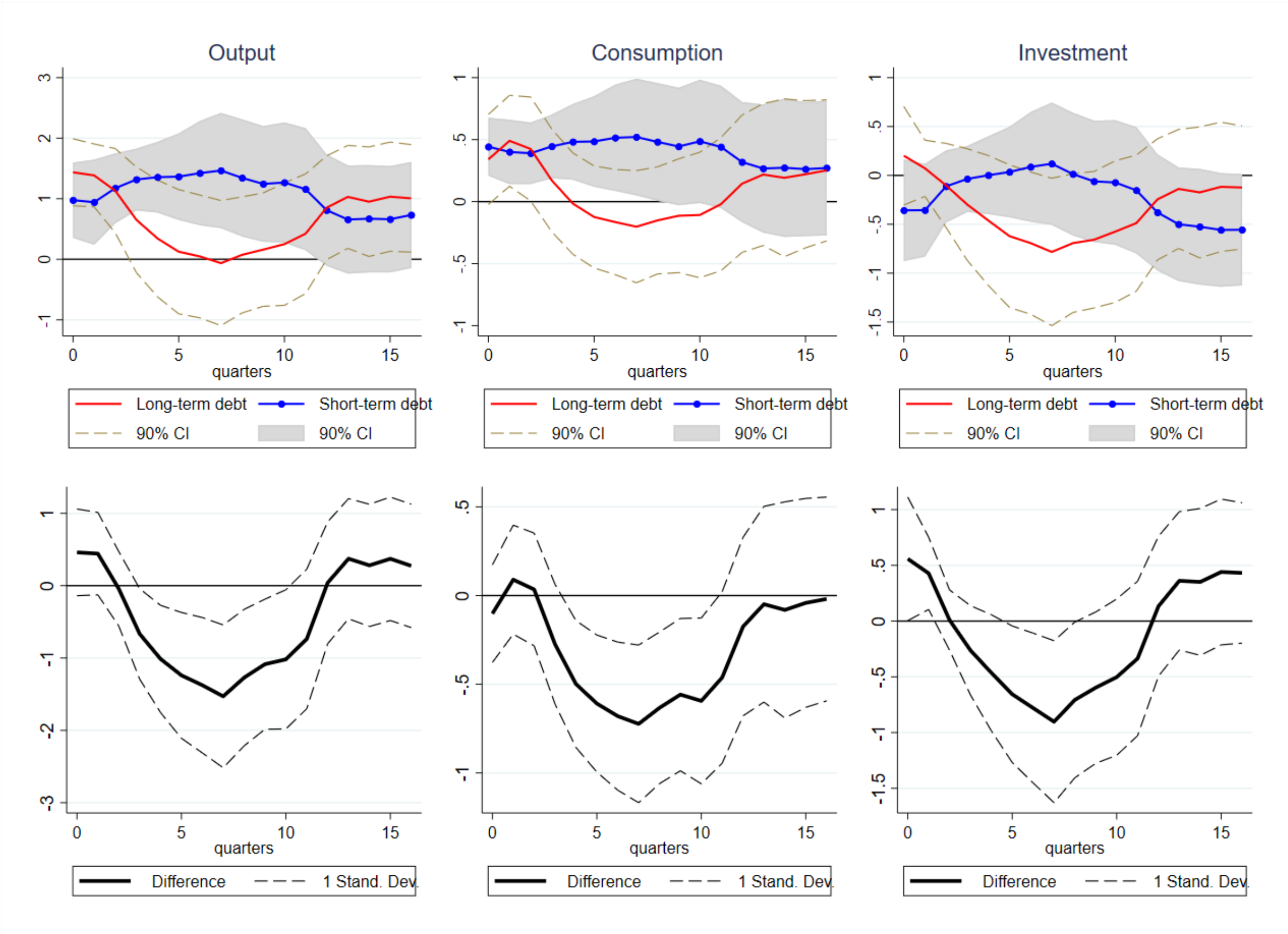
[17] Thus, our first stage regression essentially pools together the news shocks and innovations to spending identified as the difference between actual value of G and the value predicted by a fiscal rule implicitly identified in the VAR. In our specification, where we control for lagged output and spending levels, these innovations are essentially the Blanchard and Perotti (2002) shocks. That is, our approach is equivalent to obtaining the shocks from a separate VAR.

[18] It is well known, that the share of short-term debt in the US is a highly persistent variable (see, for example, Faraglia et al., 2019). The ratio of short over long also displays a high serial autocorrelation (0.93 in our data set). Moreover, note that the high persistence of R really tells us something about new issuances since a large fraction of short-term debt (defined here as maturities less than one year) is redeemed in every quarter. Hence, R is persistent when new shocks have been financed short-term when the value of R is high-and vice versa.

added variables in the previous section). Trend^2 is a quadratic time trend.[19]

2.2.2 Local projection results

Figure 4: Local Projections: Cumulative multipliers



Notes: The dotted blue lines in the top panels represent the estimated STF multipliers and the solid red line the analogous objects for LTF. The bottom panels show the difference between these two multipliers (point estimates and the corresponding one standard deviation intervals). STF and LTF are defined according to equation (4). For STF we use the 90th percentile data value of the ratio R, and for LTF the 10th percentile value. Standard errors have been adjusted for serial correlation and heteroscedasticity. The control variables in X are the lags of consumption, output, investment and spendings.

Figures 4 and 5 show the cumulative fiscal multipliers for two different values of $\beta_h + \gamma_h R_{t-1}$. The blue lines represent short-term financed (STF) shocks using the 90th percentile value of R, while the red lines represent long-term financed (LTF) shocks using the 10th percentile value.[20]

Consider first the results shown in Figure 4 in which X does not contain additional controls (wages, interest rate spread, etc). In line with our previous estimates based on the proxy SVAR, we

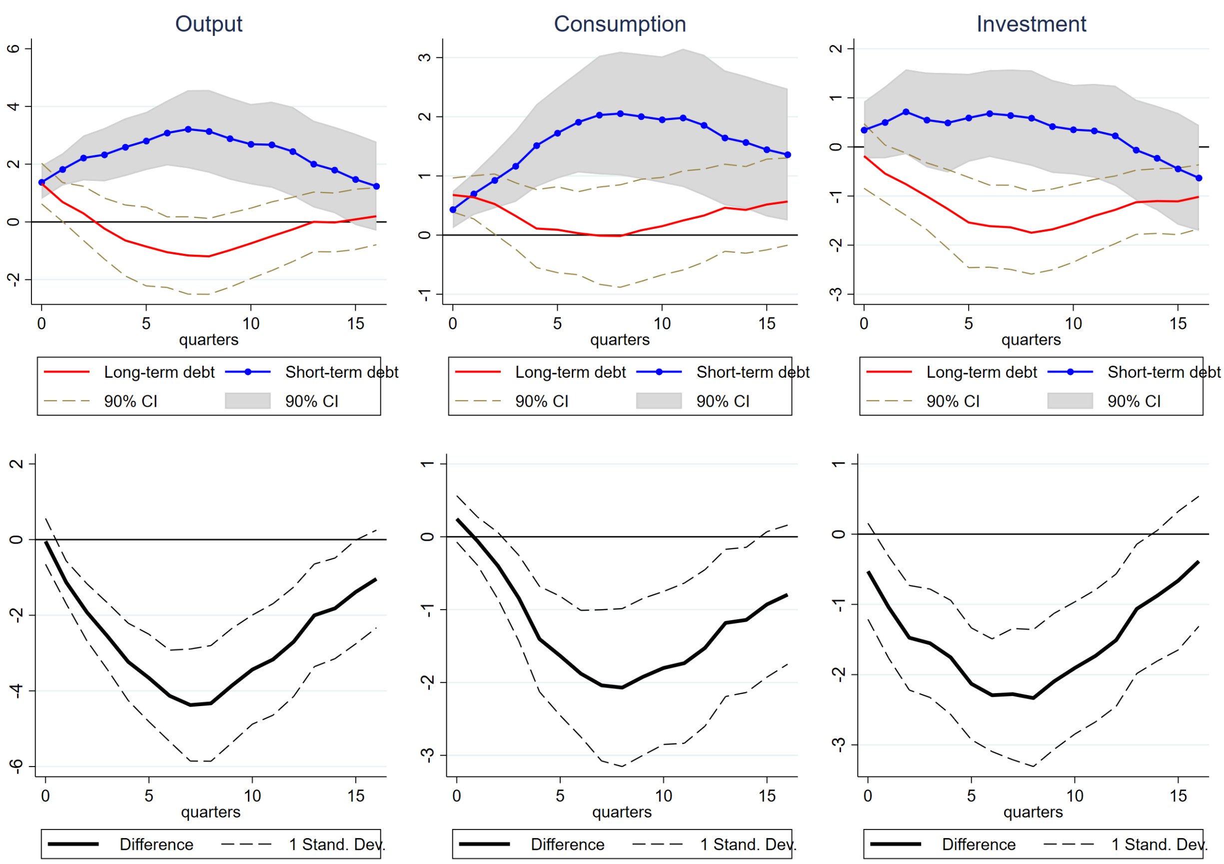
[19]For our baseline estimates we have de-trended output, consumption, investment etc, by potential GDP which we estimated as a 6th-degree polynomial of the time-trend, following Ramey and Zubairy (2018). Our results however are not sensitive towards computing potential GDP by HP-filtering real output.

[20]This choice follows Broner et al. (2022) and can help to visualize the multipliers over a wider range for R. (For different percentiles one can simply interpolate since our model is basically linear in R.)

again find that financing the spending shock short-term yields a statistically significant increase in private consumption, especially at medium term horizons, whereas the response in the LTF case is insignificant. The difference in the consumption multipliers is significant and translates into a sizable difference in the output multipliers.

Remarkably, in this empirical model, the investment channel also contributes to the different responses of output to spending shocks. Private sector investment responds differentially to STF and LTF shocks. LTF shocks produce mild crowding out around one year after the shock, while STF shocks do not. Importantly, however, consumption is a robust margin to account for the differences in the output multipliers under STF and LTF.

Figure 5: Local Projections: Cumulative multipliers with controls



Notes: The dotted blue lines in the top panels represent the estimated STF multipliers and the solid red line the analogous objects for LTF. The bottom panels show the difference between these two multipliers (point estimates and the corresponding one standard deviation intervals). STF and LTF are defined according to equation (4). For STF we use the 90th percentile data value of the ratio R, and for LTF the 10th percentile value. Standard errors have been adjusted for serial correlation and heteroscedasticity. The control variables in X also include the term spread and real wages.

Our conclusion does not change when we include wages and the interest rate spread as additional control variables in the model. This is done in Figure 5. The differences of the cumulative multipliers are even larger now, and they are statistically significant.

The online appendix presents several alternative specifications of this model, with a subset of the controls, dropping the observations of the Great Recession and conditioning on the debt level in the economy. The results from these alternative models are very similar to what we showed here. Moreover, we separately estimated the fiscal multipliers using only government consumption as the spending series and again found large differences between STF and LTF multipliers. Finally, the online appendix further extends the empirical analysis of this section drawing results from a third methodology applied to identify STF and LTF cumulative multipliers. Specifically, we used a state-dependent specification of the local projection model (as in, e.g., Auerbach and Gorodnichenko, 2013; Ramey and Zubairy, 2018) which allowed to separately estimate the multipliers under STF and LTF (not forcing a linear dependence on the ratio R). Our results were again in line with those of the baseline specifications of the empirical model.

3 A model of short- and long-term financing of spending shocks

The empirical analysis showed that the spending multiplier is higher when the government finances its deficit by issuing short-term debt. In this section we develop a theoretical model to explain this novel empirical fact. Before presenting our model in subsection 3.2, we first provide a broad discussion to outline relevant theoretical approaches and mechanisms.

3.1 Discussion

The finding that debt maturity influences the spending multiplier cannot be rationalized by a model where bonds of different maturities are only used by investors to substitute consumption intertemporally in frictionless financial markets. In standard representative agent models with Ricardian equivalence, consumption and interest rates depend on the path of spending only, not on how spending is financed. The yield curve reflects only expected consumption growth and inflation. In this framework, the relative supply of short-term and long-term bonds exerts no influence on yields and therefore no influence on consumption growth or the multiplier.[21] Explaining our empirical findings thus requires departing from this standard framework.

Theoretical models in which investors have preferences over particular maturities, where short bonds facilitate transactions and function like money, or they provide safety to investors and financial intermediaries, whereas long-term bonds provide savings to finance retirement subject to repricing risk, may imply non-trivial effects of bond quantities on yields and macroeconomic variables, and therefore we need to turn to these theories to interpret the empirical evidence.

The literature offers several models in which debt maturity can impact allocations. In an early contribution, Bansal and Coleman (1996) focus on the banking sector's demand for liquid Treasury debt. Safe and liquid Treasury bonds are used by banks to back checkable deposit accounts. Short-term Treasury bonds fulfill both safety and liquidity criteria, making them preferred by banks. In

[21] See, for example, Greenwood and Vayanos (2014) and the irrelevance of Quantitative Easing in this class of models, discussed, for example, in Curdia and Woodford (2011) and building on earlier results by Wallace (1981).

equilibrium, short bond yields align with the yields of checkable deposit accounts, a property that Bansal and Coleman (1996) exploit to explain observed term premia.[22]

Geromichalos et al. (2016) and Williamson (2016) offer microfoundations based on search-theoretic frameworks. In Geromichalos et al. (2016), short bonds are more useful for financing unexpected consumption needs because long-term bonds can only be liquidated in secondary markets subject to search frictions. The term premium reflects the low expected 'off the run' future yield of long bonds. Williamson (2016) focuses on collateral differences, assuming that short-term debt is more 'pledgeable' as collateral than long-term debt. This reflects the Federal Reserve's practice of lending a higher fraction of market value for short-term bonds at the discount window compared to long-term bonds.

The quantitative easing literature offers alternative plausible channels. These models typically feature 'bond clienteles'—different types of investors who exhibit preferred habitat for bonds of specific maturities. Some investors restrict their trading to particular maturities, while others can arbitrage across the maturity spectrum. Adjusting long bond positions typically entails portfolio transaction costs, leading to a term premium and non-trivial effects of the relative supply of different maturities on yields. More recently, several papers focus on financial intermediaries as arbitrageurs between different maturities.[23] In these models, limits to intermediaries' risk-bearing capacity imply that increased long-term debt issuance leads to higher risk premia.

Finally, another class of models where relative bond supply matters for allocations involves heterogeneous agents and incomplete financial markets (see Huggett (1993); Aiyagari (1994) and the considerable literature that followed). In this framework, households place a premium on safe and liquid assets, particularly when these can be used to accumulate precautionary savings as a buffer against labor income shocks. As a result of their insurance value, such assets tend to earn lower returns in equilibrium. Due to the repricing risk of long-term bonds, short-term bonds are a more effective for precautionary savings in this environment. Challe et al. (2013) use this argument to formalize the concept of the 'liquidation risk premium': households hit by adverse income shocks risk having to liquidate their portfolios when bond prices fall. In this environment, an increase in the supply of short assets could lead to higher private sector consumption by improving households' ability to smooth consumption when hit by adverse shocks.[24]

[22] See also Gorton and Metrick (2012) for a related view in which short bonds are used to back checkable deposits or collateralizing and facilitating transactions.

[23] See Vayanos and Vila (2021) and more recent papers by Kekre, Lenel, and Mainardi (2024) and Ray et al. (2024). See also Gertler and Karadi (2018).

[24] Another class of heterogeneous agents models that can rationalize nontrivial effects of relative bond supply on interest rates and allocations is OLG models. For example, in Guibaud et al. (2013) *bond clienteles* emerge endogenously because young households have a stronger demand for long-term assets that they can use to finance consumption in retirement. When the supply of long-term bonds increases, long bond yields fall.

Furthermore, transaction costs for long bonds arise naturally in OLG models, reflecting the fact that long-term debt is typically held in retirement accounts where withdrawals are subject to transaction costs. With heterogeneous households facing idiosyncratic risks, long-term bond prices incorporate expected portfolio adjustment costs that households bear when smoothing consumption. Long-term bonds then effectively become risky assets (e.g., Huang, 2003; Amihud and Mendelson, 1991).

Besides this channel, long bond risk premia also reflect long-run consumption risk from persistent inflation, which can impair households' ability to smooth consumption in retirement (see, for example, Piazzesi, Schneider, Benigno, and

The model that we develop below is inspired by these papers. We consider an economy in which agents solve a standard consumption/savings problem, where savings can be accumulated in short or a long-term government bonds. Agents face idiosyncratic risk, which makes them ex post heterogeneous in terms of their spending needs. Those with a high desire to consume can use their accumulated stock of short-term bonds to finance consumption more easily than their long-term bonds. Then, increasing the supply of short-term assets provides agents with additional liquidity to ward off idiosyncratic risks, and exerts a positive effect on private consumption.

Our setup is thus close to Geromichalos et al. (2016) and Williamson (2016). However, in contrast to these papers, we do not consider search frictions in the secondary market for long-term debt. Instead, we focus on a simpler way of modeling the financial market for short-term and long-term bonds. Furthermore, our model is close to quantitative easing models where long bonds are subject to portfolio adjustment costs.[25]

Finally, since government debt enables households to better cope with idiosyncratic risk, our framework also incorporates elements of Challe et al. (2013). Since we are interested in exploring the mechanisms of our model analytically, we focus on a linearized setting. Thus, the interactions between idiosyncratic risk/heterogeneity and long bond price fluctuation risk, as in Challe et al. (2013), will technically not be a driving force.

However, numerous authors have pointed out that models in which public debt facilitates transactions or enters the utility function have similar shock propagation as heterogeneous agent models (see Hagedorn, 2018a; Auclert et al., 2024; Kaplan, Moll, and Violante, 2018).[26] We thus speculate that a similar property may apply to our model. Verifying this would require solving a large-scale heterogeneous agent model with aggregate risk in which households can save in short-term and long-term assets. We defer this challenging task to future work.

3.2 The baseline model

Our baseline model extends the Hagedorn (2018a) one-asset economy, in which government debt provides liquidity/safety to the private sector by enabling households to finance unexpected spending needs/smooth consumption. Our extension incorporates two assets—short-term and long-term government bonds. In the baseline version of our model we will assume that only the short-term bond provides liquidity/safety to the private sector. This simplification also serves the purpose of enabling us to derive analytical results.

We provide a brief description of the model here, focusing on key equations, with detailed deriva-

Campbell, 2007; Bansal and Shaliastovich, 2013; Rudebusch and Swanson, 2012).

[25]To a first order approximation, assuming a transaction cost for long-term bonds or a money-like demand for short bonds should be equivalent. Both will be pinned down by the term premium. Assumptions about functional forms are not important in a linearly solved model. We are thus confident that our results below would continue to hold in a model with transaction costs for long-term debt.

[26]Angeletos, Collard, and Dellas (2022) analytically derive a reduced-form representation of bonds in the utility function, based on a microfounded heterogeneous agent framework. A similar result is provided by Hagedorn (2018b). Auclert et al. (2024) show that bonds-in-utility models predict intertemporal marginal propensities to consume which are comparable to the analogous measures in HANK models and in the data. They find notable similarities in the propagation of fiscal shocks.

tions relegated to the online appendix. A more detailed discussion of the frictions and the equilibrium than we offer here, can be found in Hagedorn (2018a).

3.2.1 Timing and preferences

The economy is populated by a continuum of infinitely lived, ex-ante identical agents/households. Time is discrete and each period t is divided in two subperiods, t_1, t_2.[27]

The timing of events is as follows. In subperiod t_1, households make standard consumption, savings, and labor supply choices, with savings accumulated in short-term and long-term assets. In subperiod 2, each household experiences an idiosyncratic preference shock that makes her desired total consumption differ from that of other households. We assume that a higher consumption need in t_2 can be financed by liquidating short-term assets chosen in t_1. To preserve tractability, we follow Hagedorn (2018a) and assume that households belong to large families that pool resources and redistribute through transfers at the end of subperiod 2. Consequently, all agents begin each period with the same wealth level and make identical consumption and portfolio decisions.

More specifically, the preferences of household i (when the shocks have been revealed) are:

$$u(C_t^i) + \theta^i v(c_t^i) - \chi \frac{{h_t}^{i,1+\gamma}}{1+\gamma} \tag{5}$$

where C_t^i (c_t^i) denotes the consumption of i in subperiod t_1 (t_2). $\theta^i \in [\underline{\theta}, \infty]$ is the household-specific preference shock that affects the relative utility derived from consumption in subperiod 2. A high realization of θ^i implies a high expenditure need in t_2 and therefore a desire for high consumption c^i. We assume θ^i is i.i.d. across households and time, following a distribution with probability density function f and cumulative distribution function$F$.[28]

The variable h_t^i denotes hours worked by household i. Parameter χ affects the disutility of working and γ is the inverse of the Frisch elasticity of labor supply.

3.2.2 Assets and asset demand

In subperiod t_1, each household solves a portfolio choice problem, selecting optimal quantities of a short-term (one-period) and a long-term nominal bond. We denote by $B_{t,S}^i, B_{t,L}^i$ the nominal quantities of the short and long bonds respectively and let $b_{t,S}^i, b_{t,L}^i$ denote the real quantities (deflated by the price level P_t).

Long-term bonds are perpetuities paying geometrically decaying coupons (see, for example, Woodford, 2001). We let δ denote the decay factor, so that each bond pays a stream $1, \delta, \delta^2, ...$ to the

[27]Technically, t_1 and t_2 need not represent different points in real time; they are simply used to introduce the idea that households can participate in asset markets and make savings decisions (in t_1) before the full vector of state variables has been revealed. In our notation below, we very frequently condense t_1 and t_2 into t. We distinguish between t_1 and t_2 whenever it is absolutely necessary.

[28]Note that assuming that shocks are i.i.d is necessary to rule out heterogeneity in portfolio choice decisions, when say agents experiencing a high θ^i today will likely expect a high θ^i tomorrow and have a stronger demand for short-term assets. This simplifies our derivations quite a bit. For simplicity, we drop the superscript i for the θ shock from now on.

investor. The long-term bond price in period t is $q_{L,t}$, and the ex-post holding period return is:

$$r_{L,t+1} = \frac{1 + \delta q_{L,t+1}}{q_{L,t}}.$$

Households purchase short-term bonds for two reasons: First, for their return (the inverse of the price $q_{S,t}$), and second, to finance consumption in subperiod 2. We assume that these expenditures c_t^i are subject to the following constraint:

$$c_t^i \leq b_{S,t}^i. \tag{6}$$

Therefore, households desiring high expenditure levels in subperiod t_2 may be constrained by their short-term bond holdings chosen in subperiod t_1.

Crucially, in subperiod 2, each household can only use its own portfolio to finance c_t^i.[29] However, since households belong to families that pool resources after transactions are completed, all households have identical wealth levels at the portfolio choice stage in subperiod t_1 and therefore hold identical quantities of short-term and long-term assets.

3.2.3 Household's problem

We now formally define the household's program. The budget constraint in subperiod t_1 is:

$$P_t C_t^i + q_{L,t} B_{L,t}^i + q_{S,t} B_{S,t}^i = P_t(1 - \tau_t) w_t h_t^i + (1 + q_{L,t}\delta) B_{L,t-1}^i + B_{S,t-1,2}^i + Div_t P_t - T_t P_t - P_t \bar{C}_t^i \tag{7}$$

The left-hand side contains the household's choice variables: subperiod t_1 consumption C_t^i and the portfolio investments $(B_{S,t}^i, B_{L,t}^i)$. The first term on the right-hand side represents net labor income $(1 - \tau_t) w_t h_t^i$ where w is the real wage rate and τ_t is the proportional labor income tax rate. Additionally, households face lump-sum taxes T_t.[30]

The terms $(1 + q_{L,t}\delta) B_{L,t-1}^i + B_{S,t-1,2}^i$ represent the nominal pay out from long- and short-term assets purchased in the previous period. Notice that $B_{S,t-1,2}^i$ has a subscript '2' which is used to denote that these are short bonds that remained in the household's portfolio after the transactions in subperiod 2 of period $t-1$ had been realized.

The variable Div_t represents dividend income. In our New Keynesian framework, monopolistically competitive firms earn profits and distribute dividends to households. We assume households hold identical equity shares across all firms and therefore receive identical dividends.[31]

[29] As explained in Hagedorn (2018a) the interpretation of the uninsurability of the expenditure shock, θ, could then be a spatial one. In subperiod 2, family members are spatially separated and so the goods c_t^i have to be obtained from the market (from other families) in exchange for the liquid asset.

[30] Our analysis considers both lump-sum and distortionary taxation. We assume lump-sum taxation in the baseline model to enable analytical solutions, then demonstrate robustness under distortionary taxation in Section 5.2.

[31] For simplicity, we assume (as many papers in the literature do) that shares cannot be traded. This assumption is not restrictive since households are identical at the beginning of each period and would choose identical portfolios if trading were permitted. What is perhaps worth emphasizing here, is that like long-term bonds, stocks cannot be used to finance subperiod 2 consumption, reflecting their lower liquidity and safety relative to short-term government bonds.

The term $\bar{C}_t^i$ denotes the goods the household expects to sell to other families in subperiod 2. Importantly, $\bar{C}_t^i$ is not a choice variable for the household but rather ensures goods market clearing.[32] It holds that:

$$E_\theta(c_t^i(\theta)) = \bar{C}_t^i, \tag{8}$$

and so the household will enter the next period with short-term bonds equal to

$$B_{S,t,2}^i = E_\theta(B_{S,t}^i - P_t(c_t^i(\theta)) + P_t\bar{C}_t^i, \tag{9}$$

We now express the household's program formally. Optimal choices solve the following value function:

(10)

$$V_t(B_{L,t-1}^i, B_{S,t-1,2}^i, \Upsilon_t) = \max_{B_{L,t}^i, B_{S,t}^i, C_t^i, c_t^i, h_t^i} \left\{ u(C_t^i) + E_\theta \theta v(c_t^i) - \chi \frac{{h_t}^{i,1+\gamma}}{1+\gamma} + \beta E_t \left[V_{t+1}(B_{L,t}^i, B_{S,t,2}^i, \Upsilon_{t+1}) \right] \right\}$$

subject to constraints (7), (9) and the constraint (6) governing consumption in subperiod 2. We use state variable Υ to denote the vector of aggregate shocks to the economy (to be described later).

Solving the Bellman equation yields the following optimality conditions (see online appendix): First,

$$u'(C_t^i) = \theta v'(c_t^i) \quad \text{if} \quad \theta < \widetilde{\theta}_t \tag{11a}$$

$$c_t^i = b_{t,S}^i \quad \text{if} \quad \theta \geq \widetilde{\theta}_t \tag{11b}$$

defines the optimal choice of c_t^i. When the realized value of θ falls below the threshold $\widetilde{\theta}_t$, the household's choice is unconstrained and satisfies the standard first-order condition $\theta v'(c_t^i) = u'(C_t^i)$. In contrast, if θ exceeds the threshold, then (6) is binding and trivially $c_t^i = b_{t,S}^i$. At the threshold, we have $\widetilde{\theta}_t v'(b_{t,S}^i) = u'(C_t^i)$.

Second, the optimal choice of short-term bonds yields:

$$q_{t,S} u'(C_t^i) = F(\widetilde{\theta}_t)\beta E_t \frac{u'(C_{t+1}^i)}{\pi_{t+1}} + \int_{\widetilde{\theta}_t}^{\infty} \theta v'(b_{t,S}^i) dF_\theta \tag{12}$$

Equation (12) equates the marginal utility cost of saving in short-term bonds, $q_{t,S}u'(C_t^i)$, with the marginal benefit of acquiring more of the asset. The benefit has two components: First, with probability $F(\widetilde{\theta}_t)$, the preference shock is below the threshold value, and short-term bonds will be carried over to the next period, providing real payoff $\frac{1}{\pi_{t+1}}$ per unit. Second, short-term bonds provide liquidity services for financing subperiod t_2 consumption, captured by the integral $\int_{\widetilde{\theta}_t}^{\infty} \theta v'(b_{t,S}^i) dF_\theta$.

[32]More specifically, since subperiods t_1 and t_2 may not represent different points in real time, households cannot distinguish between customers in t_1 and t_2 and how much is sold in either subperiod is basically exogenous to households. For details see Hagedorn (2018a).

Third, the price of the long-term bond satisfies a standard Euler equation:

$$q_{t,L}u'(C_t^i) = \beta E_t \frac{u'(C_{t+1}^i)}{\pi_{t+1}}(1 + \delta q_{t+1,L}) \tag{13}$$

Finally, the optimal choice of hours gives the familiar labor supply condition:

$$\chi \frac{(h_t^i)^\gamma}{U'(C_t^i)} = w_t(1 - \tau_t) \tag{14}$$

3.2.4 Production / Government / Resource Constraints

We now describe the production side of the model and the government.

Production. Following standard New Keynesian practice, a final good is produced by aggregating infinitely many differentiated products. Each product is produced under monopolistic competition by a single producer operating a technology which is linear in the labor:

$$Y_t(j) = H_t(j)$$

The final good is then given by the following Dixit-Stiglitz aggregator

$$Y_t = \left(\int_0^1 Y_t(j)^{\frac{\eta-1}{\eta}} dj \right)^{\frac{\eta}{\eta-1}}$$

where η governs the elasticity of substitution across the differentiated goods.

Producers maximize discounted profits subject to demand, taking labor costs w_t as given. Price adjustment involves resource costs à la Rotemberg (1982). In particular,

$$\text{Cost}_t = \frac{\omega}{2} \left(\frac{P_{jt}}{P_{jt-1}} - 1 \right)^2,$$

is the cost that the firm has to bear whenever it changes its price. Parameter ω governs price rigidity; higher values imply steeper adjustment costs. When $\omega = 0$, prices are perfectly flexible.

This standard setup (see, for example, Schmitt-Grohé and Uribe, 2004) yields a symmetric equilibrium where all firms charge identical prices P_t and hire identical labor h_t. The model admits the following New Keynesian Phillips curve:

$$\pi_t(\pi_t - 1) = \frac{\eta}{\omega}(\frac{1+\eta}{\eta} - w_t)h_t + \beta E_t \frac{U'(C_{t+1})}{U'(C_t)} \pi_{t+1}(\pi_{t+1} - 1) \tag{15}$$

Government. The government levies taxes and issues short- and long-term debt to finance exogenous spending G_t. We assume that G_t is a random variable and the only source of aggregate risk in the model. The government's nominal budget constraint is:

$$q_{t,S}B_{t,S}^g + q_{t,L}B_{t,L}^g = B_{t-1,S}^g + B_{t-1,L}^g(1 + \delta q_{t,L}) + P_t(G_t - w_t\tau_t h_t - T_t) \tag{16}$$

where the superscript g denotes government bond supply. Using market clearing conditions to equate bond demand and supply, the government budget constraint in real terms becomes:

$$q_{t,S}b_{t,S} + q_{t,L}b_{t,L} = \frac{b_{t-1,S}}{\pi_t} + \frac{b_{t-1,L}}{\pi_t}(1 + \delta q_{t,L}) + G_t - w_t \tau_t h_t - T_t \tag{17}$$

Resource Constraint. Finally, combining the household and the government budget constraints yields the economy-wide resource constraint:

$$C_t + \int c_t^i(\theta) dF_\theta + G_t + \frac{\omega}{2}(\pi_t - 1)^2 = Y_t = h_t \tag{18}$$

stating that total consumption by the households ($C_t + \int c_t^i(\theta)dF_\theta$), plus government spending (G_t) and price adjustment costs equals total output, which in turn equals hours worked given the linear production technology.

4 The Fiscal Multiplier in the Linearized Model

We now analyze the propagation of spending shocks in our model and characterize the spending multiplier under short- and long-term financing. We use a log-linearized version of the model and assume lump-sum taxation to derive analytical results. Section 5.2 considers distortionary taxation.

We further assume logarithmic utility functions for both u and v. In the online appendix, we show that the Phillips curve, the resource constraint, the government budget constraint, and the two bond pricing equations can now be written as:

$$\hat{\pi}_t = \frac{1+\eta}{\omega}\overline{h}(\gamma \hat{h}_t + \hat{C}_t) + \beta E_t \hat{\pi}_{t+1} \tag{19}$$

$$\overline{C}\hat{C}_t + \int_0^{\overline{\tilde{\theta}}} \theta dF_\theta \overline{C}\hat{C}_t + \overline{\tilde{\theta}}^2 f_{\overline{\tilde{\theta}}}\overline{C}\hat{\tilde{\theta}}_t + \overline{b}_S(1 - F_{\overline{\tilde{\theta}}})\hat{b}_{t,S} - f_{\overline{\tilde{\theta}}}\overline{\tilde{\theta}}\overline{b}_S\hat{\tilde{\theta}}_t + \overline{G}\hat{G}_t = \overline{Y}\hat{Y}_t \tag{20}$$

(21)

$$\overline{q}_S\overline{b}_S(\hat{q}_{t,S} + \hat{b}_{t,S}) + \overline{q}_L\overline{b}_L(\hat{q}_{t,L} + \hat{b}_{t,L}) = \overline{G}\hat{G}_t - \overline{T}\hat{T}_t + \overline{b}_S(\hat{b}_{t-1,S} - \hat{\pi}_t) + \overline{b}_L(1 + \delta\overline{q}_L)(\hat{b}_{t-1,L} - \hat{\pi}_t) + \delta\overline{q}_L\overline{b}_L\hat{q}_{t,L}$$

$$\frac{\overline{q}_S}{\overline{C}}(\hat{q}_{t,S} - \hat{C}_t) = -F_{\overline{\tilde{\theta}}}\frac{\beta}{\overline{C}}E_t(\hat{C}_{t+1} + \hat{\pi}_{t+1}) + \frac{\beta}{\overline{C}}f_{\overline{\tilde{\theta}}}\overline{\tilde{\theta}}\hat{\tilde{\theta}}_t - \frac{1}{\overline{b}_S}\int_{\overline{\tilde{\theta}}}^{\infty} \theta dF_\theta \hat{b}_{t,S} - \frac{1}{\overline{b}_S}\overline{\tilde{\theta}}^2 f_{\overline{\tilde{\theta}}}\hat{\tilde{\theta}}_t \tag{22}$$

$$\frac{\overline{q}_L}{\overline{C}}(\hat{q}_{t,L} - \hat{C}_t) = -\frac{\beta}{\overline{C}}(1 + \delta\overline{q}_L)E_t(\hat{C}_{t+1} + \hat{\pi}_{t+1}) + \frac{\overline{q}_L}{\overline{C}}\delta\overline{q}_L E_t\hat{q}_{t+1,L} \tag{23}$$

where hats denote that variables are expressed in log deviation from their steady state values. The threshold $\widetilde{\theta}$ satisfies $\hat{\widetilde{\theta}}_t = \hat{b}_{t,S} - \hat{C}_t$ in this log-linear model.

Equations (19) to (23) are sufficient for a competitive equilibrium when we further specify monetary and fiscal policies, setting the path of the short-term nominal interest rate and the tax schedule respectively. We now analyze fiscal multipliers under alternative policy specifications.

4.1 Simple analytics

We first show that issuing short-term debt increases the size of the spending multiplier in an analytical version of the model. Our analysis focuses on a simplified system where the Phillips curve, short-term bond Euler equation, and resource constraint(equations (19), (20) and (22)) suffice to determine output and consumption dynamics after a spending shock.

In particular, we assume that lump-sum taxes are set by the government to satisfy its budget constraint so that we do not have to keep track of equation (21). We also can dispense with equation (23), since the price $\hat{q}_{L,t}$ can be set to satisfy this equation given the path of consumption and inflation.

Recall that our empirical analysis had linked the size of the fiscal multiplier to the short-term debt share. We assume that the response of this debt share to the spending shock has the same sign as the response of $\hat{b}_{t,S}$, the real value of short-term bonds in t.[33] We consider paths $\hat{b}_{t,S} = \varrho \hat{G}_t$ where $\varrho > 0$ represents short-term financing (increasing short-term share) and $\varrho < 0$ represents long-term financing (decreasing short-term share).

Consider the Euler equation (22) that prices short-term debt. Substituting in the condition $\hat{\widetilde{\theta}}_t = \hat{b}_{t,S} - \hat{C}_t$ and rearranging we get:

(24)

$$\frac{\overline{q}_S}{\overline{C}}\hat{q}_{t,S} + F_{\overline{\widetilde{\theta}}}\frac{\beta}{\overline{C}}E_t\hat{\pi}_{t+1} + F_{\overline{\widetilde{\theta}}}\frac{\beta}{\overline{C}}\hat{C}_{t+1} = \underbrace{\left(\frac{\overline{q}_S}{\overline{C}} + (1-\beta)\frac{1}{\overline{C}}f_{\overline{\widetilde{\theta}}}\overline{\widetilde{\theta}}\right)}_{\alpha_1}\hat{C}_t - \underbrace{\left((1-\beta)\frac{1}{\overline{C}}f_{\overline{\widetilde{\theta}}}\overline{\widetilde{\theta}} + \frac{1}{\overline{b}_S}\int_{\overline{\widetilde{\theta}}}^{\infty}\theta dF_\theta\right)}_{\alpha_2}\hat{b}_{t,S}$$

where evidently $\alpha_1, \alpha_2 > 0$.

We first assume that monetary policy sets the path of the nominal interest rate so that $\frac{\overline{q}_S}{\overline{C}}\hat{q}_{t,S} + F_{\overline{\widetilde{\theta}}}\frac{\beta}{\overline{C}}E_t\hat{\pi}_{t+1} = 0$, eliminating the first two terms on the left-hand side. Under this policy, the real rate would be constant if $\frac{\overline{q}_S}{\overline{C}} = F_{\overline{\widetilde{\theta}}}\frac{\beta}{\overline{C}}$, which would hold if short-term bonds provided no liquidity services.[34] However, when short-term bonds do provide liquidity, we have $\overline{q}_S > \beta > \beta F_{\overline{\widetilde{\theta}}}$, so the nominal rate does not fully offset expected inflation to maintain a constant real rate.[35]

[33]This is not a restrictive assumption since we assume that taxes satisfy the government budget for any path of long-term debt after the shock. We can thus always ensure that the share is of the same sign as $\hat{b}_{t,S}$.

[34]For a sufficiently large stock of short-term bonds we have that $\overline{q}_S \approx \beta$ and $F_{\overline{\widetilde{\theta}}} \approx 1$. We then obtain the standard 3 equation NK model in which targeting a constant real interest rate implies no consumption response to the spending shock (Woodford, 2011). Then also $\alpha_2 = 0$.

[35]This condition can be interpreted as follows: Since $F_{\overline{\widetilde{\theta}}}\frac{\beta}{\overline{C}}E_t\hat{\pi}_{t+1}$ is the expected decrease of the real value of short bond holdings for households that retain their stock of short bonds after subperiod 2, monetary policy compensates these households for higher expected inflation. As we will now show, under this policy and if in addition we assume

Under this policy, we can write (24) as:

$$F_{\bar{\bar{\theta}}}\frac{\beta}{\overline{C}}\hat{C}_{t+1} = \alpha_1\hat{C}_t - \alpha_2\hat{b}_{t,S}$$

which defines a first order difference equation in $\hat{C}$. Since $F_{\bar{\bar{\theta}}}\frac{\beta}{\overline{C}} < \alpha_1$[36] we can solve forward to obtain:

$$\hat{C}_t = \frac{\alpha_2}{\alpha_1}E_t\sum_{\bar{t}\geq 0}(F_{\bar{\bar{\theta}}}\frac{\beta}{\alpha_1\overline{C}})^{\bar{t}}\hat{b}_{t+\bar{t},S}$$

which expresses consumption in period t as a function of the sequence of real short-term bonds. Using this result, it is simple to characterize the path of $\hat{C}_t$ following a shock to spending when $\hat{b}_{S,t} = \varrho\hat{G}_t$. Let us make the standard assumption that spending follows a first order auto-regressive process with coefficient ρ_G. Then, considering a positive innovation to spending at date 0 we have that

$$\hat{C}_t = \rho_G^t\frac{\alpha_2}{\alpha_1}\frac{1}{1-F_{\bar{\bar{\theta}}}\frac{\beta}{\alpha_1\overline{C}}\rho_G}\varrho\hat{G}_0, \qquad t\geq 0$$

Analogously, the response of total consumption (in both subperiods) can be derived as:

$$\hat{TC}_t = \kappa_1\varrho\rho_G^t\hat{G}_0$$

where $\kappa_1 > 0$ is defined in the appendix.

Using these expressions, we derive the fiscal multiplier analytically. Defining the impact multiplier as the dollar increase in output for each dollar increase in spending, or $m_0 = \frac{\overline{Y}d\hat{Y}_0}{\overline{G}d\hat{G}_0}$, we have:

$$m_0 = \frac{\overline{Y}d\hat{Y}_0}{\overline{G}d\hat{G}_0} = 1 + \frac{1}{\overline{G}}\left[\bar{b}_S(1-F_{\bar{\bar{\theta}}}) + \frac{\alpha_2}{\alpha_1}\frac{\overline{C}(1+\int_0^{\bar{\bar{\theta}}}\theta dF_\theta)}{1-F_{\bar{\bar{\theta}}}\frac{\beta}{\alpha_1\overline{C}}\rho_G}\right]\varrho \tag{25}$$

Since the expression in the square brackets is positive, equation (25) shows that ϱ is a key parameter for the value of m_0. Under short-term financing ($\varrho > 0$), the multiplier exceeds unity, while under long-term financing ($\varrho < 0$), the multiplier falls below unity.

The expression in the square brackets has two components. The first term, $\bar{b}_S(1-F_{\bar{\bar{\theta}}})$, measures the immediate effect of relaxing the constraint for households experiencing a high preference shock. The second term reflects the intertemporal effect of relaxing future constraints on current consumption C. Even if it is not likely that the constraint binds today, the possibility of future binding creates strong precautionary saving incentives. Increasing short-term debt supply ($\varrho > 0$) weakens this precautionary motive.

As is evident from (25), the significance of these margins, and consequently the value of the multiplier, depend (besides on parameter ϱ) on α_1, α_2, and $F_{\bar{\bar{\theta}}}$, influencing the elasticity of consump-

$\hat{b}_{S,t} = 0$, so that the supply of the short-term asset also does not change the payoff of holding the asset, then consumption remains constant.

[36]This follows from $F_{\bar{\bar{\theta}}}\frac{\beta}{\overline{C}} < F_{\bar{\bar{\theta}}}\frac{\beta}{\overline{C}} + \frac{1}{\bar{b}_S}\int_{\bar{\bar{\theta}}}^{\infty}\theta dF_\theta = \frac{\bar{q}_S}{\overline{C}} < \frac{\bar{q}_S}{\overline{C}} + (1-\beta)\frac{1}{\overline{C}}f_{\bar{\bar{\theta}}}\bar{\bar{\theta}} \equiv \alpha_1$.

tion with respect to $\hat{b}_{S,t}$. The more responsive is total spending to the share $\hat{b}_{S,t}$, the larger is the multiplier.

Our quantitative experiments below will discipline these parameters to match relevant moments from US data. In particular, we set parameter ϱ based on our empirical estimates in Section 2 of how the debt maturity share responds to spending shocks. Parameters α_1, α_2, and $F_{\overline{\overline{\theta}}}$ (their analogues in the calibrated model of the next paragraphs) target the empirical relationship between short-term debt supply and term spreads documented by Greenwood et al. (2015). The goal here is to verify that our framework generates the key mechanism linking debt financing choices to fiscal multiplier size.

This result can also be obtained under more plausible specifications of monetary policy than what we assumed above. For example, let us consider a standard Taylor rule:

$$\hat{i}_t = \phi_\pi \hat{\pi}_t$$

To keep the algebra tractable, we assume that shocks to spending are i.i.d, or $\rho_G = 0$. Then, conjecturing a solution of the form:

$$\hat{\pi}_t = \chi_1 \hat{G}_t \qquad \hat{C}_t = \chi_2 \hat{G}_t \qquad \hat{Y}_t = \chi_3 \hat{G}_t$$

for some coefficients χ_1, χ_2, χ_3 which satisfy the three equilibrium conditions (19), (20) and (22), we find:

$$m_0 = \alpha_3 \left[1 + \left(\bar{b}_S (1 - F_{\overline{\overline{\theta}}}) + \frac{1}{\overline{G}} \frac{\alpha_2}{\alpha_1} \frac{\overline{C} \left(1 + \int_0^{\overline{\overline{\theta}}} \theta dF_\theta \right)}{1 + \frac{1+\eta}{\omega} \frac{1}{\alpha_1} \frac{\overline{q}_S}{\overline{C}} \phi_\pi} \right) \varrho \right] \tag{26}$$

where $a_3 = a_3(\phi_\pi) < 1$ decreases in the inflation coefficient ϕ_π (see appendix).

Comparing equation (26) with equation (25) (setting $\rho_G = 0$) shows that the impact multiplier is smaller under the Taylor rule. When monetary policy raises the nominal rate in response to inflation—as occurs following inflationary spending shocks—the real interest rate increases, suppressing private consumption. In equation (26), this effect operates through two channels: the coefficient ($\alpha_3 < 1$), which captures inflation's impact via the Phillips curve, and from the fraction in the square bracket featuring ϕ_π in the denominator, which reflects standard intertemporal substitution. Both fractions decrease in ϕ_π.[37]

[37] Note that we did not specify under which condition for ϕ_π the solution to (19), (20) and (22) is a unique stable equilibrium. This merits brief discussion.

In this model the usual condition $\phi_\pi > 1$ (i.e., the Taylor principle) is not necessary for equilibrium uniqueness. Instead it suffices to have $\phi_\pi > \beta \frac{F_{\overline{\overline{\theta}}}}{\overline{q}_S}$, which defines a threshold strictly below unity since $\overline{q}_S > \beta$ and $F_{\overline{\overline{\theta}}} < 1$. Intuitively, the Euler equation (22) features 'discounting' that rules out multiple equlibria even when the Taylor principle does not hold—an analogous property obtains in the HANK models (see, e.g., Bilbiie, 2025).

The assumption of exogenous real debt $\hat{b}_{S,t}$, is crucial for this property. If instead debt issuance followed $\hat{b}_{S,t} + \hat{\pi}_t = \varrho \hat{G}_t$, then determinacy could obtain even with $\phi_\pi = 0$ under some parameterizations. The logic follows Hagedorn (2018a). In this model, where the real value of debt enters the Euler equation, the price level (and hence inflation)

Parameter ϱ remains crucial. When $\varrho = 0$ (constant debt share), the multiplier falls below unity due to consumption crowding-out. Conversely, sufficiently positive values of ϱ generate multipliers exceeding unity. The crowding-out effect from higher real interest rates is offset by crowding-in from increased short-term bond supply.

4.2 A calibrated model

We now calibrate the model to US data to investigate quantitatively how the spending multiplier varies with the financing of the spending shock.

The model horizon is quarterly, setting $\beta = 0.995$. Moreover, we set the long-term bond decay parameter $\delta = 0.96$, yielding an average maturity of 25 quarters. Combined with a short-term to long-term debt ratio matching our data sample mean, this targets an overall debt maturity of approximately 5 years. We set the steady-state debt-to-GDP ratio to 60 percent annually.

We make the following assumptions about fiscal/monetary policies and the share of short-term debt in the model. First, we assume that taxes follow a feedback rule of the form:

$$\hat{T}_t = \phi_T \hat{D}_{t-1} \tag{27}$$

where $\hat{D}$ denotes the real face value of total debt (both long- and short-term bonds).

This standard specification links taxes to lagged debt (see, e.g., Leeper, 1991). In our baseline quantitative experiments below, the parameter ϕ_τ is set equal to 0.01. This value is close to the threshold that defines the determinacy region in the model, when we assume that monetary policy is set according to an interest rate rule satisfying the Taylor principle. Moreover, it ensures that government debt displays a near unit root, consistent with the US data (Marcet and Scott, 2009).

Second, we assume that monetary policy follows an inertial rule of the form:

$$\hat{i}_t = \rho_i \hat{i}_{t-1} + (1 - \rho_i)\phi_\pi \hat{\pi}_t \tag{28}$$

We set $\rho_i = 0.9$ and $\phi_\pi = 1.25$ in the baseline calibration, with alternative specifications considered below.

Finally, we assume that the share of short-term over long-term debt follows:

$$\hat{R}_t = \varrho \hat{G}_t \tag{29}$$

We calibrate ϱ using our empirical evidence from Section 2. In the proxy-SVAR, a 1% spending shock under short-term financing leads to an average increase of 0.6% in R_t, while long-term financing episodes show a corresponding 0.6% decrease. We therefore set $\varrho = 0.6$ for short-term financing and $\varrho = -0.6$ for long-term financing.[38]

can be determinate even under a simple interest rate peg.

[38] $\hat{R}_t$ is defined by taking the log deviation of the ratio of the face value of short-term over long-term debt in the model. The average value of the share is 0.125 in our calibration and in the data. However, our model defines short-term debt as one-quarter maturity, while the empirical analysis includes all debt with maturity under one year. We

We now describe how we chose objects $F_\theta, \overline{\overline{\theta}}, \varrho$ and $\overline{q}_S$. First, given $\overline{q}_L = \frac{\beta}{1-\beta\delta}$ in steady state, we calibrate $\overline{q}_S$ so that the term premium at the annual horizon is equal to 1 percentage point. The quarterly net rate of return on the long-term asset is $\overline{r}_L - 1 = \frac{1+\delta\overline{q}_L}{\overline{q}_L} - 1 = 0.5\%$ and the analogous short-term rate ($\frac{1}{\overline{q}_S}$) equals 0.25%.

Given $\overline{q}_S$, our principle in calibrating the distribution F_θ is the following: We assume that F_θ is log normal which leaves us with two parameters (the mean and the variance) to hit relevant targets. We calibrate the mean so that in steady state, total consumption is 80% of output which we normalize to 1. The net inflation rate is zero in the deterministic steady state.

We set the variance of F so that our model produces an elasticity of the term premium with respect to the short-term debt-to-GDP ratio in line with the estimates of Greenwood et al. (2015). This paper reports that an increase of the ratio by 1 percent, reduces the (annualized) spread between T-bills and T-notes/bonds by 16 basis points in the case of 4 week bills and about 8 basis points for 10 week yields. Both are relevant numbers since the data counterpart for b_S is all debt that is of maturity up to one quarter. We target a 2 basis points change in the spread, corresponding to our quarterly model.[39]

Finally, for the remaining model parameters we adopt standard values. ω and η are set to 17.5 and -6 respectively, following Schmitt-Grohé and Uribe (2004). γ_h equals 1 implying a Frisch elasticity of labor supply of the same magnitude. The persistence of the spending shock ρ_G is 0.95. Moreover, as in the previous analytical subsection, we continue assuming that utility is log - log.

4.3 Baseline experiments

Figure 6 shows the responses of consumption (top panels), output (middle panels) and the cumulative multiplier (bottom panels) to a 1% spending shock. Blue lines show short-term financing (STF) responses, while red lines show long-term financing (LTF) responses. The middle column presents our baseline calibration with inertial monetary policy.

The differences between financing modes are striking. Short-term financing generates a much

therefore experimented with an alternative definition of the share.

In particular, consider

$$\widetilde{R}_t = \frac{b_{S,t} + b_{L,t}\frac{1-\delta^4}{1-\delta}}{b_{L,t}\frac{\delta^4}{1-\delta}}$$

to represent the share in levels. $\widetilde{R}_t$ assumes that the face value of all debt of maturity less than a year (including the coupon payments of the long-term bonds) count as short-term debt. In other words, we stripped the coupons of the long-term asset and consider the payments that are of maturity less than 4 quarters as short debt. In log deviations we obtain:

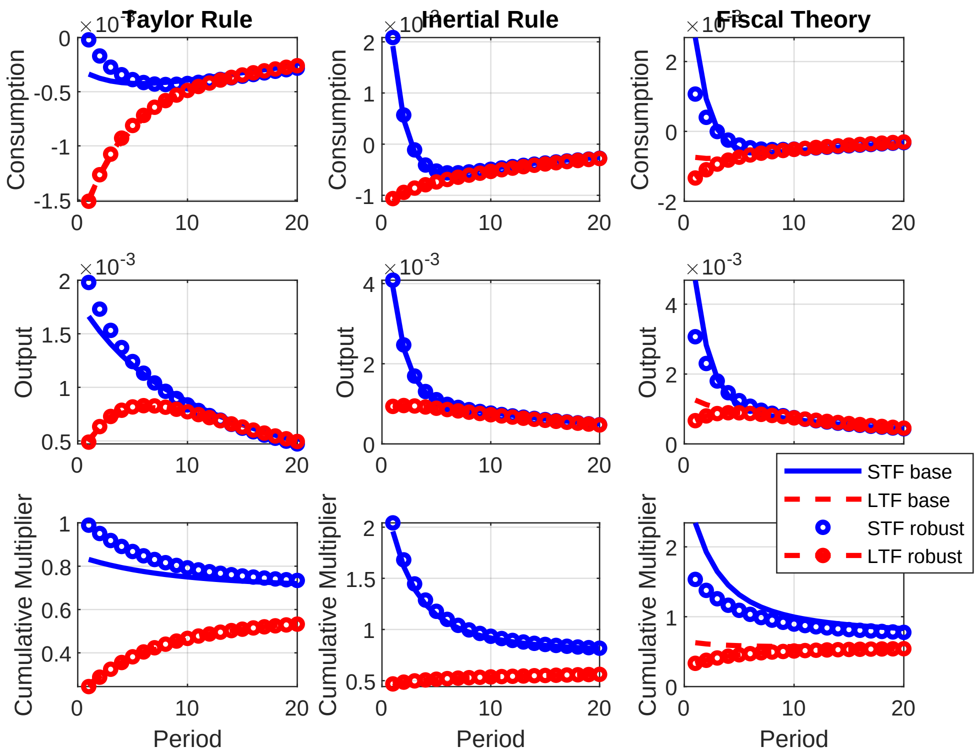
$$\hat{\widetilde{R}}_t = \frac{1}{\overline{\widetilde{R}}}\frac{\overline{b}_S}{\overline{b}_L\frac{\delta^4}{1-\delta}}\left(\hat{b}_{S,t} - \hat{b}_{L,t}\right).$$

In the online appendix we show simulations from this model, showing that our baseline results regarding the fiscal multipliers under STF and LTF do not change and if anything the differences become larger.

[39]To hit this target, we consider a shock to the ratio $\hat{b}_{S,t} - \hat{Y}_t$ using the baseline version of the model. Moreover, for every alternative calibration of the model that consider below, we repeat this exercise and if needed we re-calibrate the distribution F_θ to match the empirical evidence.

stronger output response due to the crowding-in of consumption. In contrast, under long-term financing, consumption drops significantly, resulting in a weaker output response. The STF multiplier equals 2.0 on impact and remains above unity for approximately 8 quarters. The LTF impact multiplier is 0.5 and persists at that level throughout the forecast horizon.

Figure 6: Responses to a spending shock



Notes: We plot the paths of consumption, output and the cumulative fiscal multiplier following a shock that increases spending by 1 percent on impact. In the middle panels we show our baseline calibration in which monetary policy sets the nominal interest rate according to $\hat{i}_t = \rho_i \hat{i}_{t-1} + (1-\rho_i)\phi_\pi \hat{\pi}_t$. *The solid (blue) line and the dashed (red) assume* $\phi_\pi = 1.25$ *and* $\rho_i = 0.9$ *(the baseline calibration). Responses in blue correspond to the case where the government finances with short-term debt. Red colour graphs are for long-term financing. The graphs with circles correspond to an alternative specification of the interest rate rule,* $\phi_\pi = 1$ *and* $\rho_i = 0.9$. *The left panels assume that monetary policy follows a simple inflation targeting rule* $\hat{i}_t = \phi_\pi \hat{\pi}_t$. *The 'base' value is* $\phi_\pi = 1.25$ *and the 'robust' value is* $\phi_\pi = 1$. *Lastly, the right panels correspond to the case of passive monetary policy, that is coefficient* ϕ_π *is strictly below 1. The 'base' is* $\phi_\pi = 0.5$ *and 'robust' corresponds to* $\phi_\pi = 0$.

To highlight the key driving forces behind these results let us go back to the Euler equation (24). We can write this equation as

$$\hat{i}_t = F_{\bar{\bar{\theta}}} \frac{\beta}{\overline{q}_S} E_t \hat{\pi}_{t+1} + F_{\bar{\bar{\theta}}} \frac{\beta}{\overline{q}_S} \hat{C}_{t+1} - \frac{\overline{C}\alpha_1}{\overline{q}_S} \hat{C}_t + \frac{\overline{C}\alpha_2}{\overline{q}_S} \hat{b}_{t,S} \tag{30}$$

Note that the crucial element in (30) is the last term on the RHS, $\frac{\overline{C}\alpha_2}{\overline{q}_S}\hat{b}_{t,S}$. This term acts like a standard demand shock to the Euler equation. Under short-term financing, the increase in spending is accompanied by a positive shock ($\hat{b}_{t,S}$ increases), and the opposite could happen under long financing.[40]

The reaction of monetary policy is key. As with any demand shock, if monetary policy tracks the real interest rate, it can fully eliminate the shock from the Euler equation. This would, however, require that the term $\frac{\overline{C}\alpha_2}{\overline{q}_S}\hat{b}_{t,S}$ enter into the policy rule as a stochastic intercept. But the inertial monetary policy rule in (28) does not feature real interest rate targeting and so the supply of short-term debt has non-trivial effects on the macroeconomy.

It is also evident that parameter ρ_i becomes very important in this context. Smoothing the nominal interest rate is essentially the opposite to tracking real rate fluctuations (since the latter implies a volatile process for $\hat{i}_t$) and a higher coefficient ρ_i will leave extra room to the demand shock to impact the Euler equation thus amplifying the expansionary effect on private consumption.[41]

The inflation response parameter ϕ_π also plays an important role. A stronger nominal rate response to inflation mitigates the expansionary effect of increased short-term debt supply.

4.4 The effects of varying the monetary policy rule

To analyze how ρ_i and φ_π affect fiscal multipliers, the left panels of Figure 6 show responses under a standard Taylor rule $\hat{i}_t = \varphi_\pi \hat{\pi}_t$. The baseline case uses $\varphi_\pi = 1.25$ (lines without circles). Substantial differences between STF and LTF persist (blue and red lines, respectively), though these differences are smaller than under inertial monetary policy. While inertial policies generate STF multipliers above unity with consumption crowding-in, the Taylor rule produces consumption crowding-out and multipliers below unity. Thus, ρ_i significantly affects multiplier magnitudes, but the qualitative result—that debt maturity influences fiscal transmission—remains robust across policy specifications.

Our framework abstracts from features known to amplify fiscal multipliers in New Keynesian models, such as rule-of-thumb consumers (Gali et al., 2007) or non-separable preferences between consumption and leisure (Bilbiie, 2011). Incorporating these elements would likely raise STF multipliers above unity under Taylor rules. We leave such extensions to future work, as our focus is demonstrating the debt maturity mechanism rather than precise quantitative matching.[42]

The effects of varying parameter ϕ_π are clearly visible in the left panels. The 'base' plots correspond to the calibration setting $\phi_\pi = 1.25$ whereas the plots labeled 'robust' (marked with circles)

[40] In the appendix we show that responses of $\hat{b}_{t,S}$ and $\hat{b}_{t,L}$ to the shocks for this baseline calibration. Indeed the LTF shock leads to a drop in the quantity of real short-term bonds, which can be mainly attributed to higher inflation, when the nominal quantity is roughly constant. Notice however, that even a drop in nominal short-term debt would not be unrealistic. Since short bonds mature after one period, a government that temporarily focuses on issuing long-term debt could see a contraction in the quantity of short bonds outstanding. In the data contractions relative to trend occur frequently.

[41] Simple forward iteration on (30) yields:

$$\hat{C}_t = E_t \sum_{j\geq 0} (\frac{\beta}{\overline{C}\alpha_1} F_{\overline{\overline{\theta}}})^j (-\frac{\overline{q}_S}{\overline{C}\alpha_1}\hat{i}_{t+j} + \frac{\beta}{\overline{C}\alpha_1} F_{\overline{\overline{\theta}}} E_t \hat{\pi}_{t+j+1} + \frac{\overline{C}\alpha_2}{\overline{C}\alpha_1}\hat{b}_{t+j,S})$$

An STF shock will result in a persistent increase of the short bond supply and of inflation. With a smooth path of the interest rates, $\hat{i}_{t+j}$ will not strongly compensate for the increase in the RHS variables and this will result into a stronger reaction of current consumption to the shock.

[42] Even with these extensions, inertial monetary policy remains the most empirically plausible specification, consistent with extensive evidence of interest rate smoothing in post-1980s US data (see, e.g., Bianchi and Ilut, 2017).

assume $\phi_\pi = 1$. A higher inflation coefficient induces a weaker response of output and a smaller fiscal multiplier. Interestingly, however, this effect is mainly present in the STF responses. The reason is that inflation after an LTF shock reacts much less, the negative demand impact of reducing the supply of short-term debt compensates for the positive demand impact of the spending shock.[43]

The online appendix considers alternative values for ρ_i and φ_π, as well as monetary policy rules targeting both the output gap and inflation. The main message is that a significant difference between the fiscal multiplier under STF and under LTF applies also in these cases.

5 Extensions

We now present results from three different versions of the model. First, we consider the case where monetary policy is 'passive' (e.g., Leeper, 1991). Second, we show that our findings continue to hold when instead of lump-sum taxes, the government levies distortionary taxes on labor income. Third, we study a model in which long-term bonds can be partially utilized to finance unexpected consumption needs.

5.1 Unbacked fiscal deficits/ Passive monetary policy

Our baseline model focuses on a scenario in which monetary policy (implicitly) pursues an inflation stabilization goal and fiscal policy ensures the solvency of government debt through taxes. Parameter ϕ_T is large enough so that debt is a mean-reverting process, even though it displays considerable persistence in our baseline calibration. Assuming higher values of ϕ_T will not dramatically change the results we showed previously.[44] However, what may significantly change the model's behavior is to assume a low enough coefficient ϕ_T so that debt becomes an explosive process. In this case, fiscal deficits need to be financed by inflation and it is well understood that monetary policy needs to follow a rule that prescribes a weak response to inflation (e.g., Leeper, 1991). We now explore this scenario.

In particular, we let taxes be constant through time (i.e., $\phi_T = 0$) and also let the nominal interest rate be set according to a rule $\hat{i}_t = \phi_\pi \hat{\pi}_t$ but now coefficient ϕ_π is either 0.5 or 0 ('base' and 'robust' legends respectively). The results are shown in the right panel of Figure 6. Notice that the spending multipliers are now larger. This is to be expected: In an equilibrium where monetary policy cannot focus fully on stabilizing inflation and has to satisfy debt solvency, inflation will be pinned down by the intertemporal government budget constraint and a spending shock will not only impact the macroeconomy through the usual channels (the Euler equation and the Phillips curve) but will also be filtered through the consolidated budget. This adds more volatility; macroeconomic variables in this model are more exposed to the fiscal shock (see, for example, Leeper, Traum, and

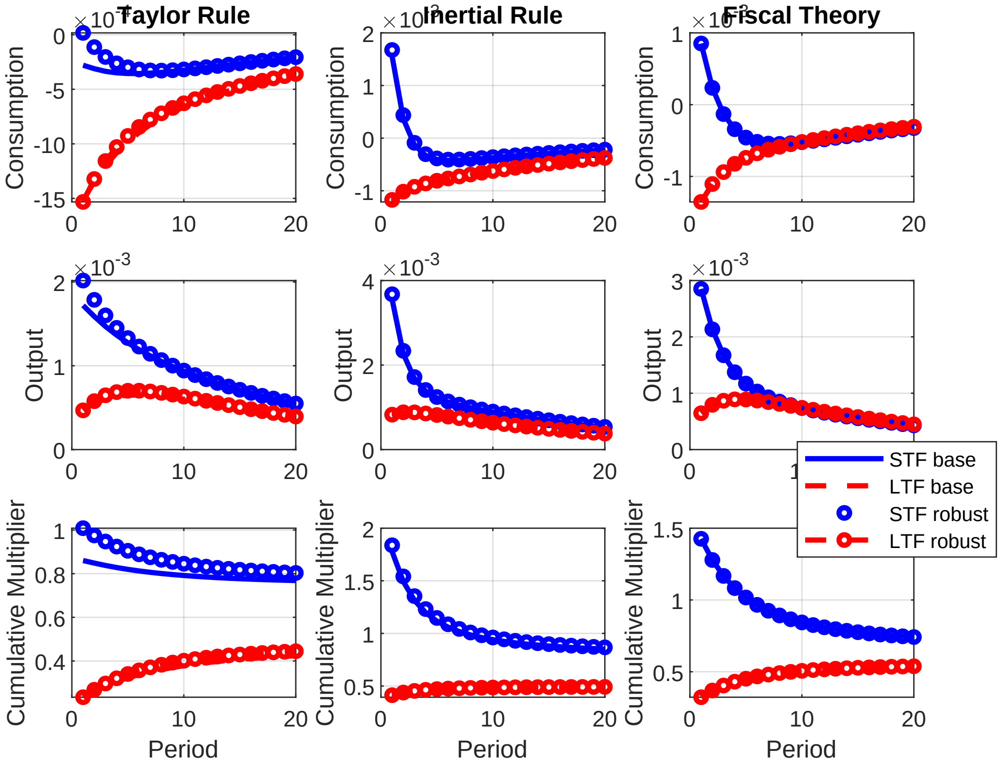
[43] See online appendix for the responses of inflation.

[44] Since our model is non-Ricardian (even with lump-sum taxes), the value of ϕ_T in principle will affect the behavior of debt aggregates and the multipliers. We have, however, simulated various scenarios assuming different values for ϕ_T and our results did not change.

Walker, 2017).[45] The differences in the fiscal multiplier stemming from how the government finances spending are clearly present in this model.

5.2 Distortionary Taxation

Figure 7: Responses to a spending shock: Distortionary taxes



Notes: We plot the paths of consumption, output and the cumulative fiscal multiplier following a shock that increases spending by 1 percent on impact, and assuming distortionary taxation. The calibration of the monetary and fiscal rules corresponding to each of the graphs shown, is discussed in the notes of Figure 6.

Our results carry over to the case where distortionary taxes are levied on labor income at a proportional rate τ. Under distortionary taxation, equations (20), (22) and (23) continue to hold. The only changes to the system of equilibrium conditions concern the government's budget constraint and the Phillips curve. In particular, the government's revenue now becomes

$$\text{Revenue} = \overline{\tau}\overline{Y}\frac{1+\eta}{\eta}\left((1+\gamma_h)\hat{Y}_t + \hat{C}_t + \frac{1}{1-\overline{\tau}}\hat{\tau}_t\right)$$

where $\overline{\tau}$ and $\hat{\tau}_t$ denote the steady state and log-deviation of the tax rate, respectively. Thus, revenue

[45] An important difference between the STF and LTF shocks concerns how the intertemporal constraint of the government is impacted. Since short debt is 'cheap' in this model (its average price is higher than the discount factor), the government extracts profits from liquidity/safety provision (see Angeletos et al., 2022). These rents increase the intertemporal revenues of the government. An STF spending shock will result in a relatively higher short bond supply and lower rents, reinforcing the drop in the intertemporal surplus of the government. For debt to be stabilized, a larger increase in inflation and output is needed, relative to the case of the LTF shock.

depends also on aggregate output and on consumption, and hence on the path of these variables following a spending shock. Moreover, the Phillips curve now is:

$$\hat{\pi}_t = \frac{1+\eta}{\omega}\overline{Y}\left(\gamma\hat{Y}_t + \hat{C}_t + \frac{\overline{\tau}}{1-\overline{\tau}}\hat{\tau}_t\right) + \beta E_t\hat{\pi}_{t+1} \tag{31}$$

and therefore the path of taxes will also influence inflation in this version of the model.

In Figure 7 we repeat the experiments from the previous section assuming distortionary taxes. As is evident from the figure, the impulse responses and the cumulative multipliers are very close to the corresponding results in Figure 6. Thus, our findings continue to hold.

5.3 Assuming that long bonds provide partial liquidity/safety services.

Our theoretical model explains the differential effect of financing spending shocks with short- and long-term bonds, assuming that only the former enable agents to finance idiosyncratic unexpected expenditure needs. With this assumption, our aim has been to capture in a simplistic manner both the money-like services provided by short-term debt (Greenwood et al., 2015; Geromichalos et al., 2016) as well as its safety value for heterogeneous agents. In our baseline calibration, we attributed the term premium to the differential role played by short bonds in order to capture these forces. Though this assumption is justified in the context of our model (in a roughly equivalent way linear models in the QE literature explain the term premium employing transaction costs to long-term bonds as, for example, Chen et al. (2012), one could certainly argue that long-term bonds also provide safety/liquidity to households relative to other available assets (stocks).

To show that our results continue to hold in this alternative setting, we now assume the following constraint for the subperiod 2 consumption of households:

$$c_t^i \leq b_{S,t}^i + \kappa b_{L,t}^i \tag{32}$$

where κ denotes a parameter that governs the relative liquidity/safety provided by long-term debt. For brevity, we omit the derivation of the model equations when (32) replaces (6) and refer the reader to the online appendix.

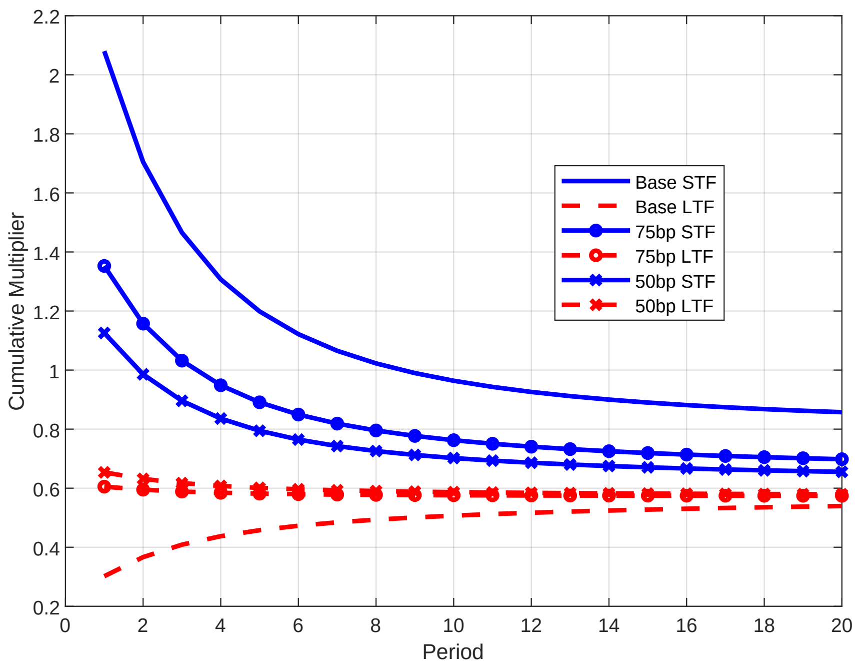
We calibrate the model for different values of κ to target different levels of the term premium. Figure 8 plots the cumulative multipliers under the baseline model ($\kappa = 0$) and when the annual term premium is 75 bps and 50 bps (lines with circles and crosses, respectively). We focus on the benchmark model where monetary policy follows an inertial rule and only show the cumulative output multipliers.[46] In each case, we have adjusted the parameters of F_θ to make our model consistent with

[46]The appendix plots the impulse responses of consumption and output, as well as the simple Taylor rule specification. Interestingly, for any $\kappa > 0$ it is not possible to obtain a determinate equilibrium when fiscal deficits are unbacked. For example, setting $\phi_T = 0$ and $\phi_\pi = 0$ gives rise to multiple equilibria. This finding is in line with the discussion in Hagedorn (2018a) that in models where debt facilitates transactions or enters the utility function, the price level may be determinate, making pinning it down by the intertemporal budget constraint superfluous. It is interesting to note, however, that if one of the assets (here long-term debt) does not have the safety/liquidity attribute (our baseline model) then it is possible to find parameter values within the standard FTPL configuration range where the intertemporal budget constraint pins down the price level. We will not go any further with this interesting property

the empirical evidence of Greenwood et al. (2015).

As is evident from the figure, our results continue to hold (qualitatively) when $\kappa > 0$. We continue finding considerable differences in the fiscal multipliers across STF and LTF. The differences are now somewhat smaller; however, this is to be expected, as—in the limit–when long-term bonds provide as many services to agents as short-term bonds do, the multipliers ought to be equal. The appendix repeats this exercise for several variants of the baseline model. We establish that the gap between the STF and LTF cumulative multipliers is persistent and is even bigger than in the baseline calibration considered in this section.

Figure 8: Responses to a spending shock when long bonds provide partial safety/liquidity



Notes: We plot the cumulative fiscal multiplier following a shock that increases spending by 1 percent on impact. We solve the model assuming the specification in equation (32). See text for further details.

6 Conclusion

We show that fiscal multipliers depend crucially on how governments finance spending shocks. Using US data, we find that short-term debt financing generates substantially larger multipliers than long-term debt financing. Our theoretical model explains this pattern through financial market frictions: short-term bonds provide liquidity and safety services that enable households facing idiosyncratic spending needs to maintain higher consumption levels.

Our calibrated model quantitatively matches the empirical patterns, generating substantial multiplier differences that depend on debt maturity structure. Under our baseline inertial monetary policy

here.

rule, short-term financing produces multipliers exceeding unity while long-term financing yields multipliers below one. These differences persist across alternative policy regimes: under standard Taylor rules the gap narrows but remains significant, while under fiscally-dominated regimes the differences are as large as in our baseline specification.

Future work could extend our framework in several directions. Heterogeneous agent models with realistic wealth distributions would provide stronger microfoundations for our liquidity mechanism. In such models, households would naturally prefer short-term assets to buffer consumption risk, either because these assets offer greater safety or because they avoid the repricing risk of long-term bonds.

Our tractable framework enabled us to derive analytical insights that would be impossible in more complex models. Nevertheless, large-scale heterogeneous agent models incorporating realistically risky long-term bonds would provide valuable settings to explore how debt maturity affects fiscal transmission across richer distributions of household characteristics.

Our findings have important implications for optimal debt management policy. The literature on optimal debt maturity typically focuses on hedging fiscal shocks through portfolio composition, but overlooks how debt maturity affects the shocks' transmission. We show that short-term debt financing systematically amplifies spending effects, revealing that the choice of financing maturity is itself a crucial policy tool because it affects the propagation mechanism of spending shocks.

References

Aiyagari, S. R. (1994). Uninsured idiosyncratic risk and aggregate saving. *The Quarterly Journal of Economics 109*(3), 659–84.

Alesina, A. and S. Ardagna (2010). Large changes in fiscal policy: taxes versus spending. In *Tax Policy and the Economy, Volume 24*, pp. 35–68. The University of Chicago Press.

Amihud, Y. and H. Mendelson (1991). Liquidity, maturity, and the yields on US treasury securities. *The Journal of Finance 46*(4), 1411–1425.

Angeletos, G.-M. (2002). Fiscal policy with noncontingent debt and the optimal maturity structure. *The Quarterly Journal of Economics 117*(3), 1105–1131.

Angeletos, G.-M., F. Collard, and H. Dellas (2022). Public debt as private liquidity: Optimal policy. mimeo.

Aparisi de Lannoy, L. R., A. Bhandari, D. Evans, M. Golosov, and T. J. Sargent (2022). Managing public portfolios. *NBER Working Paper 30501*, 1–49.

Auclert, A., B. Bardóczy, and M. Rognlie (2023). MPCs, MPEs, and multipliers: A trilemma for New Keynesian models. *The Review of Economics and Statistics 105*(3), 700–712.

Auclert, A. and M. Rognlie (2020). Inequality and aggregate demand. mimeo.

Auclert, A., M. Rognlie, and L. Straub (2024). The intertemporal Keynesian cross. *Journal of Political Economy 132*(12), 4068–4121.

Auerbach, A. J. and Y. Gorodnichenko (2012). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy 4*(2), 1–27.

Auerbach, A. J. and Y. Gorodnichenko (2013). Output spillovers from fiscal policy. *American Economic Review 103*(3), 141–46.

Bansal, R. and W. J. Coleman (1996). A monetary explanation of the equity premium, term premium, and risk-free rate puzzles. *Journal of Political Economy 104*(6), 1135–1171.

Bansal, R. and I. Shaliastovich (2013). A long-run risks explanation of predictability puzzles in bond and currency markets. *The Review of Financial Studies 26*(1), 1–33.

Barnichon, R., D. Debortoli, and C. Matthes (2022). Understanding the size of the government spending multiplier: It's in the sign. *The Review of Economic Studies 89*(1), 87–117.

Bayer, C., B. Born, and R. Luetticke (2023). The liquidity channel of fiscal policy. *Journal of Monetary Economics 134*, 86–117.

Bianchi, F. and C. Ilut (2017). Monetary/fiscal policy mix and agents' beliefs. *Review of Economic Dynamics 26*, 113–139.

Bilbiie, F. O. (2011). Nonseparable preferences, frisch labor supply, and the consumption multiplier of government spending: One solution to a fiscal policy puzzle. *Journal of Money, Credit and Banking 43*(1), 221–251.

Bilbiie, F. O. (2025). Monetary policy and heterogeneity: An analytical framework. *Review of Economic Studies*, forthcoming.

Blanchard, O. and R. Perotti (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *Quarterly Journal of Economics 117*(4), 1329–1368.

Born, B., F. Juessen, and G. J. Müller (2013). Exchange rate regimes and fiscal multipliers. *Journal of Economic Dynamics and Control 37*(2), 446–465.

Bouakez, H., O. Rachedi, and E. Santoro (2023). The government spending multiplier in a multi-sector model. *American Economic Journal: Macroeconomics 15*(1), 209–239.

Broner, F., D. Clancy, A. Erce, and A. Martin (2022). Fiscal multipliers and foreign holdings of public debt. *The Review of Economic Studies 89*(3), 1155–1204.

Buera, F. and J. P. Nicolini (2004). Optimal maturity of government debt without state contingent bonds. *Journal of Monetary Economics 51*(3), 531–554.

Canzoneri, M., F. Collard, H. Dellas, and B. Diba (2016). Fiscal multipliers in recessions. *The Economic Journal 126*(590), 75–108.

Caramp, N. and S. R. Singh (2023). Bond premium cyclicality and liquidity traps. *Review of Economic Studies 90*(6), 2822–2879.

Challe, E., F. Le Grand, and X. Ragot (2013). Incomplete markets, liquidation risk, and the term structure of interest rates. *Journal of Economic Theory 148*(6), 2483–2519.

Chen, H., V. Cúrdia, and A. Ferrero (2012). The macroeconomic effects of large-scale asset purchase programmes. *The Economic Journal 122*(564), F289–F315.

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

Curdia, V. and M. Woodford (2011). The central-bank balance sheet as an instrument of monetary policy. *Journal of Monetary Economics 58*(1), 54–79.

Debortoli, D., R. Nunes, and P. Yared (2017). Optimal time-consistent government debt maturity. *The Quarterly Journal of Economics 132*(1), 55–102.

Faraglia, E., A. Marcet, R. Oikonomou, and A. Scott (2016). Long term government bonds. mimeo.

Faraglia, E., A. Marcet, R. Oikonomou, and A. Scott (2019). Government debt management: The long and the short of it. *The Review of Economic Studies 86*(6), 2554–2604.

Faraglia, E., A. Marcet, and A. Scott (2010). In search of a theory of debt management. *Journal of Monetary Economics 57*(7), 821–836.

Ferriere, A., P. Grübener, G. Navarro, and O. Vardishvili (2021). Larger transfers financed with more progressive taxes? On the optimal design of taxes and transfers. mimeo.

Ferriere, A. and G. Navarro (2025). The heterogeneous effects of government spending: It's all about taxes. *Review of Economic Studies*, forthcoming.

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

Gali, J., J. D. Lopez-Salido, and J. Valles (2007). Understanding the effects of government spending on consumption. *Journal of the European Economic Association 5*(1), 227–270.

Geromichalos, A., L. Herrenbrueck, and K. Salyer (2016). A search-theoretic model of the term premium. *Theoretical Economics 11*(3), 897–935.

Gertler, M. and P. Karadi (2018). Qe 1 vs. 2 vs. 3...: A framework for analyzing large-scale asset purchases as a monetary policy tool. *29th issue (January 2013) of the International Journal of Central Banking*.

Goncalves, S. and L. Kilian (2004). Bootstrapping autoregressions with conditional heteroskedasticity of unknown form. *Journal of Econometrics 123*(1), 89–120.

Gorton, G. and A. Metrick (2012). Securitized banking and the run on repo. *Journal of Financial Economics 104*(3), 425–451.

Greenwood, R., S. G. Hanson, and J. C. Stein (2015). A comparative-advantage approach to government debt maturity. *The Journal of Finance 70*(4), 1683–1722.

Greenwood, R. and D. Vayanos (2014). Bond supply and excess bond returns. *The Review of Financial Studies 27*(3), 663–713.

Guibaud, S., Y. Nosbusch, and D. Vayanos (2013). Bond market clienteles, the yield curve, and the optimal maturity structure of government debt. *The Review of Financial Studies 26*(8), 1914–1961.

Hagedorn, M. (2018a). A demand theory of the price level. mimeo.

Hagedorn, M. (2018b). Prices and inflation when government bonds are net wealth. *CEPR Discussion Paper DP12769.*

Hagedorn, M., I. Manovskii, and K. Mitman (2019). The fiscal multiplier. *NBER Working Paper 25571*, 1–70.

Hall, R. E. (2009). By how much does GDP rise if the government buys more output? *Brookings Papers on Economic Activity 40*(2), 183–249.

Huang, M. (2003). Liquidity shocks and equilibrium liquidity premia. *Journal of Economic Theory 109*(1), 104–129.

Huggett, M. (1993). The risk-free rate in heterogeneous-agent incomplete-insurance economies. *Journal of Economic Dynamics and Control 17*(5), 953–969.

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

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review 95*(1), 161–182.

Kaplan, G., B. Moll, and G. L. Violante (2018). Monetary policy according to hank. *American Economic Review 108*(3), 697–743.

Kekre, R., M. Lenel, and F. Mainardi (2024). Monetary policy, segmentation, and the term structure. *NBER Working Paper 32324*.

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

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

Lustig, H., C. Sleet, and Ş. Yeltekin (2008). Fiscal hedging with nominal assets. *Journal of Monetary Economics 55*(4), 710–727.

Mankart, J., R. Priftis, and R. Oikonomou (2024). The long and short of financing government spending. mimeo.

Marcet, A. and A. Scott (2009). Debt and deficit fluctuations and the structure of bond markets. *Journal of Economic Theory 144*(2), 473–501.

Mertens, K. and M. O. Ravn (2013). The dynamic effects of personal and corporate income tax changes in the United States. *American Economic Review 103*(4), 1212–47.

Nosbusch, Y. (2008). Interest costs and the optimal maturity structure of government debt. *The Economic Journal 118*(527), 477–498.

Parker, J. A. (2011). On measuring the effects of fiscal policy in recessions. *Journal of Economic Literature 49*(3), 703–18.

Passadore, J., G. Nuno, S. Bigio, et al. (2017). Optimal debt management. mimeo.

Piazzesi, M., M. Schneider, P. Benigno, and J. Y. Campbell (2007). Equilibrium yield curves. *NBER Macroeconomics Annual 21*, 389–472.

Priftis, R. and S. Zimic (2021). Sources of borrowing and fiscal multipliers. *The Economic Journal 131*(633), 498–519.

Ramey, V. A. (2011a). Can government purchases stimulate the economy? *Journal of Economic Literature 49*(3), 673–85.

Ramey, V. A. (2011b). Identifying government spending shocks: It's all in the timing. *The Quarterly Journal of Economics 126*(1), 1–50.

Ramey, V. A. and S. Zubairy (2018). Government spending multipliers in good times and in bad: evidence from US historical data. *Journal of Political Economy 126*(2), 850–901.

Rannenberg, A. (2021). State-dependent fiscal multipliers with preferences over safe assets. *Journal of Monetary Economics 117*, 1023–1040.

Ray, W., M. Droste, and Y. Gorodnichenko (2024). Unbundling quantitative easing: Taking a cue from Treasury auctions. *Journal of Political Economy 132*(9), 3115–3172.

Rotemberg, J. J. (1982). Sticky prices in the united states. *Journal of Political Economy 90*(6), 1187–1211.

Rudebusch, G. D. and E. T. Swanson (2012). The bond premium in a DSGE model with long-run real and nominal risks. *American Economic Journal: Macroeconomics 4*(1), 105–43.

Schmitt-Grohé, S. and M. Uribe (2004). Optimal fiscal and monetary policy under sticky prices. *Journal of Economic Theory 114*(2), 198–230.

Stock, J. H. and M. W. Watson (2012). Disentangling the channels of the 2007-2009 recession. *NBER Working Papers 18094*, 1–55.

Uhlig, H. (2010). Some fiscal calculus. *American Economic Review 100*(2), 30–34.

Vayanos, D. and J.-L. Vila (2021). A preferred-habitat model of the term structure of interest rates. *Econometrica 89*(1), 77–112.

Wallace, N. (1981). A Modigliani-Miller theorem for open-market operations. *American Economic Review 71*(3), 267–274.

Williamson, S. D. (2016). Scarce collateral, the term premium, and quantitative easing. *Journal of Economic Theory 164*, 136–165.

Woodford, M. (2001). Fiscal requirements for price stability. *Journal of Money, Credit, and Banking 33*(3), 669.

Woodford, M. (2011). Simple analytics of the government expenditure multiplier. *American Economic Journal: Macroeconomics 3*(1), 1–35.