Public Debt, iMPCs & Fiscal Policy Transmission*

Stefano Grancini†

First version: March 2024.
This version: April 2026.

Abstract

I study how household holdings of safe government claims shape the transmission of fiscal policy. Using U.S. local-projection IV regressions, I document that government spending multipliers are smaller when federal debt held directly by households, relative to GDP, is higher—both output and consumption respond less strongly to identified spending shocks in high-debt states. Cross-country evidence from a panel of OECD economies, using the domestic sovereign debt share as the state variable, delivers the same qualitative message: fiscal transmission is weaker when domestic absorption of public debt is higher. To interpret these facts, I develop and calibrate a heterogeneous-agent New Keynesian model in which government bonds provide self-insurance. Higher household bond holdings weaken fiscal transmission by reducing the mass of liquidity-constrained households and by raising equilibrium real interest rates, which together compress aggregate marginal propensities to consume. A steady-state decomposition shows that the bond-price channel is the dominant force, while the distributional channel is smaller because additional safe assets are disproportionately held by already-wealthy, low-MPC households. The results imply that fiscal-space assessments based on headline public debt can misstate fiscal transmission when the household absorption of government liabilities changes over time.

Keywords: Fiscal multipliers; Public Debt; HANK; Government Spending; iMPCs.
JEL Classification: E21; E62; H31

*I am grateful for suggestions and feedback from an anonymous referee, Mark Aguiar, Max Alston, Tiago Bernardino, Florin Bilbiee, Giorgio Primiceri, Pedro Brinca, João Brogueira, Markus Brunnermeier, Francisco Cocco, João Duarte, Nick Flamang, Francesco Franco, Sebastian Guarda, Michael Jenuwine, Moritz Lenel, Michele Lenza, Selma Malmberg (discussant), Georgios Nikolakoudis, Valter Nobrega, Lorenzo Pesaresi, Simone Pesce, Giacomo Porcellotti (discussant), Ricardo Reis, Rodolfo Rigato, Richard Rogerson, Victor Sancibrian, Thomas Sargent, Ettore Savoia (discussant), Daniele Siena (discussant), Oreste Tristani, Gianluca Violante, and all the participants in the Nova Macro Research Group, the Princeton Student Seminars, the 17th Annual Meeting of the Portuguese Economic Journal, Insper, FGV EESP, the ECB brownbag, the European Central Bank Workshops on Household and Fiscal Policy, the Fourth PhD Workshop in Money and Finance (Stockholm), the 14th PhD Student Conference on International Macroeconomics (Paris Nanterre), the IMF Fiscal Policy Division, the 1st Lausanne PhD Macroeconomics Conference, the 47th SBE Conference (São Paulo). All errors are my own.

†Nova School of Business and Economics. R. da Holanda 1, 2775-405 Carcavelos. I am thankful for financial support from Fundação para a Ciência e a Tecnologia (2021.06215.BD).
Email: stefano.grancini@novasbe.pt

1 Introduction

After the global financial crisis and again during the COVID-19 pandemic, advanced economies enacted large discretionary fiscal expansions on top of already elevated public-debt levels. These episodes revived a classic question in modern form: does the effectiveness of government spending depend on the level of outstanding public debt? The question is not only about fiscal "space" in the sense of solvency or market access. It is also about who absorbs the additional government liabilities and, through that, how fiscal policy reshapes households' ability to self-insure.

This paper studies how the stock of household-relevant safe liquidity affects the transmission of government spending shocks. The key idea is simple. When the government issues more safe nominal claims and these claims are absorbed domestically, the private sector holds a larger buffer of safe liquid wealth. In heterogeneous-agent economies, this reshapes marginal propensities to consume and therefore the aggregate response to fiscal expansions. Conversely, if the marginal issuance is absorbed by non-residents, the mechanism is attenuated: the domestic stock of safe liquidity available for self-insurance changes much less, so the transmission channel emphasized in this paper is weaker.

A central challenge is empirical: the model experiment "increase B" must map to a meaningful observable object. Headline government debt does *not* directly measure household liquidity because it includes foreign holdings and because a substantial fraction of domestic absorption occurs through resident financial intermediaries. Throughout the paper, I therefore distinguish two related empirical counterparts: (i) resident-held public debt, which measures broad domestic absorption (households and resident intermediaries); (ii) household direct holdings of domestic government debt securities from the ECB Securities Holdings Statistics (SHSS), which isolates the household sector's direct bond portfolio.[1]

[1] In the one-asset model, B is the net supply of a *safe, liquid, non-contingent claim* (an "outside" asset) available to resident households for self-insurance. This object is conceptually closer to government liabilities absorbed domestically than to "liquid assets" broadly construed. Private liquid instruments such as deposits are typically inside liabilities within the domestic private sector and require an explicit banking sector (balance-sheet constraints and intermediation) to map into a coherent state variable. The model therefore captures a consolidated safe-asset-supply experiment rather than a literal statement that households directly hold all outstanding government bonds. Following Kaplan et al. (2018), B should be read as the aggregate supply of safe liquid wealth available to households, with government debt as the canonical outside safe asset.

Empirical facts. The paper provides new evidence on state-dependent fiscal multipliers using U.S. local-projection IV and a panel of OECD economies. For the U.S., I introduce state dependence by interacting identified government spending shocks with the lagged ratio of federal debt held directly by U.S. households relative to GDP—the measure closest to the model object: the stock of safe government claims held by households for self-insurance relative to economic size. The estimated output multiplier is systematically smaller when this household-holdings ratio is higher, with the high-minus-low gap negative at all horizons and economically large. Consumption exhibits the same qualitative pattern, consistent with the mechanism in which higher household bond holdings reduce aggregate marginal propensities to consume and attenuate fiscal transmission. I then turn to a panel of 17 OECD economies, using the domestic sovereign debt share as the state variable and narrative fiscal shocks of Guajardo et al. (2014) as instruments. The cross-country evidence delivers the same qualitative message: fiscal expansions are systematically less potent in high-domestic-debt-share states, with the attenuation most precisely estimated for private investment.

Cross-country data also speak directly to the household-liquidity channel. Using HFCS measures of hand-to-mouth (HTM) behavior and SHSS household direct holdings of domestic government debt securities, I document a robust negative relationship between domestic absorption of government liabilities and the share of constrained households, supporting the interpretation that the relevant state variable is the domestic stock of safe liquid claims available for household self-insurance.

A quantitative mechanism. To interpret these facts, I develop and calibrate a Heterogeneous Agent New Keynesian (HANK) model for the U.S. economy with a risk-free nominal asset in fixed net supply, issued by the government. Households face idiosyncratic income risk and incomplete markets; monetary and fiscal policy jointly determine the equilibrium real rate and the path of taxes/transfers that finance spending. The quantitative experiment raises the steady-state supply of safe nominal claims absorbed domestically and studies how the equilibrium response to a government spending shock changes with the level of B.

The mechanism operates through two conceptually distinct forces. First, a higher supply of safe liquid claims increases households' self-insurance and reduces the

mass of high-MPC households (the insurance, or distribution, channel). Second, and more fundamentally in general equilibrium, a higher level of domestic absorption changes equilibrium factor prices—most importantly the real interest rate—which shifts consumption-saving decisions at a given distribution (the factor-price, or policy-function, channel). Using sequence-space Jacobians, I provide a first-order decomposition of the change in aggregate MPC between low- and high-B steady states into these two primitives. In the calibrated economy, the factor-price channel accounts for the majority of the decline in aggregate MPC, while the distributional channel is smaller because additional safe assets are disproportionately held by already-wealthy, low-MPC households. Consistent with the empirical evidence, the model implies that higher safe-asset supply substantially lowers iMPCs and reduces fiscal transmission, while the decline in output multipliers is more modest because the bond-price channel primarily reshapes the timing and incidence of consumption responses rather than the impact response to a given spending path.

Contribution. This paper contributes to the growing reduced-form literature on state-dependent fiscal policy and fiscal space (e.g. Ilzetzki et al. (2013), Cho and Rhee (2023)) in three ways. First, it documents state dependence using household direct holdings of public debt as the U.S. state variable—the empirical counterpart closest to the model object B—rather than headline debt, and it shows that a broader domestic sovereign debt share delivers the same directional pattern in international panel data. Second, it documents a negative cross-country relationship between domestic absorption of government liabilities and household marginal propensities to consume, using HFCS and SHSS evidence, which directly supports the self-insurance mechanism. Third, it offers a unified quantitative account of the causal chain linking household safe-asset holdings to real interest rates, iMPCs, and fiscal multipliers within a data-consistent HANK framework, and it introduces a sequence-space decomposition that cleanly separates factor-price from distributional forces in aggregate MPC changes.[2]

[2]Government bonds as private liquidity are emphasized in classic work such as Woodford (1990) and Aiyagari and McGrattan (1998). The role of MPCs as sufficient statistics for fiscal transmission is developed in Auclert et al. (2024). This paper connects these insights by mapping the relevant safe-asset object to observable measures of domestic absorption and by quantifying the implied change in fiscal transmission across debt/liquidity states.

Literature. The concept of the fiscal multiplier, a summary statistic of the effectiveness of fiscal policy in stimulating economic activity, has been a subject of extensive research in macroeconomics. However, as highlighted by Ramey (2011) and Ramey (2019), there is no singular "fiscal multiplier." Instead, its magnitude can vary depending on several factors, including the type and size of policy change, economic conditions, and characteristics of the economy where the policy is implemented.

Woodford (1990) shows that public debt can act as a form of private liquidity. His idea challenges traditional views of government debt as a burden on future generations and instead suggests that it can serve as a valuable asset for private agents. He argues that government debt provides liquidity services to private agents by serving as a store of value and a means of payment. This liquidity function is crucial for facilitating transactions and smoothing consumption over time. He discusses the implications of his analysis for monetary policy. He suggests that central banks should consider the role of government debt in influencing liquidity conditions when formulating policy decisions. Aiyagari and McGrattan (1998) investigate the optimal quantity of government debt within a heterogeneous agent model framework, incorporating individual income risk, borrowing constraints, and precautionary savings. They challenge the traditional view that government debt should be minimized, demonstrating that a positive amount of government debt can enhance welfare by providing liquidity, thereby enabling better consumption smoothing for individuals facing income uncertainty. Their analysis highlights that the optimal debt level balances the benefits of liquidity against the costs associated with higher taxes needed to service the debt.

From the empirical side, recently Cho and Rhee (2023), using data from 24 OECD countries, find that fiscal policy is generally ineffective in high-debt economies but effective in low-debt economies, highlighting the importance of labor market stimulation for effective fiscal stimulus. Additionally, they show that aged economies experience negligible fiscal policy benefits regardless of debt levels, while non-aged economies benefit positively from fiscal policy in low-debt conditions but suffer negative effects in high-debt situations. Broner et al. (2022) explores the relationship between fiscal multipliers and the proportion of public debt held by foreign creditors. It posits that fiscal expansions can enhance domestic economic activity but may also

cause crowding-out effects if domestic consumption and investment decline due to debt acquisition. These crowding-out effects are mitigated when governments sell debt to foreign investors, leading to larger fiscal multipliers. Auerbach and Gorodnichenko (2012), McKay and Reis (2016), Ramey and Zubairy (2018) and Berge et al. (2021) further explore how the effectiveness of fiscal policy can vary depending on the economic environment, including the stage of development, exchange rate regime, and openness of the economy.

Bayer et al. (2023) explore how expansionary fiscal policy influences the liquidity premium—the difference in returns between public debt and less liquid assets. Using an estimated HANK model, the authors show that increased public debt enhances private-sector liquidity, thereby stabilizing fixed-capital investment. They further quantify the long-term impact of higher public debt, finding minimal crowding out of capital but a significant reduction in the liquidity premium, which raises the fiscal cost of debt. The study also indicates that the optimal level of public debt, which maximizes revenue, has increased to 60% of US GDP since 2010.

Brinca et al. (2016) and Brinca et al. (2021) analyze the size and variability of fiscal multipliers depending on various characteristics of the country. They find multipliers depend on the fraction of the population facing binding credit constraints and the economy's average wealth level. The study also reveals significant cross-country differences in multiplier effects due to variations in economic structures and fiscal positions. Antunes and Ercolani (2020) find that the tightening of the household borrowing constraint over time can substantially magnify the government spending multiplier by strengthening the negative wealth effect on labor supply induced by the fiscal stimulus. Gorton and Ordonez (2022) find that the supply of government bonds discourages information acquisition about the heterogeneous underlying qualities of private safe assets, improving their safety, crowding out the creation of private safe assets, but crowding in their safety. The optimal supply of government bonds should factor in the dual role of intra- and intertemporal smoothing and their impact on the quantity and safety of private assets. Moreover, the literature on state-dependent fiscal multipliers has emerged, aiming to elucidate how the effectiveness of fiscal policy varies under different economic conditions. Studies by Blanchard and Perotti (2002), Mountford and Uhlig (2009), Fernández-Villaverde et al. (2011), Ilzetzki et al.

(2013), Woodford (2011) and Eggertsson (2011) have contributed valuable insights into the determinants and implications of state-dependent fiscal multipliers. These works highlight the importance of accounting for economic conditions, nominal rigidities, and the zero lower bound on nominal interest rates in assessing the efficacy of fiscal policy measures.

Other recent studies have investigated fiscal multipliers within the context of HANK models. Broer et al. (2021) compare the implications of different sources of nominal rigidity on fiscal multipliers in a HANK framework, while Auclert et al. (2024) introduce intertemporal marginal propensities to consume as sufficient statistics of fiscal multipliers. Bellifemine et al. (2024) develop a multi-country HANK model of a monetary union with ex-ante heterogeneity in legacy public debt across member states to find that heterogeneity in fiscal space across members of a monetary union leads to unequal transmission of monetary policy and gives rise to a trade-off between stabilization and synchronization for monetary policy.

Outline The remainder of the paper is organized as follows. In section 2 I briefly show the empirical association between the level of public debt and state-dependent fiscal multipliers. Section 3 describes the HANK model and section 4 the respective calibration. In section 5 I discuss the results of the model. Section 6 presents the main theoretical contribution. Section 8 concludes.

2 Empirical Evidence

This section documents how fiscal multipliers vary with domestic absorption of public debt. I first present U.S. time-series evidence using quarterly data and the Ramey defense news instrument, with household direct holdings of federal debt as the state variable. I then present cross-country evidence for a panel of OECD economies, using the domestic sovereign debt share as the state variable and narrative fiscal shocks as instruments. The two exercises use different empirical implementations and different debt-exposure measures, but they point to the same qualitative conclusion: fiscal multipliers are lower when domestic absorption of government debt is higher.

2.1 U.S. data and empirical strategy

To study the U.S. relationship between household public-debt holdings and fiscal multipliers, I combine the U.S. time-series setup of Broner et al. (2022) with data on household direct holdings of federal debt. Full details on sources, variable construction, and transformations are reported in the data appendix.

I estimate state-dependent local projections following Jordà (2005), using government spending instrumented with the defense news shocks of Ramey and Zubairy (2018). The baseline specification is

$$\sum_{j=0}^{h} y_{t+j} = \alpha_h + \beta_{1h} \sum_{j=0}^{h} g_{t+j} + \beta_{2h} \left(\sum_{j=0}^{h} g_{t+j} \times d_{t-1} \right) + \sum_{k=1}^{K} \Gamma_{k,h} X_{t-k} + \varepsilon_{t+h}, \qquad (1)$$

where y is real output, g is government spending, and d_{t-1} is the lagged state variable. The U.S. state variable is the ratio of federal debt held directly by U.S. households to GDP. This measure is the closest empirical counterpart to the model object: the per-capita stock of safe government claims available for household self-insurance, scaled by potential output. Appendix A.2 shows that the qualitative pattern is robust to replacing this measure with broader domestic-absorption proxies, including the full resident-held debt ratio and the domestic share of total outstanding public debt.

The empirical design closely follows Broner et al. (2022). Government spending is normalized by potential GDP, the horizon is quarterly up to eight quarters, and the estimated coefficients are cumulative fiscal multipliers. The interaction term allows the cumulative multiplier to vary continuously with the level of household debt holdings. A continuous specification is used because, in the quarterly U.S. time series, discrete high-versus-low state splits are substantially less stable.

2.2 U.S. results

The main U.S. result is that fiscal multipliers are systematically smaller when household holdings of public debt relative to GDP are higher. Figure 1 reports the implied high-minus-low difference in the cumulative output multiplier from the continuous interaction specification. The estimated difference is negative at all horizons and grows with the horizon, indicating persistent state dependence in fiscal transmission.

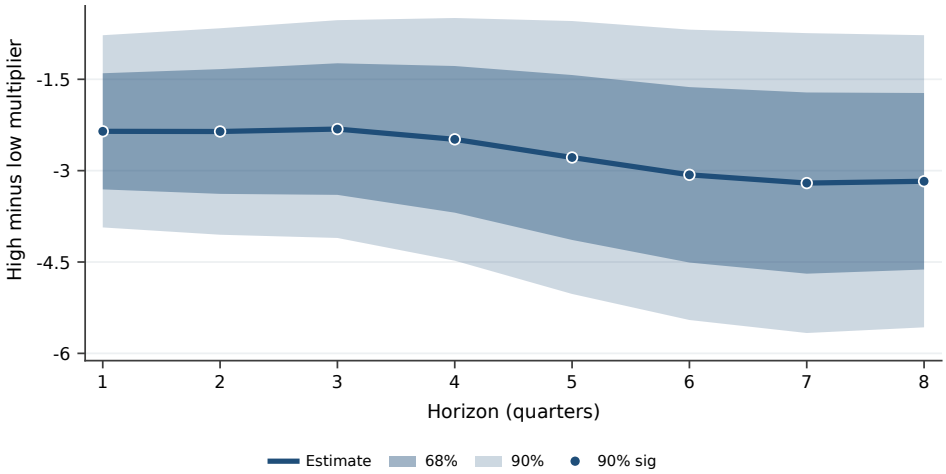


Figure 1: U.S. fiscal output multiplier: high minus low. The figure plots the difference in cumulative output multipliers evaluated at the 90th and 10th percentiles of the household-public-debt-to-GDP distribution. The state variable is federal debt held directly by U.S. households, normalized by GDP (Flow of Funds, 1953–2019). Estimation follows the continuous interaction LP-IV design of Broner et al. (2022), using Ramey defense news as the instrument and the exact Broner control set. A negative gap indicates that cumulative multipliers are smaller in high-household-debt states. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

The consumption response provides the key mechanism evidence. Figure 2 reports the corresponding high-minus-low difference for consumption. The gap is negative at all horizons, tracking the output result closely. This pattern is consistent with the model channel: when households hold more safe government claims, their self-insurance capacity is higher, aggregate marginal propensities to consume are lower, and fiscal spending shocks generate weaker demand responses.

Together, these two figures establish the main empirical fact motivating the quantitative analysis: fiscal multipliers are smaller in states with higher household public-debt holdings, and this attenuation is visible in both aggregate output and consumption. The household-holdings measure is the best available empirical counterpart to the model object B—the per-capita stock of safe government claims held by households for self-insurance. Appendix A.2 shows that the same directional pattern survives when the state variable is replaced by broader domestic-absorption proxies or by the Broner-style domestic share of outstanding sovereign debt.

2.3 Panel evidence

I next turn to a panel of 17 OECD countries over 1978–2014, using the international dataset and narrative fiscal shocks of Broner et al. (2022); Guajardo et al. (2014). I

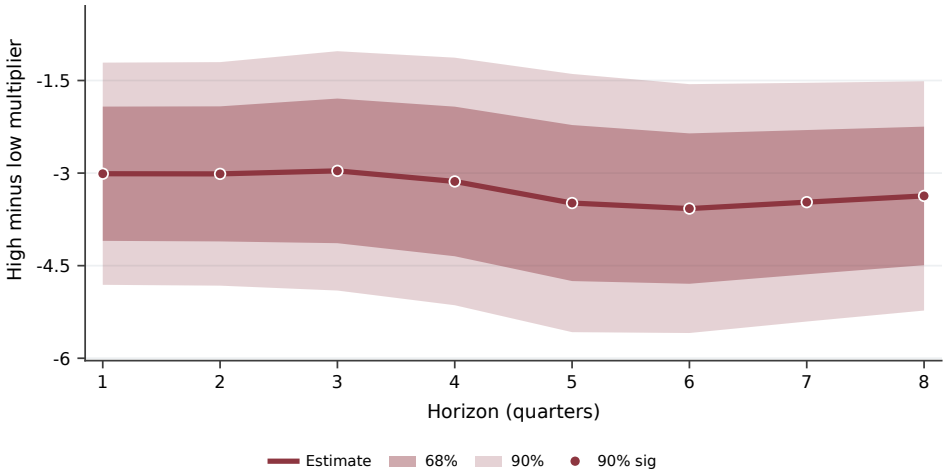


Figure 2: U.S. fiscal consumption multiplier: high minus low. The figure plots the difference in cumulative consumption multipliers evaluated at the 90th and 10th percentiles of the household-public-debt-to-GDP distribution. State variable, LP-IV design, and instruments are identical to Figure 1: federal debt held directly by U.S. households normalized by GDP, continuous interaction specification of Broner et al. (2022), Ramey defense news instrument. Consumption is measured as real personal consumption expenditures normalized by real GDP. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

estimate cumulative local projections with a one-step IV procedure, in the spirit of Ramey and Zubairy (2018), according to

$$\sum_{j=0}^{h} y_{i,t+j} = \alpha_{i,h} + \gamma_{t,h} + \beta_{1h} \sum_{j=0}^{h} g_{i,t+j} + \beta_{2h} \left(\sum_{j=0}^{h} g_{i,t+j} \times d_{i,t-1} \right) + \sum_{k=1}^{K} \delta_{k,h} X_{i,t-k} + \varepsilon_{i,t+h}, \tag{2}$$

where $g_{i,t}$ is the fiscal policy variable, $d_{i,t-1}$ is the lagged state variable, $\alpha_{i,h}$ are country fixed effects, and $\gamma_{t,h}$ are time fixed effects. The coefficients are cumulative fiscal multipliers rather than elasticities.

The panel exercise uses an annual dataset across 17 countries, so the empirical implementation differs from the U.S. in two respects: the state variable is the lagged domestic sovereign debt share,

$$\text{domshare}_{i,t-1} = \frac{\text{domestic sovereign debt}}{\text{total sovereign debt}},$$

rather than household direct holdings relative to GDP, and the state classification is discrete (top decile) rather than continuous. The discrete classification is preferred because it is empirically more stable in the annual cross-country data; a continuous-state analogue delivers the same directional pattern but with substantially wider confidence intervals.

Table 1 and Figure 3 summarize the preferred panel estimates for output. A clear pattern emerges: fiscal multipliers are systematically larger in low-domestic-debt-share states than in high-domestic-debt-share states at all horizons. The low-debt-share multiplier rises from 0.77 at horizon $h = 1$ to 1.34 at horizon $h = 4$, whereas the high-debt-share multiplier remains small and fairly flat, ranging between 0.05 and 0.19. The implied low-minus-high output gap is therefore positive throughout, taking values of 0.72, 0.39, 0.71, and 1.15 over horizons $h = 1, \ldots, 4$.

Table 1: Estimated cumulative multipliers for output. Rows: horizon × state (*linear* / *low* / *high* / *diff*). *diff* is the LP interaction coefficient $\hat{\beta}^{\text{high}} - \hat{\beta}^{\text{low}}$; negative values indicate a larger multiplier in the low-debt state. 90% confidence interval.

Horizon	State	Estimate	CI_{90} lower	CI_{90} upper
1	diff	−0.716	−1.396	−0.035
1	high	0.050	−0.289	0.389
1	linear	0.295	0.032	0.558
1	low	0.766	0.171	1.360
2	diff	−0.387	−1.011	0.236
2	high	0.242	−0.141	0.626
2	linear	0.414	0.075	0.754
2	low	0.630	0.098	1.162
3	diff	−0.712	−1.721	0.297
3	high	0.178	−0.347	0.704
3	linear	0.497	0.086	0.909
3	low	0.890	0.162	1.618
4	diff	−1.151	−2.734	0.432
4	high	0.192	−0.512	0.896
4	linear	0.555	−0.171	1.281
4	low	1.343	−0.057	2.742

The direction of state dependence is consistent across all horizons: fiscal multipliers are lower in high-domestic-debt-share states. Table 2 reports weak-identification diagnostics. First-stage strength varies across horizons, with the cleanest identification at medium horizons ($h = 3$). I focus on the medium-horizon results as the most credible and note that the directional pattern is robust throughout.

Averaging the low-minus-high output gap over horizons $h = 1$ through $h = 4$ gives a window-average gap that is positive and economically meaningful, reinforcing the persistent same-signed pattern across horizons.

To understand which expenditure components account for this state dependence, Table 3 and Figure 4 decompose the output gap into consumption, investment, and net exports. The most informative component in the panel is investment. The investment

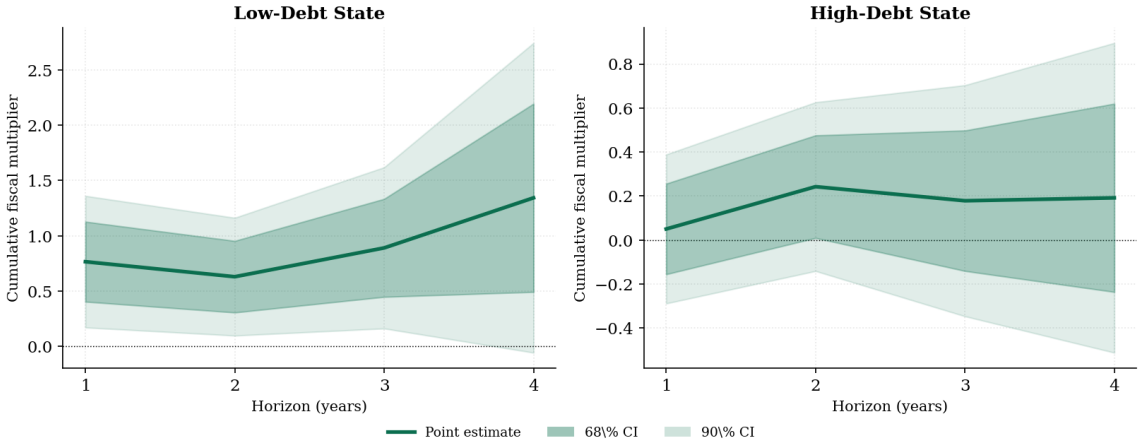


Figure 3: Fiscal output multipliers by domestic-debt-share state: 17-country panel. Cumulative output multiplier estimates from local projection IV, reported separately for high domestic-debt-share periods (top decile) and low domestic-debt-share periods. The state variable is the domestic share of outstanding sovereign debt (domestically held debt / total outstanding), with high-state observations defined as those in the top decile ($p90$) of the sample distribution. Preferred specification. Darker shaded bands denote 68% confidence intervals; lighter shaded bands denote 90% confidence intervals.

Table 2: Weak-identification diagnostics for the main panel specification. Kleibergen–Paap F-statistic for the interaction instrument; Stock–Wright F for the interaction term.

Horizon	KP F	SW F	Assessment
1	3.3	11.1	Weak — impact estimate interpreted cautiously
2	8.2	33.1	Borderline — directionally informative
3	10.9	33.7	Acceptable — cleanest identification horizon
4	7.4	18.2	Borderline — same-sign pattern, limited precision

Note: Full diagnostics across all specifications and components are in Appendix A.1.

multiplier is positive and economically large in both states, but substantially stronger in the low-debt-share state: the low-minus-high investment gap ranges from 0.97 on impact to 1.78 at horizon $h = 4$, and is statistically significant at the 90% level at both $h = 1$ and $h = 4$.

Taken together, the panel results confirm the same broad message as the U.S. evidence, using an independent dataset, a different instrument, and a different debt-exposure measure. Fiscal multipliers are lower when domestic absorption of public debt is higher. In the panel, the attenuation is most precisely estimated for investment, with a low-minus-high investment gap that is statistically significant and economically large at medium horizons. The output gap is also consistently positive across all horizons.

Together, the U.S. and cross-country results establish that reduced fiscal transmission in high-debt states is not a feature of U.S. institutional arrangements alone. It is

Table 3: State-dependent cumulative multipliers and low-minus-high gaps by component. Components: Output (Y), Investment (I), Consumption (C), Net Exports (NX). 90% confidence interval for the gap.

Horizon	Component	Low state	High state	Gap	CI_{90} lower	CI_{90} upper
1	Y	0.766	0.050	0.716	0.035	1.396
1	I	1.474	0.501	0.972	0.060	1.885
1	C	0.472	−0.068	0.540	−0.785	1.866
1	NX	−0.915	−0.082	−0.833	−1.872	0.207
2	Y	0.630	0.242	0.387	−0.236	1.011
2	I	1.510	0.959	0.552	−0.255	1.358
2	C	0.279	−0.043	0.321	−0.660	1.303
2	NX	−1.042	−0.403	−0.639	−1.592	0.314
3	Y	0.890	0.178	0.712	−0.297	1.721
3	I	2.194	1.035	1.159	−0.242	2.561
3	C	0.160	−0.139	0.299	−0.872	1.471
3	NX	−1.667	−0.526	−1.141	−2.538	0.256
4	Y	1.343	0.192	1.151	−0.432	2.734
4	I	2.931	1.150	1.781	0.475	3.087
4	C	0.268	−0.126	0.394	−1.311	2.099
4	NX	−1.763	−0.738	−1.025	−2.817	0.767

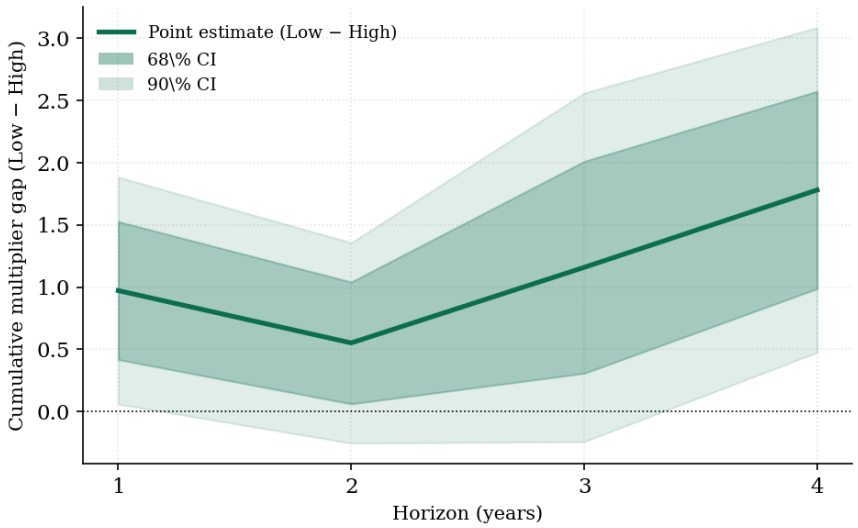


Figure 4: Investment multiplier gap, low minus high domestic-debt-share state: 17-country panel. Difference in cumulative investment multipliers between low and high domestic-debt-share periods; a positive value indicates larger investment multipliers in low-debt-share states. The state variable is the domestic share of outstanding sovereign debt, with the high state defined as the top decile ($p90$) of the sample distribution. Same LP-IV design and preferred specification as Figure 3. Darker shaded bands denote 68% confidence intervals; lighter shaded bands denote 90% confidence intervals.

a pattern that holds across OECD economies, with the strongest within-panel channel running through private investment. This motivates the quantitative analysis that follows.

3 Theoretical model

In this section, I describe the details of the quantitative framework used to study the economic response to a fiscal expansion shock for different levels of public debt. The model I propose to study this question is a Heterogeneous Agent New Keynesian (HANK) model, following Auclert et al. (2024) and McKay and Reis (2016). The model features sticky wages, flexible prices, a monetary authority that follows a standard Taylor rule, and a fiscal authority that can run a balanced budget, or finance itself with deficits.

3.1 Households

The economy is populated by a mass of heterogeneous agents that face idiosyncratic risk and aggregate uncertainty. At state s the household has a fixed transition matrix Π, and the mass of households in state s is equal to π_s, such that $\sum_s \pi_s e(s) = 1$. There exist n_e idiosyncratic states, and in any period t, agents transition between any two such states e and e' with exogenous probability $P(e, e')$. Each household decides how much to consume and save given their state. The felicity function of a household at time t depends on consumption, c_t and work time, N_t and it is given by:

$$U(c_t, n_t) = \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{\varphi n_t^{1+1/\eta}}{1+1/\eta} \tag{3}$$

where $\sigma > 0$ is the coefficient of relative risk aversion (so that the elasticity of intertemporal substitution is $1/\sigma$), φ governs the disutility of labor, and η is the inverse Frisch elasticity.

Households work the same number of hours, N_t, which is determined by the labor union, as in Erceg et al. (2000). The labor union setting is presented in section 3.3.

Recursive formulation of the household problem At any given time, a household is characterized by the vector (e, a). A union chooses for the agents the hours worked n_{it}. They pay taxes proportionally on their income. The household's optimization problem over consumption and future asset holdings recursively is defined as follows:

$$
\begin{aligned}
V_t(e_{it}, a_{it-1}) = \max_{c_{it}, a_{it}} & \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{\varphi n_t^{1+1/\eta}}{1+1/\eta} + \beta \mathbb{E}_t V_{t+1}(e_{it+1}, a_{it}) \right\} \\
\text{s.to} \quad & c_{it} + a_{it} = (1+r_t)a_{it-1} + \frac{W_t}{P_t} e_{it} N_t - \tau_t \\
& a_{it} \geq \underline{a},
\end{aligned} \tag{4}
$$

3.2 Firms

The firm setting is simple because the prices are flexible. There is a representative firm that follows an aggregate production function $Y_t = X_t N_t$ where X_t is the total factor productivity. This setting leads to flexible prices: $P_t = \frac{W_t}{X_t}$. The goods inflation is equal to the wage inflation minus TFP growth.

$$
\pi = \pi_w - (X_t - X_{t-1}) \tag{5}
$$

The real wage equals the marginal product of labor and the production function exhibits constant returns to scale, so there are no profits distributed to households. Sticky wages are preferred to sticky prices here because, in a HANK model, sticky prices generate strongly procyclical wages and countercyclical markups that create problematic redistribution between households with different wage and profit income shares. Under sticky wages, a positive demand shock raises prices and profits rather than wages, which is closer to the data and avoids these distributional complications.

3.3 Labor Unions

Following Auclert et al. (2024), and as in a standard New Keynesian model with sticky wages, household labor hours, n_{it}, are determined by union labor demand. A continuum of unions exists, k, and a different labor union settles each labor type wage. Firms use labor in their production function, which is a CES bundle of type-specific labor inputs. This is each union, k, aggregates efficient units of work into a union-specific task $N_{kt} = \int e_{it} n_{ikt} di$. At a given time each union asks their members to supply hours according to, $n_{ikt} = N_{ikt}$, and setting wages to maximize the average utility of households, taking as given their consumption-savings decisions. Setting a nominal wage, W_{kt}, involves a quadratic adjustment cost similar to the price

adjustment cost incurred by the firm:

$$\psi_t^w\left(W_{kt}, W_{kt-1}\right) = \left(\frac{\mu_w}{\mu_w - 1}\right)\left(\frac{1}{2\kappa_w}\right)\left[\log\left(W_{kt}/W_{kt-1}\right)\right]^2.$$

The union maximization problem leads to a Phillips curve[3] for wage inflation:

$$\pi_t^w = k_w\left(\phi N_t^v - \frac{\epsilon - 1}{\epsilon}\frac{W_t}{P_t}c_t^{-\sigma}\right) + \beta(\pi_{t+1}^w) \tag{6}$$

3.4 Monetary authority

The monetary authority follows a standard Taylor rule to set the nominal interest rate:

$$i_t = r_t^* + \phi_\pi \pi_t + \epsilon_t \tag{7}$$

where r_t^* is the optimal real interest rate, and ϕ_π is the inflation Taylor rule coefficient.

3.5 Fiscal Authority

The government issues bonds, B^g, sets a lump-sum tax τ_t, and spends on goods and services, G_t, in order to balance its budget constraint period by period:

$$\tau_t = (1 + r_t)B_{t-1} + G_t - B_t \tag{8}$$

This holds in steady-state when the budget is balanced, assuming lump-sum transfers adjust to keep the real debt stock constant. In the case of deficit-financed changes in spending, I assume that the following fiscal rule for lump-sum transfers:

$$\tau_t = T_{ss} + \phi_T\left(B_{t-1} - B_{ss}\right) + r_{ss} * B_{ss} + G_{ss} \tag{9}$$

where $\phi_T > 0$.

3.6 Stationary Equilibrium

Definition (Competitive Equilibrium). Given a distribution of agents D, the competitive equilibrium can be summarized as follows:

[3] See Appendix C for the derivation.

1. The value function $V(e,a)$ and the policy functions $c(e,a)$, and $a'(e,a)$ solve the household problem, given in (4), taking factor prices and initial conditions as given.

2. Firms optimize their decisions.

3. Labor union chooses wages maximizing its objective function.

4. The monetary authority follows the Taylor rule, described by Equation (7).

5. The government budget is balanced. The fiscal authority spends G_t, issues one-period nominal bonds B, and adjusts the level of taxes τ_t to balance its budget period by period $\tau_t = (1 + r_t)B_{t-1} + G_t - B_t$.

6. Asset markets clear, that is, total saving by households equals government bonds:

$$B^g = \int adD$$

7. Goods market clears when the final good is used for private and public consumption:

$$Y = \int cdD + G$$

3.7 Balanced-Budget vs. Deficit-Financed Government Spending

In this section, I contrast two fiscal financing regimes for a one-time, unexpected increase in government consumption G. The overall structure of the economy—households, firms, and monetary policy—remains identical across the two experiments. The difference lies in how the fiscal authority finances this increase in G and how it subsequently manages the path of public debt.

3.7.1 Balanced-Budget Regime

Under the *balanced-budget* regime, the government chooses period-by-period taxes τ_t so that it does not issue any net new debt in response to higher spending.[4]

[4]Equivalently, one can say that the government "keeps debt at its steady-state level" if the economy already has some positive B_{ss} in the baseline.

The government's per-period budget constraint in real terms is:

$$\tau_t \;=\; (1 + r_t)\, B_{t-1} \;+\; G_t \;-\; B_t, \tag{10}$$

with $B_t = B_{t-1}$ in a pure balanced-budget setting, so that τ_t adjusts each period to fully absorb spending changes.

Steady State. If government spending G_{ss} and debt B_{ss} are constant, the required tax burden simply covers the steady-state interest on B_{ss} plus G_{ss} itself.

After the Shock. Following a one-time shock that raises G_t by 1% relative to its steady-state level, taxes jump up immediately (since the government refuses to incur a new deficit). Consumption, therefore, tends to fall more sharply on impact (relative to the deficit-financed case), and private agents internalize the immediate increase in their tax burden. Debt shows little or no change from its steady-state path.

3.7.2 Deficit-Financed Regime

Under the *deficit-financed* regime, the government initially permits a rise in public debt to absorb most (or all) of the extra spending. Over time, taxes gradually adjust to bring the debt ratio back toward its steady-state target.

A convenient way to model this is to posit a fiscal rule for lump-sum taxes:

$$T_t \;=\; T_{ss} \;+\; \phi_T \left(B_{t-1} - B_{ss}\right) \;+\; r_{ss}\, B_{ss} \;+\; G_{ss}, \tag{11}$$

with $\phi_T > 0$ determining the speed at which taxes respond to deviations of debt from its steady-state level B_{ss}.[5] The law of motion for debt is then

$$B_t \;=\; (1 + r_t)\, B_{t-1} \;+\; G_t \;-\; T_t. \tag{12}$$

If ϕ_T is sufficiently small (or zero), the government initially finances most of the increase in G by issuing debt rather than raising current taxes. Over time, taxes rise

[5] I use a standard debt-feedback rule so taxes gradually stabilize debt. For stability in real terms, ϕ_T is chosen so that the linearized debt dynamics satisfy $|1 + r - \phi_T|$; in practice $\phi_T > r$ ensures mean reversion of real debt. I set $\rho_B \in (0, 1)$ as the persistence parameter governing how quickly the shock to G cumulates into B.

above T_{ss} to service and gradually retire the extra debt.

Interpretation of the Single Asset and Data Mapping The model contains a single nominal, risk-free asset B_t in exogenous net supply, issued by the government and held by domestic households. In the household problem, B_t is the only vehicle for intertemporal saving and is therefore best interpreted as the stock of safe, liquid claims that households can use to smooth consumption. In reality, households hold a portfolio of safe and liquid assets (government securities, bank deposits, money market funds, and other near-money instruments), and governments borrow from both domestic residents and foreigners.

The quantitative exercises in this paper should therefore be read as follows. First, I interpret B_t as the aggregate stock of safe, liquid assets available to domestic households, in the spirit of the one-asset HANK benchmark. Second, in the empirical analysis I proxy this object with resident-held public debt as a share of GDP, which is the most consistently measured cross-country component of domestic safe/liquid wealth. The thought experiment "increasing B_t and letting domestic households absorb it" thus corresponds to a joint rise in resident-held public debt and domestic liquid asset holdings, abstracting from the other components of households' financial portfolios.

3.8 Fiscal experiment and transition

The fiscal experiment I analyze in section 5 is a one-time increase in government consumption, G. I assume this increase in government consumption is an "MIT shock", i.e. an unpredictable and never-again-to-occur departure from the steady-state equilibrium. The analysis will be on the transition back to the steady-state along a perfect-foresight path, under the assumption that no shock will ever occur again.

For the main results of the paper, the financing rule is deficit-financed: the government covers the increase in G through borrowing and commits to gradually restoring the debt level by adjusting lump-sum taxes over time, following the fiscal rule in equation 9. Furthermore, taxes are chosen by the government such that public debt fully captures the government spending: $dB_t = \rho_B(dB_{t-1} + dG_t)$.[6] ρ_B is the degree de-

[6] I use the same parameter or persistence for the government debt as for the government expenditure.

termining the level of deficit financing: if $\rho_B = 0$, the policy keeps a balanced budget, while for greater ρ_B, the policy leads to a greater deficit.

3.9 Computational strategy and definition of fiscal multiplier

The model transition is solved using the sequence-space Jacobian method of Auclert et al. (2021), which computes equilibrium impulse responses by composing and inverting the linearized mappings between aggregate sequences. The fiscal experiment is a one-time shock to government spending that decays with persistence 0.9 (G_t rises by 1% of its steady-state value on impact and then gradually returns).

Given the IRFs I can then compute the fiscal multipliers. I define the impact multiplier generated by the model as:

$$\text{impact mult} = \frac{\Delta Y_0}{\Delta G_0}, \tag{13}$$

where ΔY_0 is the change in output from period 0 to period 1 and ΔG_0 is the change in government spending in the same time interval. The cumulative multiplier follows the same definition, but it is computed over a period of four horizons, i.e. the four periods after the shock.

4 Quantification

I calibrate the model to match the US economy with moments following the literature, in particular, Kaplan et al. (2018) and Auclert et al. (2024). I also report endogenously calibrated parameters, for the main calibrated benchmark economy. These remain fixed also when transitioning from one steady-state to another. All aggregate variables are in relation to GDP.

4.1 Preferences and Labor

I set the standard Frisch elasticity of labor supply to 1, in line with the literature. The disutility of work and the discount factor are among the parameters calibrated to match key moments in the data. Households have CRRA preferences with coefficient of relative risk aversion $\sigma = 2$, implying an elasticity of intertemporal substitution of

$1/\sigma = 0.5$, in line with Bayer et al. (2019). As standard in the literature, the levels of β and ϕ are calibrated to hit a target for the level of government bonds in the economy. For the standard calibration, β is 0.972 and the disutility of labor is 1.69.

4.2 Government and Monetary Policy

I set government spending, G, to 16% of GDP and government bonds, as in Auclert et al. (2020). I use the value of ρ_G as in Nakamura and Steinsson (2014), i.e., 0.9 at a quarterly frequency to calibrate the persistence of the government spending shocks. For monetary policy, I use the same parameters as in Auclert et al. (2020), that is, I set the response of the central bank to be equal to 1.5.

4.3 Other Parameters

The nominal rigidity of the New Keynesian Phillips Curve is set to be 0.1. Productivity and labor demand (when the economy is in full employment) are both set to 1. The factor prices (real interest rate and wage) are endogenously calibrated, for each calibration for the different levels of government debt. The Markov chain has 7 states, one for each income level. The asset grid has 500 points. The rest of the parameters are reported in appendix B.

5 Model results

I first characterize steady-state behavior through comparative statics, comparing the economy under low and high debt. I then present aggregate responses to an unexpected increase in government consumption under deficit financing, and examine how the size of fiscal multipliers varies with the level of public debt, following the empirical patterns in Section 2.

5.1 Comparative Statics and the Determination of the Interest Rate

To understand the aggregate responses of the economy following a fiscal shock, it is essential first to examine how the economy behaves in each steady state. Each steady state represents a different equilibrium configuration of the economy, characterized by

specific levels of government debt and associated macroeconomic variables. Suppose in steady-state the government follows a simple fiscal rule given by:

$$\tau = rB + G \tag{14}$$

In this framework, both B and G are treated as exogenous parameters. Government spending G is fixed and does not change across steady states, while the level of government debt B varies. In each steady state, the economy must satisfy the asset market clearing condition:

$$A(r) = B \tag{15}$$

where $A(r)$ represents the aggregate assets held by households, which depend on the real interest rate r. This condition ensures that the total assets supplied by households equal the government's demand for funds through debt issuance.

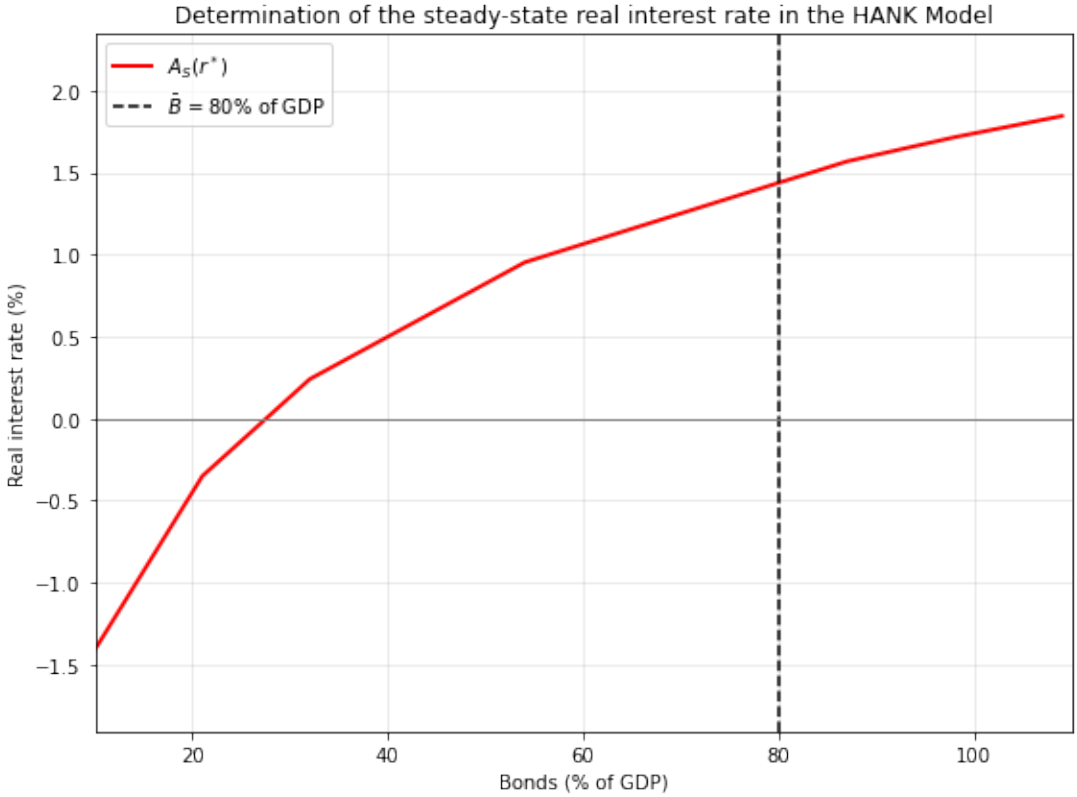


Figure 5: Determination of the interest rate in the HANK Model.

As explained also in Achdou et al. (2022) and in the parallel work of Campos et al. (2024), given market incompleteness, the stock of public debt determines how much

households can self-insure against negative idiosyncratic shocks and, therefore, the interest rate at which the savings market clears. As B changes, the real interest rate r adjusts endogenously to maintain market equilibrium. Specifically, an increase in government debt B leads to a higher demand for funds, necessitating an adjustment in r to equilibrate the asset market.

5.2 Steady State Analysis

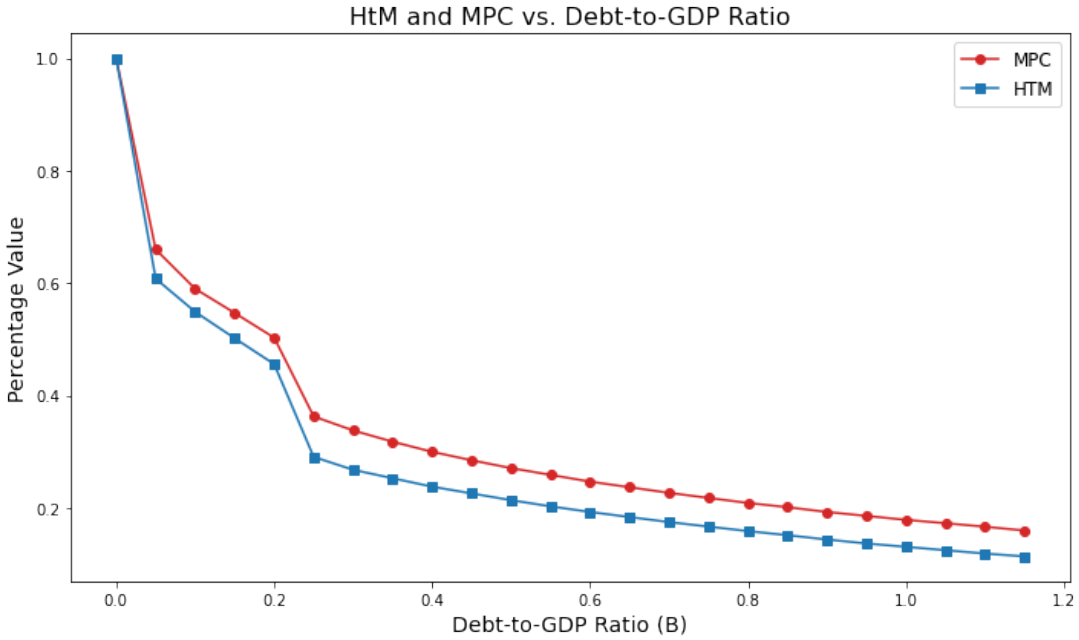


Figure 6: Changes of HtM households and aggregate MPC in the model.

Figure 6 shows the steady states model behavior with different levels of government debt. With higher public debt, the aggregate marginal propensity to consume of households decreases. This is related to the fact that the share of constrained agents (hand-to-mouth)[7] also declines. To construct steady states with different levels of public debt, I start from a benchmark calibration with government bond holdings held by U.S. households at the empirical target level. To do this, as explained in section 4.1, I choose the discount factors to hit the target of debt/GDP. This is the benchmark level of the economy. From here, I increase the level of debt/GDP, without changing any other parameter: what will adjust will be only the interest rate. The preferences are kept fixed, across all the experiments reported.

[7]The hand-to-mouth agents are computed as the agents at the borrowing constraint, not holding any amount of assets.

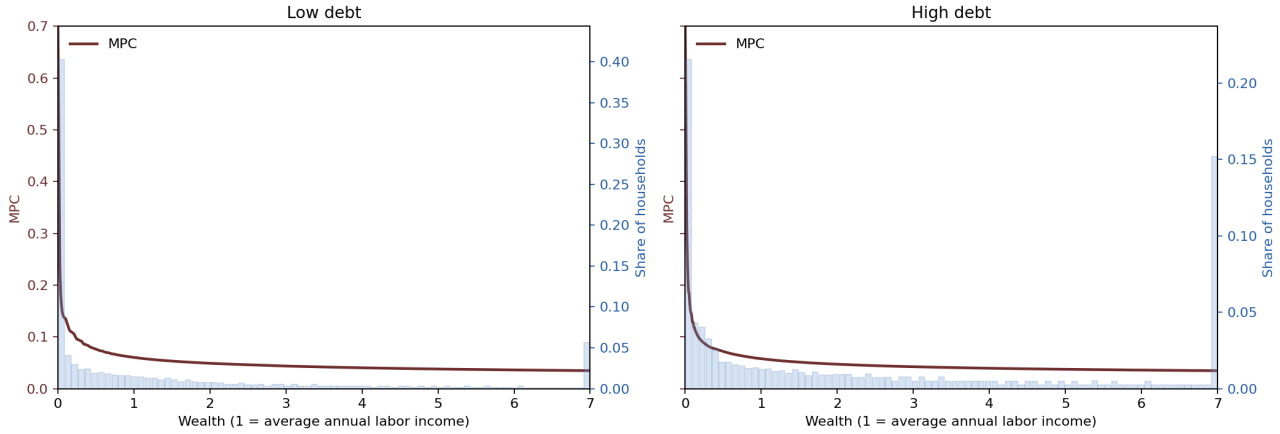


Figure 7: Wealth distribution and MPC by assets. Bars (right axis) plot the share of households in bins of liquid wealth, normalized by average annual labor income in each steady state. The line (left axis) is the unconditional MPC as a function of assets (income-averaged at each asset level). The high-debt economy features more mass at higher liquid wealth and a lower MPC(a), lowering the aggregate MPC.

Wealth reallocation and MPCs across steady states. Figure 7 documents how the wealth distribution and the consumption response vary with public debt. I normalize liquid wealth by average annual labor income within each steady state and plot the household mass across bins (right axis). Overlayed is the unconditional MPC as a function of assets, constructed by averaging individual MPCs across income states at each asset level (left axis). In the high-debt steady state, the distribution shifts to the right: households hold more liquid wealth, while the MPC schedule declines in assets. This composition shift toward wealthier, lower-MPC households compresses the aggregate MPC.

From composition to aggregation. Figure 8 shows the full distribution of quarterly MPCs. Relative to the low-debt economy, the high-debt distribution places more probability at low MPCs and less mass in the high-MPC tail. Together, the two figures demonstrate that higher debt lowers the aggregate MPC primarily through a reallocation of mass toward agents with greater liquidity.

These figures are relevant to understand the aggregate responses in the next section.[8]

[8]Note that no alternative calibration strategy can deliver high public debt and many constrained agents at the same time.

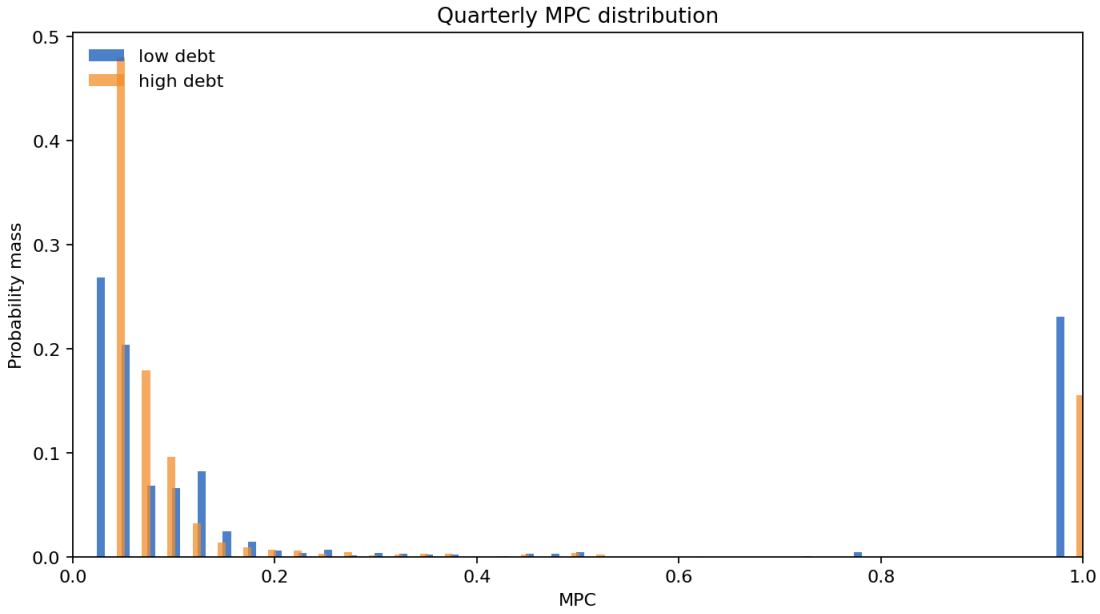


Figure 8: Distribution of quarterly MPCs: low vs. high debt. Bars show weighted probability mass by MPC bin. The high-debt steady state concentrates more mass at low MPCs and less in the upper tail, consistent with Fig. 7.

5.3 Aggregate responses

I consider a 1% increase in government consumption, fully financed by an increase in government debt of the same magnitude, so that the public debt stock B_t rises along the transition. Figure 9 shows that both impact and cumulative multipliers decline with the level of safe-asset supply. The size of the decline is somewhat smaller than the empirical high-minus-low gap, and the relationship is steeper at low debt/GDP ratios, as the kink in the figure suggests.

Figure 10 illustrates the impulse response functions of different aggregate variables: public and private consumption, output, after-tax income, labor demand, and government debt response.

Under the fiscal experiment explained in section 3.8, the impact fiscal multiplier is 0.81 when the level of public debt is 20 %, and it is 0.74 when the level of debt is 100 %. The cumulative multipliers in the first 4 quarters also change and are very close to the impact multipliers.

To understand the underlying mechanism it is crucial to focus on the marginal propensity to consume (MPC) of agents, as anticipated in the preceding sections. A higher level of debt translates to greater asset holdings and consequently, smaller MPCs among households. This diminished aggregate MPC leads to a lower aggregate

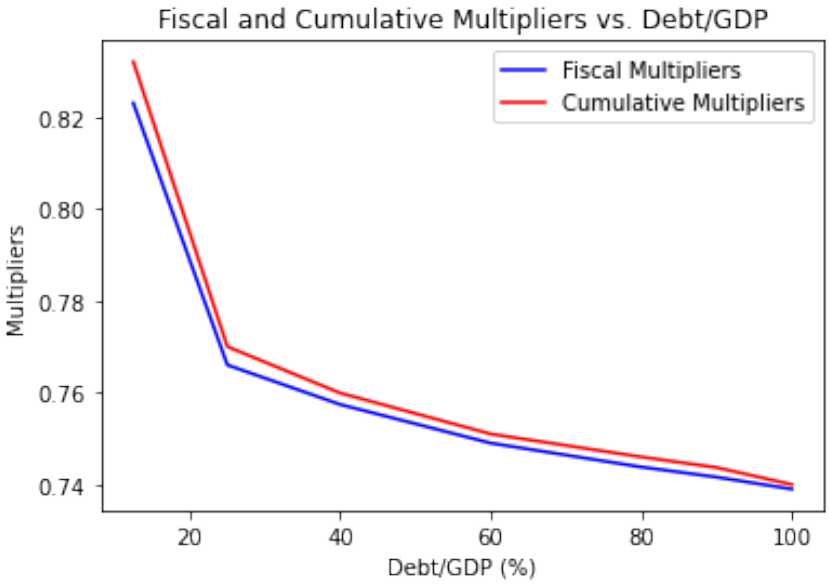


Figure 9: Plot of impact and fiscal multipliers for different levels of public debt in the HANK economy.

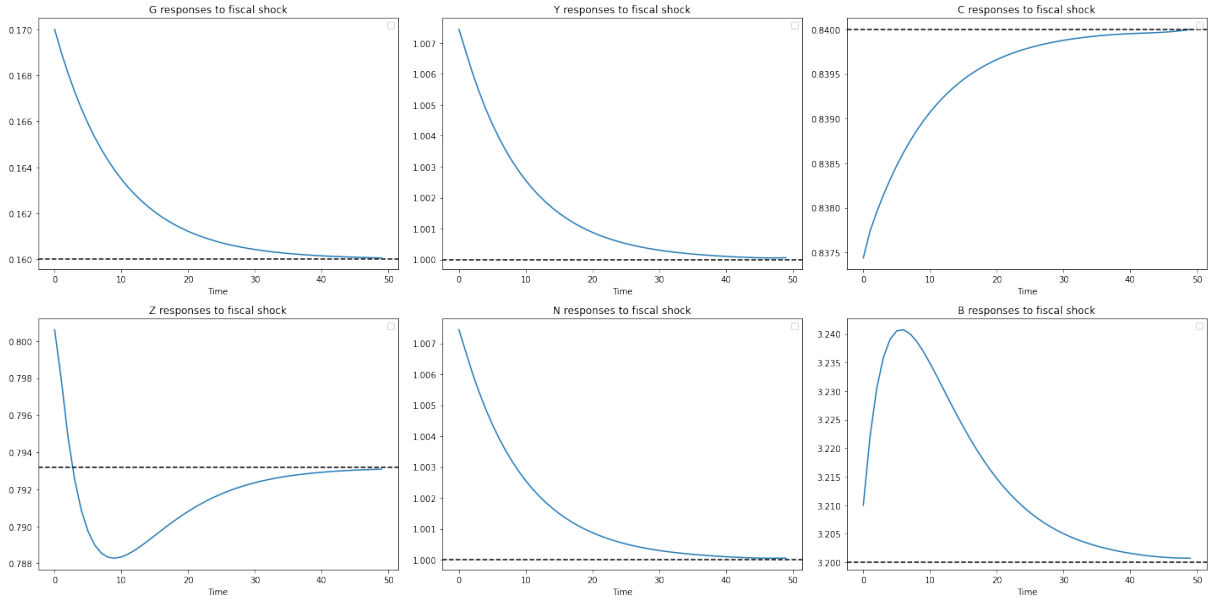


Figure 10: Impulse response functions for government expenditure, output, consumption, after-tax income, labor, and wage, for an economy with the 80% of debt/GDP ratio.

demand response following the shock, resulting in a weaker employment response. The impulse response functions reveal that following an increase in government expenditure financed by public expenditure, output levels are higher in scenarios with lower debt burdens. After the shock, lower debt prompts agents to exhibit more pronounced adjustments in their labor response, thereby driving a more substantial change in aggregate labor demand. As a result, wage levels rise more sharply. While the interest rate and wage initially rise post-shock, the adjustment is more pronounced in contexts with lower debt burdens, showing a stronger negative impact. This dy-

namic ultimately influences consumption behavior, with agents exhibiting a greater propensity to consume in instances of lower debt, amplifying the output response. These results show why the impact and cumulative fiscal multiplier are diminished in scenarios characterized by higher debt. Conversely, agents exhibit less reactive behavior in situations of heightened debt, as they rely on government debt as a buffer against aggregate shocks. Given their enhanced liquidity and reduced constraints, their behavioral adjustments are comparatively subdued.

5.3.1 Impulse Responses in the Two Regimes - Comparison

Figure 11 compares the impulse responses under the two regimes. In the *deficit-financed* case, government debt B_t rises sharply on impact, then gradually returns. Taxes adjust slowly, leaving consumption higher initially but inducing a more persistent decline as taxes eventually rise. By contrast, in the *balanced-budget* scenario,

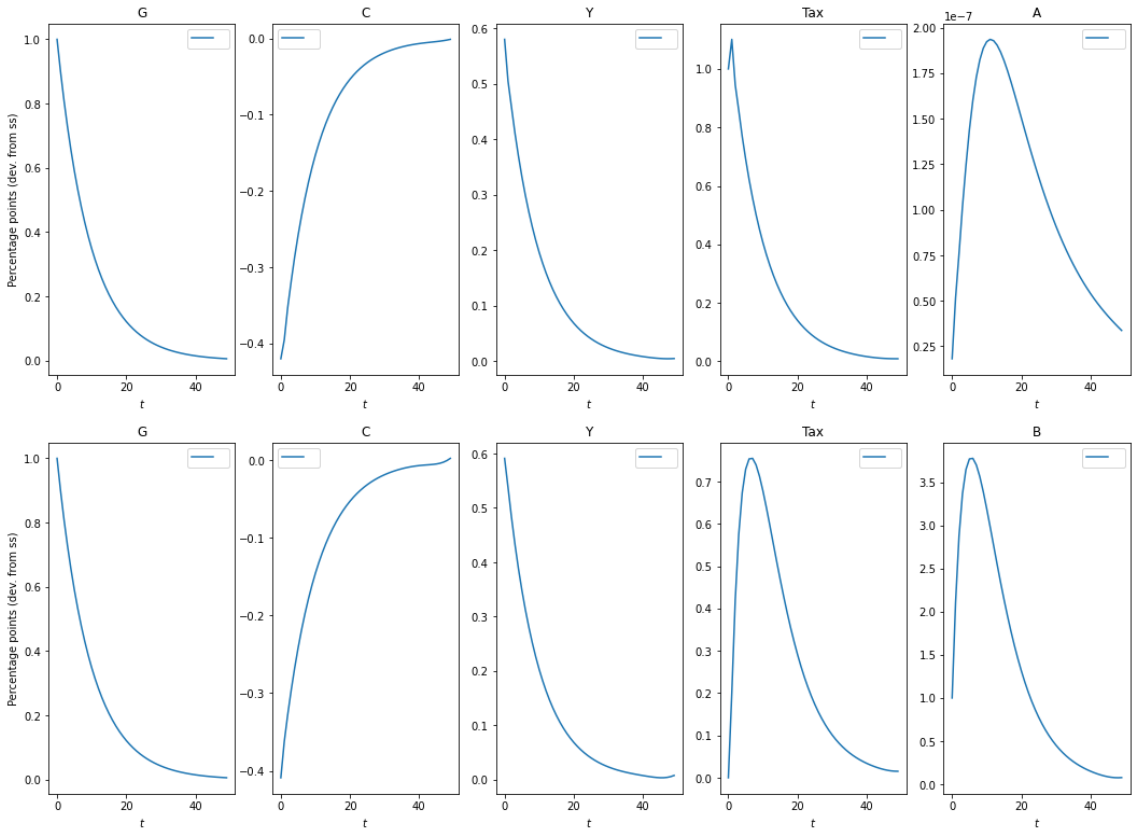


Figure 11: Impulse response functions for government expenditure, consumption, after-tax income, taxes, and assets/government bonds for an economy with the 40% of debt/GDP ratio. At the top (first row) is the one for the balanced-budget exercise; at the bottom (second row) is the one for the deficit-financed.

there is no large change in B_t, and taxes τ_t jump immediately to fund G_t. Consump-

tion thus drops more on impact, though the subsequent drag from increased taxes is shorter lived. Quantitatively, the deficit-financed shock produces a larger stimulus to aggregate demand and output in the short run, at the cost of higher future taxes and greater debt dynamics.

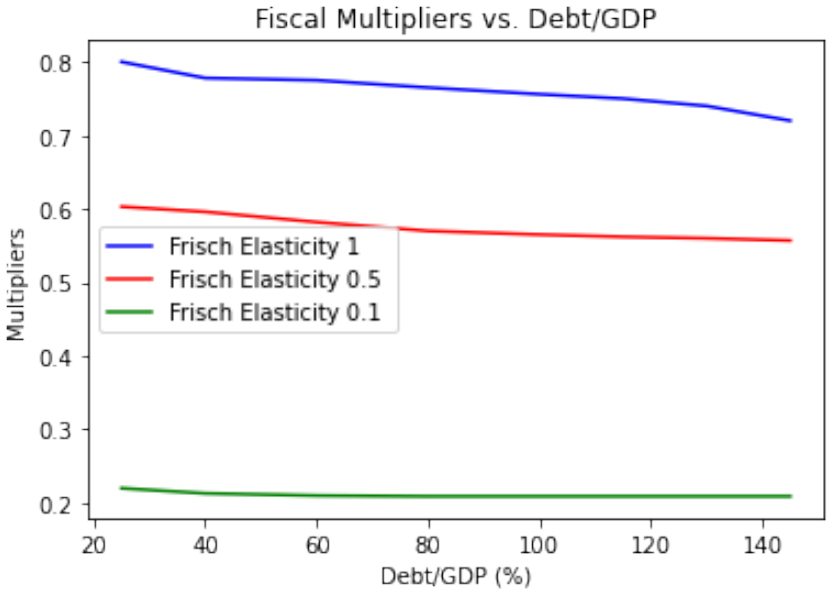


Figure 12: Sensitivity of the fiscal multipliers to the elasticity of the labor supply.

Stock versus Flow of Public Debt. A key aspect of the analysis is the distinction between the stock of public debt, captured by the calibration of different steady states, and the flow of debt resulting from fiscal expansions. In this model, the stock of debt is a predetermined state variable: different steady states correspond to different equilibrium levels of debt holdings by households, influencing real interest rates and marginal propensities to consume (MPCs) in a cross-sectional sense. These long-run levels of government debt shape the economic environment in which fiscal policy operates.

By contrast, the flow of debt is represented by the fiscal shock itself and the associated deficit-financed response—i.e., the temporary increase in government spending and the corresponding increase in government bonds issued along the transition. The model therefore separately identifies how the background debt environment (stock) conditions the impact of a new round of debt issuance (flow). This is key for understanding state-dependent fiscal multipliers: the same flow shock (fiscal impulse) yields different output responses depending on the initial stock of debt, precisely be-

cause the level of public debt influences both the interest rate and the consumption-saving decisions of households. This two-tier mechanism underpins the core mechanism of the paper and connects the empirical and theoretical parts in a unified framework.

5.3.2 A Classic Mechanism

Figure 12 shows a classic explanation of the mechanism from the literature on fiscal multipliers. Impact multipliers are computed in the model for different levels of Frisch, the parameter that determines the elasticity of labor supply. When the labor supply is fully elastic, the multipliers decrease by more, and there is a more accentuated slope in the diminishing behavior of the multipliers. The red line shows the same impact multipliers computed in the main exercise, as in figure 9. When the labor supply is inelastic, the multipliers do not change.

This confirms a channel already present in the literature, showing how labor supply elasticity matters for fiscal multipliers. However, from this analysis, it is still not possible to distinguish the main fundamental channel driving the results. I will study this in more detail in the next section.

6 Theoretical Results

This section provides the theoretical backbone for the quantitative results in Sections 3–5. I restate the Intertemporal Keynesian Cross (IKC) of Auclert et al. (2024) in an operator form that can be computed from the model's Jacobians. I then establish two general results: (i) a monotonicity lemma showing that, for nonnegative iMPC matrices, smaller iMPCs mechanically imply smaller multipliers for a fixed nonnegative primary-deficit impulse; and (ii) a decomposition of the aggregate (static) MPC with respect to the *stock* of public debt into a policy-function (factor-price) term and a distribution (insurance) term. These are mathematical identities under explicit regularity assumptions. Whether a given term dominates is a quantitative question answered in Section 5.

6.1 Intertemporal Keynesian Cross in operator form

Let $\mathbf{Y}, \mathbf{G}, \mathbf{T}$ denote bounded sequences of output, government purchases, and taxes, elements of $\ell_\infty(\mathbb{R})$. Let $\mathbf{M} : \ell_\infty \to \ell_\infty$ be a bounded linear operator that maps an *after-tax income* path into a consumption path. In (infinite) matrix notation, $\mathbf{M} = [M_{t,s}]_{t,s\geq 0}$, where $M_{t,s}$ is the intertemporal marginal propensity to consume (iMPC) from income at date s to consumption at date t.

In compact form, the IKC can be written as the fixed-point system

$$d\mathbf{Y} = d\mathbf{G} - \mathbf{M}\, d\mathbf{T} + \mathbf{M}\, d\mathbf{Y}, \tag{16}$$

where $d\mathbf{Y}$ is the path of output responses to the fiscal experiment $(d\mathbf{G}, d\mathbf{T})$.

[Stability and nonnegativity] $\mathbf{M}$ is bounded, has nonnegative entries (maps nonnegative sequences to nonnegative sequences), and satisfies $\rho(\mathbf{M}) < 1$, where $\rho(\cdot)$ denotes the spectral radius.

Proposition 1 (IKC solution and multiplier operator; cf. Auclert et al. (2024))**.** *Under Assumption G.1, for any bounded fiscal paths* $(d\mathbf{G}, d\mathbf{T})$*, equation* (16) *has a unique solution given by*

$$d\mathbf{Y} = (\mathbf{I} - \mathbf{M})^{-1}\Big(d\mathbf{G} - \mathbf{M}\, d\mathbf{T}\Big), \tag{17}$$

where the inverse is defined by the convergent Neumann series

$$(\mathbf{I} - \mathbf{M})^{-1} = \sum_{k=0}^{\infty} \mathbf{M}^k. \tag{18}$$

Define the IKC *multiplier operator* as

$$\mathcal{M}(\mathbf{M}) \equiv (\mathbf{I} - \mathbf{M})^{-1}. \tag{19}$$

For any fixed fiscal rule $(d\mathbf{G}, d\mathbf{T})$, the output response is therefore $d\mathbf{Y} = \mathcal{M}(\mathbf{M})\big(d\mathbf{G} - \mathbf{M}d\mathbf{T}\big)$, so the iMPC matrix $\mathbf{M}$ is a sufficient statistic for intertemporal fiscal transmission in the IKC sense.

Lemma 6.1 (Monotonicity of multipliers in the iMPC matrix)**.** *Let* $\mathbf{M}^{(1)}$ *and* $\mathbf{M}^{(2)}$ *be two nonnegative bounded operators on* ℓ_∞ *satisfying Assumption G.1. If* $\mathbf{M}^{(2)} \leq \mathbf{M}^{(1)}$ *element-*

wise, then for any $\mathbf{X} \in \ell_\infty$ *with* $\mathbf{X} \geq 0$ *elementwise,*

$$(\mathbf{I} - \mathbf{M}^{(2)})^{-1}\mathbf{X} \;\leq\; (\mathbf{I} - \mathbf{M}^{(1)})^{-1}\mathbf{X}, \tag{20}$$

componentwise.

Lemma 6.1 is purely algebraic: holding fixed a nonnegative net impulse $\mathbf{X}$, a smaller iMPC matrix (elementwise) implies a smaller output response. The subtlety in applying this to (17) is that the term $(d\mathbf{G} - \mathbf{M}d\mathbf{T})$ depends on $\mathbf{M}$. The next lemma isolates the role of $\mathbf{M}$ by rewriting the IKC in terms of the *primary-deficit* impulse $(d\mathbf{G} - d\mathbf{T})$.

Lemma 6.2 (IKC rewritten with the net primary impulse)**.** *Under Assumption G.1, the IKC solution can be rewritten as*

$$d\mathbf{Y} = (\mathbf{I} - \mathbf{M})^{-1}\big(d\mathbf{G} - d\mathbf{T}\big) + d\mathbf{T}. \tag{21}$$

[When does "smaller iMPC" imply "smaller multiplier"?] Equation (21) shows that $\mathbf{M}$ enters only through the multiplier operator applied to the *net primary impulse* $(d\mathbf{G} - d\mathbf{T})$. Hence, if $(d\mathbf{G} - d\mathbf{T}) \geq 0$ elementwise and $d\mathbf{T}$ is held fixed across counterfactuals, then Lemma 6.1 delivers an unambiguous monotone comparative static: an elementwise smaller $\mathbf{M}$ yields a weakly smaller $d\mathbf{Y}$. Without a sign restriction on $(d\mathbf{G} - d\mathbf{T})$, or if $d\mathbf{T}$ changes across regimes, the sign need not be pinned down by algebra alone.

6.2 Debt and multipliers: conditional comparative statics

To link the level of resident-held government debt B to multipliers, one needs to understand how the iMPC matrix $\mathbf{M}(B)$ moves with B and how the fiscal rule translates a spending shock into a path for $(d\mathbf{G}, d\mathbf{T})$. Propositions 1–6.2 and Lemma 6.1 provide the general mapping, but do not by themselves pin down the sign of the effect of B on multipliers. The next assumptions isolate a conditional statement.

[Fixed fiscal paths and nonnegative primary impulse] Consider two steady states that differ only in B and evaluate the same fiscal experiment with paths $(d\mathbf{G}, d\mathbf{T})$ such that $(d\mathbf{G} - d\mathbf{T}) \geq 0$ elementwise.

[Monotone iMPC matrix in debt (verified numerically)] Let $\mathcal{B}$ be an ordered set of admissible debt levels. For any $B_H > B_L$ in $\mathcal{B}$, the associated iMPC matrices satisfy

$$\mathbf{0} \leq \mathbf{M}(B_H) \leq \mathbf{M}(B_L) \quad \text{elementwise,} \tag{22}$$

with strict inequality for at least one entry.

Proposition 2 (Conditional effect of debt on multipliers)**.** *Suppose Assumptions G.1, 6.2, and 6.2 hold. Then, for $B_H > B_L$,*

$$d\mathbf{Y}(B_H) \;\leq\; d\mathbf{Y}(B_L) \quad \textit{componentwise,}$$

where $d\mathbf{Y}(B)$ denotes the IKC solution (21) evaluated at $\mathbf{M}(B)$. In particular, impact and cumulative spending multipliers computed from $d\mathbf{Y}(B)$ are weakly smaller in the high-debt steady state.

Assumption 6.2 is not a general theorem of HANK models; establishing elementwise monotonicity of $\mathbf{M}(B)$ analytically in a fully dynamic incomplete-markets GE environment is intractable. In this paper, it is treated as a disciplined qualitative hypothesis and is verified numerically using the model's Jacobian/iMPC objects (see Appendix 6.5).

6.3 Aggregate (static) MPC and its decomposition in B

I now turn to the relationship between public debt and the *aggregate static MPC* in a heterogeneous-agent environment. The goal is to separate the effect of B operating through changes in policy functions (mainly via factor prices such as the real rate) from the effect operating through changes in the stationary distribution of household states.

Let $(a, e) \in \mathcal{A} \times \mathcal{E}$ denote liquid assets and idiosyncratic earnings states. For each B in a set $\mathcal{B}$, assume there exists a stationary equilibrium with: (i) equilibrium factor prices and fiscal variables (including $r(B)$ and any steady-state tax objects), (ii) household policies $c_B(a, e)$, and (iii) a stationary distribution Ψ_B over (a, e) consistent with those policies.

[Regularity for differentiating aggregate objects] The mapping $B \mapsto c_B(a,e)$ is differentiable for almost every (a,e) and the mapping $B \mapsto \Psi_B$ is differentiable in the sense that there exists a signed measure Ψ'_B such that, for any bounded measurable f, the map $B \mapsto \int f\, d\Psi_B$ is differentiable with derivative $\frac{d}{dB}\int f\, d\Psi_B = \int f\, d\Psi'_B$. Moreover, derivatives can be interchanged with integration for the objects defined below (a dominated convergence condition).

[Individual and aggregate MPC] For each B, define the individual MPC at state (a,e) as

$$\mathrm{MPC}_B(a,e) \equiv \frac{\partial c_B(a,e)}{\partial y}, \tag{23}$$

where y denotes *disposable* (after-tax) income under the income perturbation used to measure MPC. Define the aggregate MPC as

$$\mathrm{MPC}_{agg}(B) \equiv \int_{\mathcal{A}\times\mathcal{E}} \mathrm{MPC}_B(a,e)\, d\Psi_B(a,e). \tag{24}$$

Lemma 6.3 (Derivative decomposition of $\mathrm{MPC}_{agg}(B)$)**.** *Under Assumption G.1,*

$$\frac{d}{dB}\mathrm{MPC}_{agg}(B) = \underbrace{\int \frac{\partial\, \mathrm{MPC}_B(a,e)}{\partial B}\, d\Psi_B(a,e)}_{\textit{policy-function / factor-price term}} + \underbrace{\int \mathrm{MPC}_B(a,e)\, d\Psi'_B(a,e)}_{\textit{distribution / insurance term}}. \tag{25}$$

Lemma 38 is an identity: it holds regardless of the sign or size of either term. It formalizes the decomposition used in the quantitative analysis. Importantly, the distribution term does *not* vanish in general: the stationary distribution typically moves at first order when primitives (including B) change. Whether the MPC-weighted distribution term is small is a quantitative, model-specific result.

A related decomposition, which matches exactly what is computed when comparing two steady states, is the following two-point identity.

Lemma 6.4 (Two-point decomposition (add-and-subtract identity))**.** *Let* (MPC^L, Ψ^L) *and* (MPC^H, Ψ^H) *be two steady states (e.g. low vs. high debt). Then*

$$\mathrm{MPC}^H_{agg} - \mathrm{MPC}^L_{agg} = \underbrace{\int \left(\mathrm{MPC}^H - \mathrm{MPC}^L\right) d\Psi^L}_{\textit{policy-function / factor-price}} + \underbrace{\int \mathrm{MPC}^H\, d(\Psi^H - \Psi^L)}_{\textit{distribution / insurance}}. \tag{26}$$

Corollary 6.4.1 (Shapley (symmetric) decomposition)**.** *Define the "policy" and "distribu-*

tion" contributions as the average of the two evaluation orders:

$$\Delta^{pol} \equiv \tfrac{1}{2}\int (\mathrm{MPC}^H - \mathrm{MPC}^L)\, d\Psi^L + \tfrac{1}{2}\int (\mathrm{MPC}^H - \mathrm{MPC}^L)\, d\Psi^H, \qquad \Delta^{dist} \equiv \tfrac{1}{2}\int \mathrm{MPC}^H\, d(\Psi^H - \Psi^L) +$$

Then $\mathrm{MPC}^H_{agg} - \mathrm{MPC}^L_{agg} = \Delta^{pol} + \Delta^{dist}$.

6.4 Why the stationary distribution cannot be "invariant" in B

The following observation clarifies why statements such as "$\partial \Psi_B / \partial B = 0$ at first order" cannot hold literally in equilibrium when B is pinned down by asset-market clearing.

Lemma 6.5 (Market clearing implies first-order movement of Ψ_B)**.** *Suppose the stationary distribution Ψ_B satisfies the asset-market clearing condition*

$$\int_{\mathcal{A}\times\mathcal{E}} a\, d\Psi_B(a,e) = B. \tag{27}$$

If $B \mapsto \Psi_B$ is differentiable in the sense of Assumption G.1, then its derivative Ψ'_B satisfies

$$\int_{\mathcal{A}\times\mathcal{E}} a\, d\Psi'_B(a,e) = 1. \tag{28}$$

In particular, Ψ'_B cannot be the zero measure.

Lemma 6.5 does *not* contradict the quantitative finding that the MPC-weighted distribution term in (25) is small in the calibration: it only rules out a general theoretical claim that distributional shifts are second order. The smallness of the MPC-weighted distribution term is instead interpreted quantitatively: in the calibrated economy, marginal debt is absorbed disproportionately by low-MPC households, so the reweighting term is small even though the first moment of Ψ_B moves one-for-one with B.

6.5 Matrix-level analogue (IKC-relevant decomposition)

The IKC depends on the *intertemporal* object $\mathbf{M}(B)$ rather than on the static impact MPC alone. For a given steady state, define the iMPC (Jacobian) matrix

$$\Lambda_{t,s}(B) \equiv \frac{\partial C_t}{\partial Z_s}\bigg|_{\text{prices fixed at SS}(B)}, \qquad t,s = 0,\ldots,T-1, \tag{29}$$

where Z_s is a (small) one-time disposable-income perturbation at date s and prices are held fixed at their steady-state values associated with B (as in the computational IKC/Jacobian construction). Entry-by-entry, the two-point decomposition in Lemma 6.4 applies to $\Lambda_{t,s}(B)$ once one writes each entry as an aggregation of micro responses under Ψ_B (see Appendix G).

6.6 Distribution or factor prices?

From a theoretical point of view, it is relevant to have a new-Keynesian setting featuring heterogeneous agents to study the implications of fiscal policy. Auclert et al. (2024) show how HANK matters for fiscal policy, and how this is different from RANK.[9] One primitive unsolved question is whether this difference in the fiscal multipliers depends on the distribution of assets or factor prices. The theory presented above shows these might be two ways to explain the heterogeneous state-dependence of fiscal multipliers, leading to the impulse response function response seen in the quantitative section. These two channels can each explain part of the state-dependent pattern. The insurance (distribution) channel operates through the fact that households hold more assets, reducing the share of constrained agents. The factor-price (bond-price) channel operates through higher real interest rates, which shift consumption-saving decisions at every point in the distribution. To quantify the relative importance of each channel, I propose a first-order decomposition: I compare the economy's response under the high-debt policy functions but the low-debt distribution, and vice versa, to isolate how much of the MPC change is attributable to each force. Moving from a stationary point to the other one, where there is more debt, there is more liquidity in a steady state. People prefer higher interest rates; the level of debt affects

[9] This is not true for monetary policy. Kaplan et al. (2018) show how for monetary policy in the aggregate, a RANK captures the same aggregate effects of a HANK model.

the level of the real interest rates and consequently affects household consumption policy function, but also the stationary distribution of households. Potentially there might be two different channels. One depends on the stationary distribution, which changes: the government issues more debt, and there are fewer hand-to-mouth agents in the economy because they are more insured by the additional liquidity they hold. The other one depends on the bond-price channel: issuing more debt, interest rates increase, making consumption more costly. After a fiscal shock, the response will be fully captured by the labor supply response of agents that will be moving and generate different responses in output. In a RANK economy, the change is fully captured by changes in the policy functions, but in HANK, changes in the wealth distribution are also expected. So given this double potential channel, the question is what is generating this response in this HANK economy?

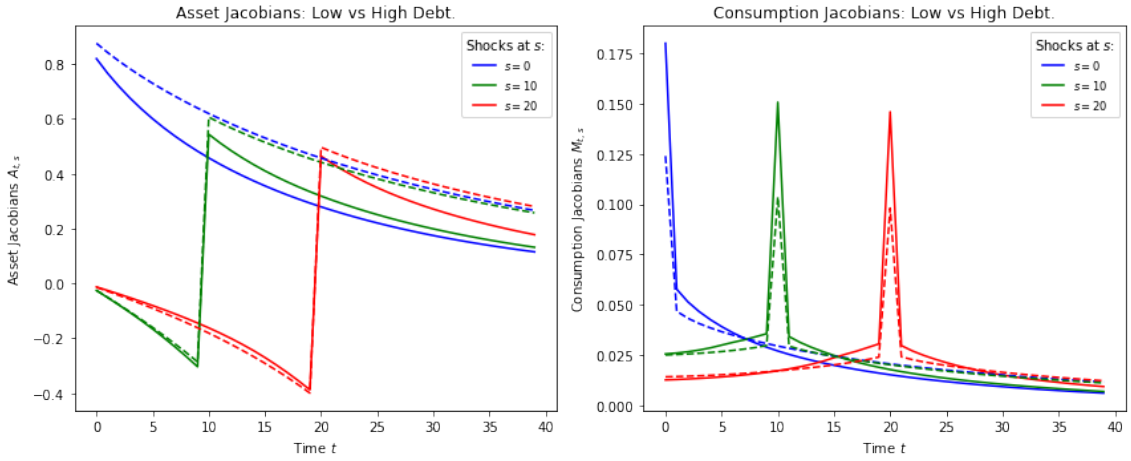


Figure 13: Assets and consumption Jacobians for income, of the two economies with low and high debt (solid line economy with low-debt, dashed line for the high-debt economy).

Figure 13 shows the consumption and asset Jacobians for income at shock horizons 0, 10, and 20 quarters (all variables at quarterly frequency). For a given pair (t, s), the Jacobian captures the response at date t to an income shock at date s. The shape is standard for a one-asset HANK model—agents dissave ahead of the shock and accumulate afterward—but the level of the Jacobian differs visibly between the low- and high-debt economies.

The decomposition evaluates outcomes under the factor prices of each steady state applied to the distribution of the other. After obtaining the policy functions and stationary distribution for each debt level, I decompose to first order the changes in aggregate MPCs across steady states. The result is that MPCs are primarily driven

by changes in the real rate, rather than by changes in the wealth distribution per se: the bond-price channel explains the dominant share of the MPC decline, while the insurance channel contributes a smaller fraction.

Lemma 6.6. *Changes in factor prices, affect individual MPC, leading to substantial changes in the fiscal multiplier, whereas changes in the wealth distribution $\Psi(a,e)$ have a limited impact on the aggregate MPC and fiscal multiplier.*

Considering the change in the level of government bonds B, the total variation of the aggregate MPC can be decomposed into two parts:

$$\frac{d}{dB}(\text{MPC}) = \underbrace{\int_{\mathcal{A}\times\mathcal{E}} \frac{\partial \text{MPC}(a,e)}{\partial B}\,\Psi(a,e)}_{\text{Factor-Price Channel}} + \underbrace{\int_{\mathcal{A}\times\mathcal{E}} \text{MPC}(a,e)\,\frac{\partial \Psi(a,e)}{\partial B}}_{\text{Insurance Channel}}$$

The changes in B affect individual MPCs through factor prices, while the wealth distribution effect at first order is negligible.

Proposition 1 establishes that Jacobians and the iMPC matrix are sufficient statistics for intertemporal fiscal transmission. Lemma 6.6 implies that the factor-price channel is the dominant force behind the decline in state-dependent multipliers: households respond primarily to the change in real interest rates, rather than to the change in wealth holdings.[10]

The consumption Jacobians reflect how households' consumption responds over time to an income impulse. By re-weighting the distribution or the policy function, I isolate how much of the consumption-income sensitivity is from bond-price changes contrary to the wealth distribution changes. Figure 14, shows the consumption–income Jacobians at three shock horizons (0, 10, 20 quarters). The left panel demonstrates that re-weighting the new (high-debt) distribution on the old (low-debt) policy function produces almost no shift in consumption responses relative to the baseline. By contrast, the right panel shows that changing the policy function-i.e., adopting the factor prices from the high-debt scenario–significantly alters consumption responses. Hence, I conclude that *factor-price changes*, not purely shifts in $\Psi(a,e)$, are what primarily drive the changes in the MPC and thus the fiscal multiplier.

[10] See Appendix G for the formal derivation.

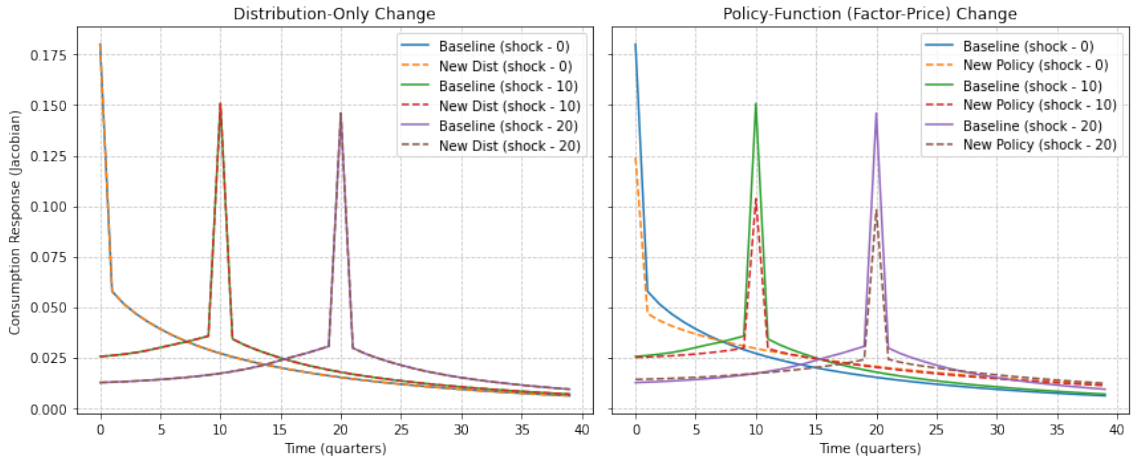


Figure 14: Consumption Jacobians for income: on the left, two economies with low and high debt (solid line economy with low-debt, dashed line for the high-debt economy) and same rates. On the right, the same debt (benchmark level) for both economies, but different rates.

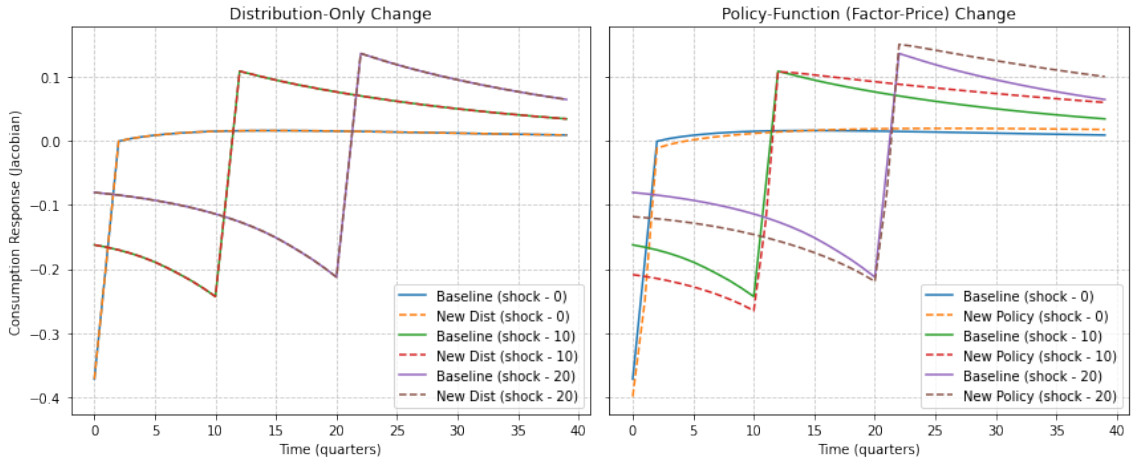


Figure 15: Consumption Jacobians for the interest rate: on the left, two economies with low and high debt (solid line economy with low-debt, dashed line for the high-debt economy) and same rates. On the right, the same debt (benchmark level) for both economies, but different rates.

Why the insurance channel is small? When public debt rises the economy must absorb the extra government bonds while keeping the asset market in equilibrium. In the high-debt steady state this absorption occurs almost entirely through the portfolios of the already-wealthy, low-MPC households. The decile-level decomposition shows that only 0.3 percent of the probability mass migrates toward higher-asset bins, and that migration takes place in cells whose individual MPCs are well below 0.25. Because the mass that moves is tiny and the MPCs attached to it are low, the insurance term contributes just –0.02 to the total Δ MPC = –0.093, i.e. about one quarter of the overall effect. By contrast, the 45 bp increase in the real rate tilts every consumption policy function, delivering the remaining three quarters via the factor-price channel.

The result is therefore structural, not mechanical. High-MPC households do not

end up holding the marginal unit of public debt precisely because they spend additional income on impact; wealth therefore continues to be concentrated in the low-MPC tail, muting the re-weighting effect. To demonstrate that the insurance channel can be powerful under a different redistribution, one can run a counterfactual experiment that shifts only 1 percent of aggregate wealth from the richest to the poorest decile while keeping policy functions fixed; this single transfer raises the aggregate MPC by +0.01—roughly half the magnitude of the total debt-induced change studied before.

Who buys the extra government bonds? When the government issues more debt, the asset market has to clear. In general equilibrium the new bonds end up in the portfolios of households that already save a lot—those with plenty of liquid wealth and therefore very low marginal propensities to consume (MPCs). High-MPC households could have bought them, but whenever they get extra income they spend most of it right away, so they never accumulate enough assets to absorb the new supply. The endogenous redistribution of wealth due to high debt, barely moves the average MPC because the mass of people switching asset positions is tiny (a few-tenths of a percent of the population) and they sit in the low-MPC tail, so the re-weighting of the cross-section (the insurance channel) hardly changes the aggregate MPC—only about one-quarter of the total effect in our baseline.

The aggregate MPC is moved by the higher public debt, which pushes the equilibrium real rate up. A higher r affects the policy function of every household, rich and poor. Low-MPC, high-wealth households save even more because the return is higher. High-MPC, hand-to-mouth households also reduce current consumption a bit, because postponing a euro now yields a larger payoff tomorrow. Since this bond-price change applies to the whole distribution—especially the numerous high-MPC households—it has a big impact. That's why the bond-price channel explains roughly three-quarters of the drop in the aggregate MPC. Overall, the small insurance effect is not a universal result; it is specific to the way the equilibrium absorbs extra debt. But given that absorption pattern, the real-rate change is what dominates the aggregate consumption response.

7 Cross-country link between MPCs and bond holdings

Micro–survey evidence suggests that households in high-debt countries tend to hold a larger share of their wealth in government bonds. If those bonds provide liquidity for self-insurance, the theory in Sections 3–6 implies a lower marginal propensity to consume (MPC) out of windfall income. [11]

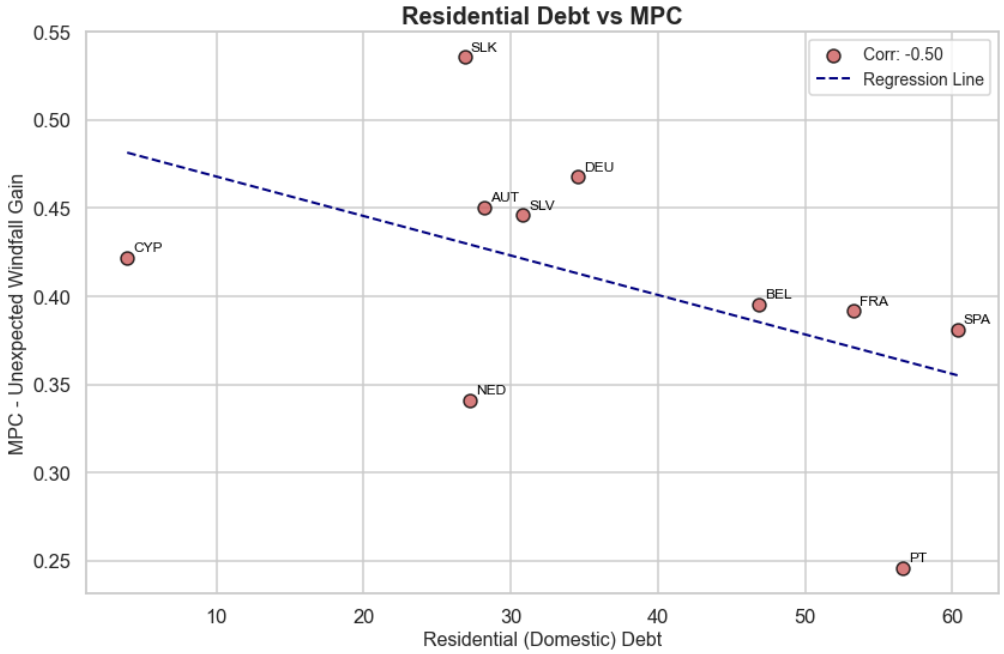


Figure 16: Residential debt and household MPCs, 2020. Each point is one euro-area economy; the dashed line is the OLS fit. The slope is statistically different from zero ($p < 0.05$) and implies that a 10-percentage-point increase in resident-held debt is associated with a 2-point decline in the average MPC.

Figure 16 shows a clear negative relationship (correlation -0.50) between resident-held public debt and the MPC out of an unexpected gain. Countries such as Portugal and Spain, where households hold large quantities of domestic bonds, display average MPCs below 0.30, whereas Cyprus or Slovakia—low-debt countries—exhibit MPCs above 0.40.[12]

The cross-sectional pattern mirrors the time-series and panel evidence in section 2

[11] This figure combines two data sources. The Household Finance and Consumption Survey (HFCS) 2020 wave for 12 euro-area economies, which reports each household's marginal propensity to consume out of an unexpected EUR 5,000 windfall, and Eurostat statistics on domestically held central-government securities as a share of GDP for the same countries and year. Country-level MPCs are constructed by weighting household responses with population weights provided in the HFCS and matched to the corresponding domestic-debt ratios.

[12] The OLS slope coefficient remains significant after controlling for median income and unemployment, confirming that the relationship is not driven by simple business-cycle factors.

and the analytical results in section 6: when resident households already own a sizable stock of safe public assets, they are better insured and therefore spend a smaller fraction of an extra euro. This micro fact reinforces the mechanism in the HANK model, and helps explain why higher public debt translates into smaller fiscal multipliers at the aggregate level.

8 Conclusion

This paper studies how household holdings of safe government claims shape the transmission of fiscal policy. Using U.S. local-projection IV with identified spending shocks, I document that output and consumption multipliers are systematically smaller when federal debt held directly by households is higher relative to GDP. Cross-country evidence from a panel of OECD economies reinforces this finding using an independent dataset and a related debt-exposure measure—the domestic sovereign debt share—and delivers the same qualitative message: fiscal transmission is weaker in high-debt states. Together, these results indicate that the household absorption of public debt—not headline government debt—is the margin that matters for fiscal transmission.

To interpret these findings, I build a one-asset HANK model with sticky wages in which a single risk-free asset, issued by the government and held by domestic households, summarizes the supply of safe and liquid claims in the economy. Comparing steady states with different levels of this asset, I find that higher liquid-asset supply lowers intertemporal marginal propensities to consume and, as a result, dampens the output response to a tax-financed increase in government spending. A steady-state decomposition shows that most of the decline in iMPCs operates through a bond-price channel: higher public debt raises the real interest rate, which shifts consumption-saving decisions across the entire wealth distribution, while the reallocation of wealth across households plays a smaller but non-negligible role.

Quantitatively, the decline in iMPCs with higher liquid wealth is larger than the decline in output multipliers. This wedge arises because multipliers depend on the full matrix of iMPCs and the timing of taxes and transfers, not just on a single-period average MPC. In the model, higher debt reduces long-horizon iMPCs and alters the

path of net transfers, so that the impact multiplier falls less than a static iMPC comparison would suggest. This highlights the importance of combining sufficient-statistics objects such as iMPCs with a structural environment that disciplines the dynamics of fiscal policy.

These findings illuminate two broader policy questions. First, is the reduced potency of fiscal policy in high-debt economies necessarily undesirable, or does it reflect improved consumption-smoothing and a decline in overall constraints? Second, even when higher debt constrains policy efficacy, are there still vital macroeconomic roles for fiscal intervention in such contexts? Future research can explore how these mechanisms evolve in international contexts or under alternative policy regimes, and whether similar patterns hold for other asset classes beyond government bonds.

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A Empirical Appendix

A.1 Additional panel robustness

This appendix reports additional checks for the preferred panel specification. Three results are worth emphasizing. First, the main output and investment gaps are not driven by any single country: leave-one-country-out exercises preserve the sign of the low-minus-high gap at all reported horizons (Figures 19 and 20). Second, the same qualitative pattern survives both a balanced $p50$ split and a common-sample restriction (Figure 17); Table 4 reports the full component decomposition and Table 6 the window-average gaps. Third, a continuous-state panel specification delivers the same sign as the preferred discrete specification, but with substantially wider confidence intervals (Figure 18); Table 5 reports the corresponding weak-identification diagnostics for each horizon.

A.2 U.S. state-variable robustness

This appendix reports the U.S. local-projection results for three alternative state variables. All specifications use the same continuous interaction design as in the main text: cumulative LP-IV local projections with Ramey news shocks, quarterly U.S. data from 1952Q1, and four lags of output, government spending, and the shock interacted with the state variable.

Domestic debt / total debt. The domestic share of outstanding sovereign debt is the closest algebraic analogue to the Broner et al. original state variable (foreign creditor share). Figures 21 and 22 report the high-minus-low output and consumption gaps. The output gap is negative throughout and large, indicating that the state-dependent pattern in output is not specific to the household-holdings measure.

Domestic debt / GDP. This measure replaces total debt in the denominator with GDP, yielding a standard debt-to-output ratio for the domestically held portion of public debt. The output gap (Figure 23) is negative at all horizons but smaller in magnitude than for the household-holdings or domestic-share measures, reflecting the lower cross-sectional spread of this series. Consumption (Figure 24) shows the same directional pattern.

Table 4: Component decomposition of state-dependent panel multipliers in the preferred specification

Horizon	Component	Low state	High state	Gap (Low − High)	90% CI low	90% CI high
1	Output (Y)	0.766	0.050	0.716	0.035	1.396
1	Investment (I)	1.474	0.501	0.972	0.060	1.885
1	Consumption (C)	0.472	-0.068	0.540	-0.785	1.866
1	Net exports (NX)	-0.915	-0.082	-0.833	-1.872	0.207
2	Output (Y)	0.630	0.242	0.387	-0.236	1.011
2	Investment (I)	1.510	0.959	0.552	-0.255	1.358
2	Consumption (C)	0.279	-0.043	0.321	-0.660	1.303
2	Net exports (NX)	-1.042	-0.403	-0.639	-1.592	0.314
3	Output (Y)	0.890	0.178	0.712	-0.297	1.721
3	Investment (I)	2.194	1.035	1.159	-0.242	2.561
3	Consumption (C)	0.160	-0.139	0.299	-0.872	1.471
3	Net exports (NX)	-1.667	-0.526	-1.141	-2.538	0.256
4	Output (Y)	1.343	0.192	1.151	-0.432	2.734
4	Investment (I)	2.931	1.150	1.781	0.475	3.087
4	Consumption (C)	0.268	-0.126	0.394	-1.311	2.099
4	Net exports (NX)	-1.763	-0.738	-1.025	-2.817	0.767

Table 5: Weak-identification diagnostics for the preferred panel specification

Horizon	Kleibergen–Paap F	Assessment	Comment
1	3.335	Weak	Impact estimate should be interpreted cautiously
2	8.230	Borderline	Directionally informative, but not tightly identified
3	10.938	Acceptable	Cleanest horizon in the preferred specification
4	7.359	Borderline	Same-sign pattern remains, but precision is limited

Table 6: Window-average low-minus-high multiplier gaps in the preferred panel specification

Window	Output gap	s.e.	Investment gap	s.e.
$h = 1$ to $h = 4$	0.741	0.318	1.116	0.345
$h = 1$ to $h = 3$	0.605	0.277	0.894	0.376
$h = 2$ to $h = 4$	0.750	0.401	1.164	0.421

Notes: Reported gaps are low-minus-high averages of the horizon-specific cumulative multipliers in the preferred specification. These window averages are best interpreted as supplementary summary statistics for a persistent same-signed pattern, not as replacements for the horizon-by-horizon local projections.

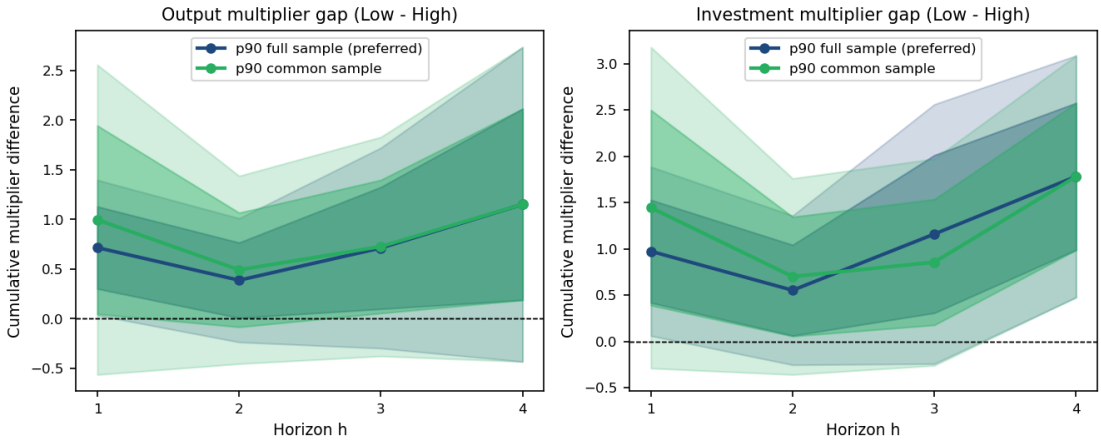


Figure 17: Panel robustness: preferred specification versus common-sample restriction. The figure compares the output multiplier gap (low minus high domestic-debt-share) from the full-sample preferred specification (Spec. A, $p90$ discrete split) against the common-sample variant (Spec. D) in which output and investment are estimated on the identical set of country-period observations. Restricting to the common sample leaves the sign and qualitative ordering of the multiplier gap unchanged. Same LP-IV design throughout; 17-country panel. Darker bands denote 68% confidence intervals; lighter bands denote 90% confidence intervals.

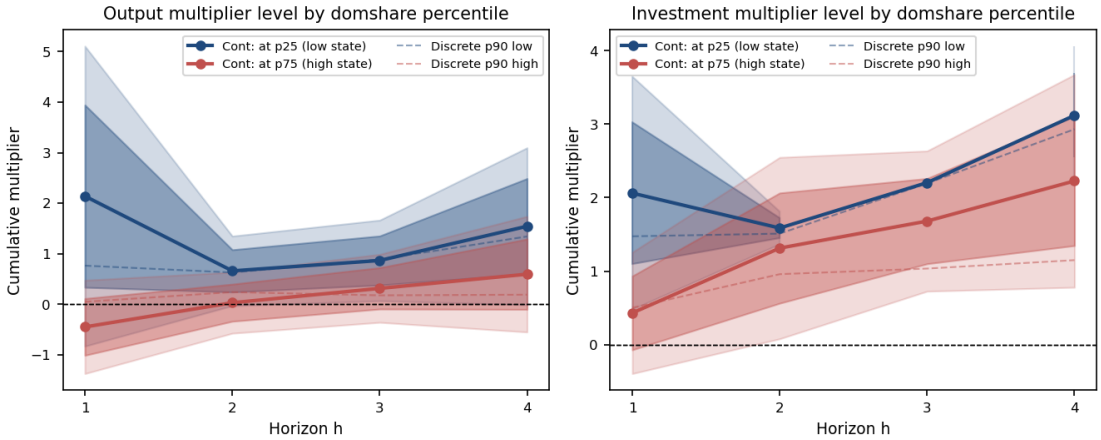


Figure 18: Panel robustness: continuous-state interaction specification. The figure plots the implied low-minus-high output multiplier gap from a continuous interaction LP-IV, where the domestic-debt-share state variable enters linearly and the gap is evaluated at the 90th and 10th percentiles of its distribution. The continuous specification delivers the same qualitative sign pattern as the preferred discrete $p90$ specification but with substantially wider confidence intervals, supporting the choice of discrete split as the main specification. 17-country panel. Darker bands denote 68% confidence intervals; lighter bands denote 90% confidence intervals.

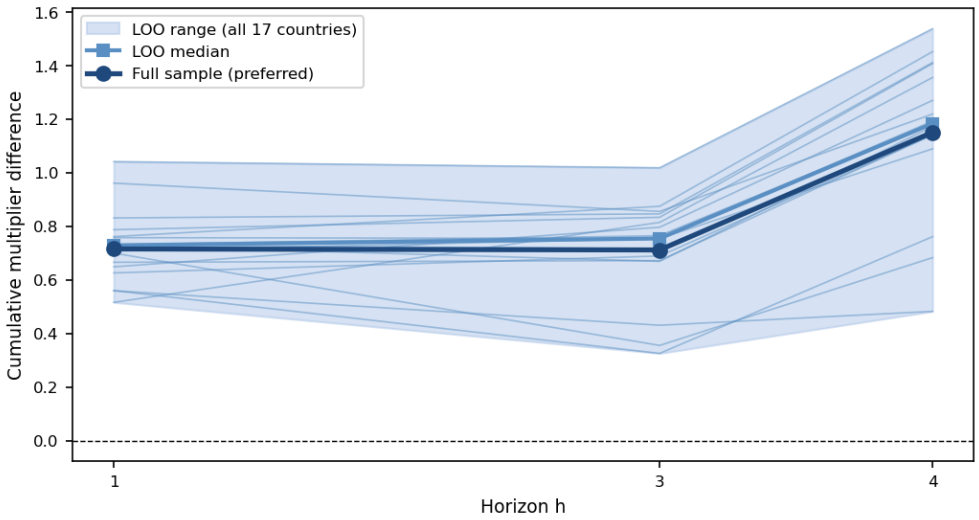


Figure 19: Leave-one-country-out robustness: output multiplier gap. Each line corresponds to a 16-country subsample obtained by omitting one of the 17 panel countries. The low-minus-high domestic-debt-share output multiplier gap (preferred $p90$ LP-IV specification) is positive at all reported horizons across all 17 subsamples, confirming that no single country drives the state-dependent pattern in output.

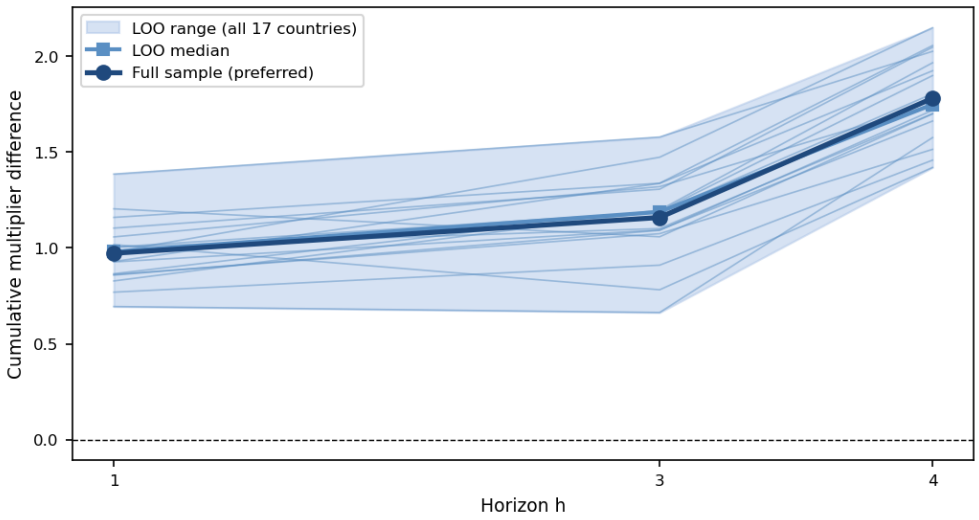


Figure 20: Leave-one-country-out robustness: investment multiplier gap. Each line corresponds to a 16-country subsample obtained by omitting one of the 17 panel countries. The low-minus-high domestic-debt-share investment multiplier gap is positive at all reported horizons across all 17 subsamples. Same LP-IV design and preferred specification as Figure 19; outcome is gross fixed capital formation normalized by GDP.

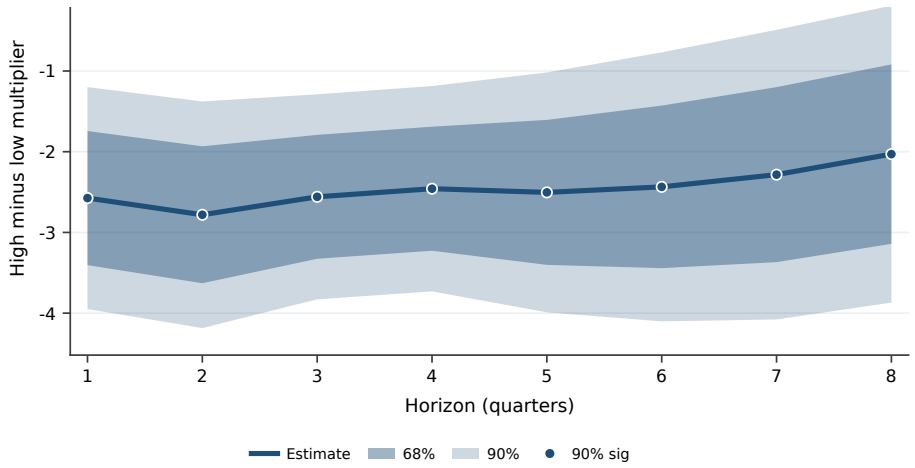


Figure 21: U.S. fiscal output multiplier, high minus low: domestic debt / total debt state variable. The state variable is the domestic share of outstanding U.S. sovereign debt (domestically held debt / total outstanding public debt), the closest algebraic analogue to the Broner et al. original foreign-creditor-share measure. Same continuous interaction LP-IV design and Ramey defense news instruments as the main text. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

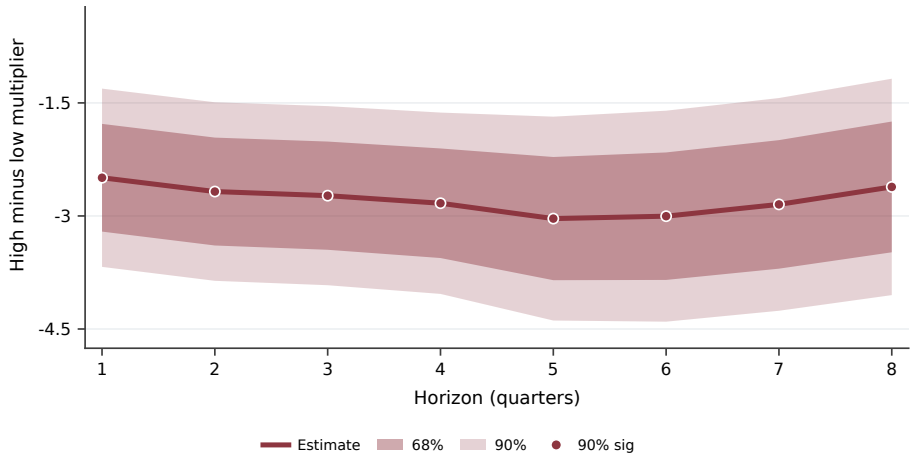


Figure 22: U.S. fiscal consumption multiplier, high minus low: domestic debt / total debt state variable. State variable and LP-IV design are identical to Figure 21. Consumption is measured as real personal consumption expenditures normalized by real GDP. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

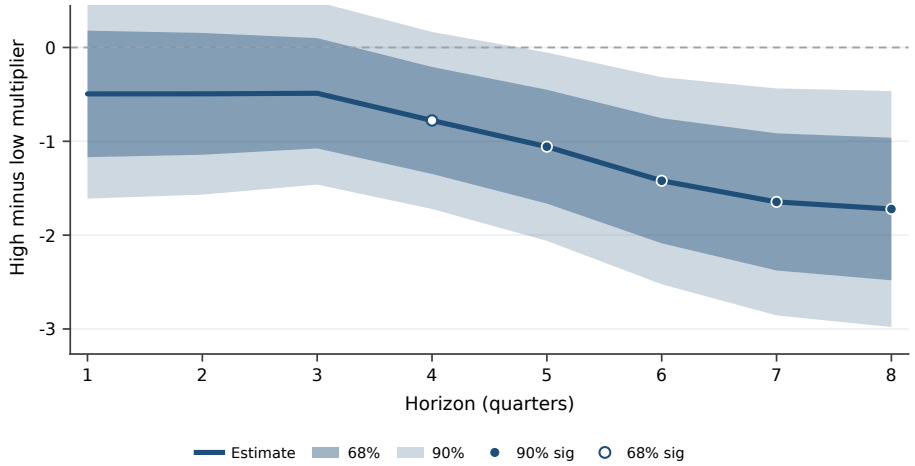


Figure 23: U.S. fiscal output multiplier, high minus low: domestic debt / GDP state variable. The state variable is total domestically held U.S. public debt normalized by GDP, a standard debt-to-output ratio for the domestically absorbed portion of sovereign debt. Same LP-IV design and Ramey news instruments as the main text. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

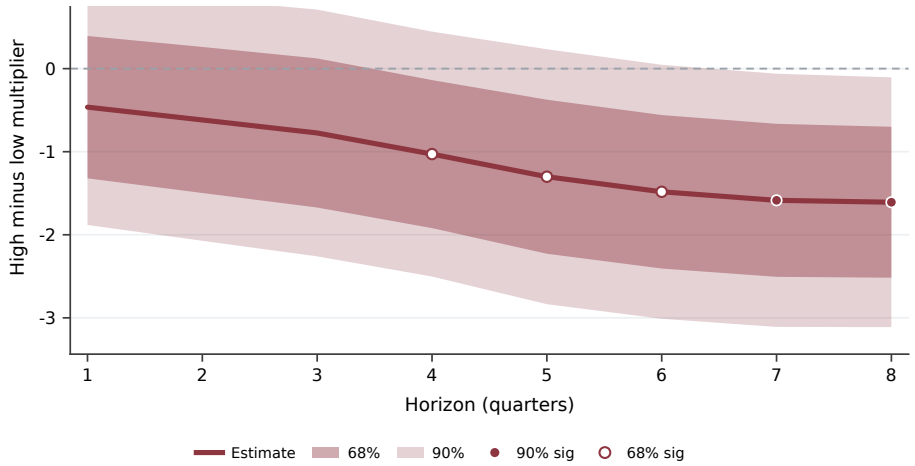


Figure 24: U.S. fiscal consumption multiplier, high minus low: domestic debt / GDP state variable. State variable and LP-IV design identical to Figure 23. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

Household debt / total debt. This measure uses household direct holdings as a share of total outstanding sovereign debt. It is the weakest of the four state variables in terms of the implied state-dependent spread (Table 7), reflecting the narrower variation in the raw series, and is therefore reported here as a supplementary robustness exercise only.

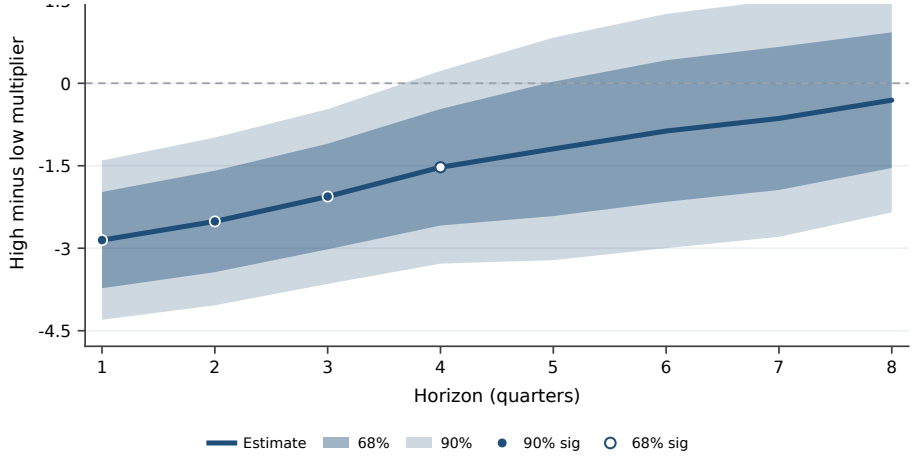


Figure 25: U.S. fiscal output multiplier, high minus low: household debt / total debt state variable. The state variable is federal debt held directly by U.S. households as a share of total outstanding sovereign debt. This is the weakest of the four state-variable measures, reflecting the narrower cross-sectional spread of the raw series. Same LP-IV design and Ramey defense news instruments as the main text. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

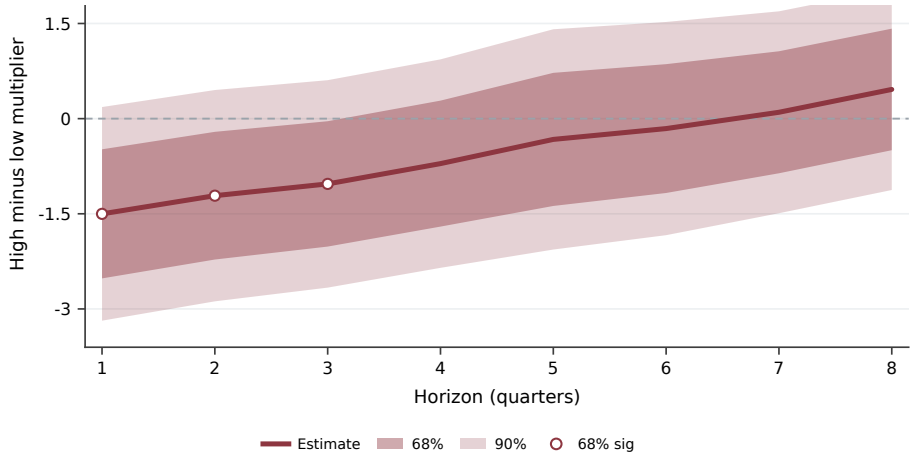


Figure 26: U.S. fiscal consumption multiplier, high minus low: household debt / total debt state variable. State variable and LP-IV design identical to Figure 25. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

State-variable comparison. Figure 27 overlays the four high-minus-low output gaps in a single panel. Figure 28 does the same for consumption. All four measures agree on the sign of the state-dependent pattern; they differ mainly in the level of the estimated gap, which reflects differences in the empirical spread of each series at P10

and P90.

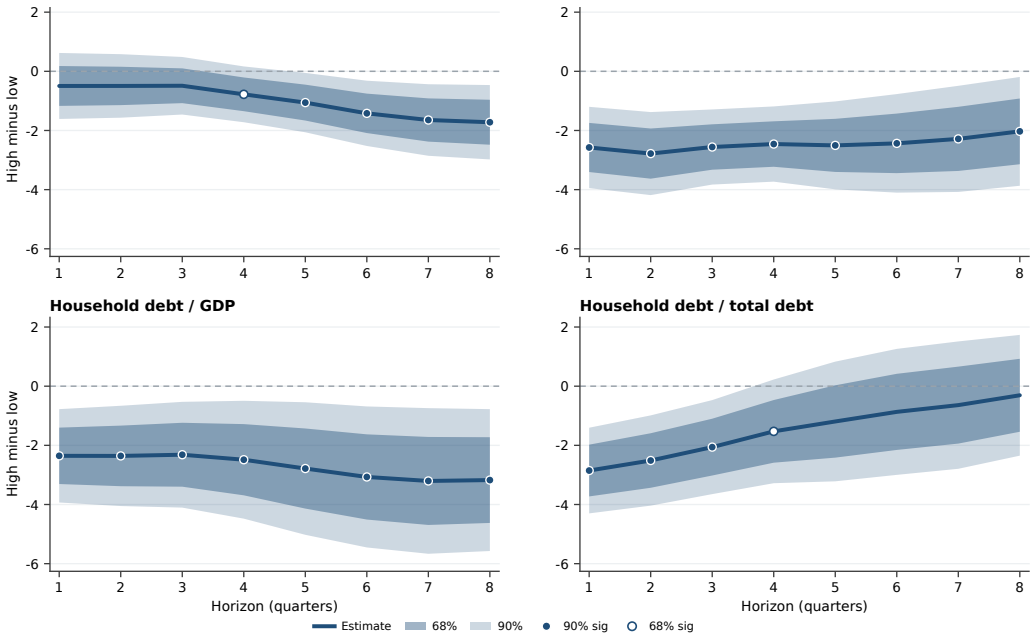


Figure 27: U.S. fiscal output multiplier gaps across all four state-variable measures. Each panel reports the high-minus-low difference in cumulative output multipliers evaluated at the 90th and 10th percentiles of the respective distribution. The four measures are: household debt / GDP (main text), domestic debt / total debt (Broner-style analogue), domestic debt / GDP (aggregate ratio), and household debt / total debt (weakest measure). All estimates use the same Broner-aligned LP-IV design with Ramey defense news instruments. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

Table 7 summarizes the P10 level, mean level, P90 level, and high-minus-low gap for all four state variables and both outcomes at each horizon. Household debt / GDP delivers the largest spread for output; domestic debt / GDP the smallest. All four state variables imply negative high-minus-low gaps for output at horizons 1–8.

Table 7: Broner-aligned U.S. state diagnostics levels

State variable	Outcome	Horizon	P10	Mean	P90	High−Low
Domestic debt / GDP	Output (Y)	1	1.353	1.129	0.858	-0.495
Domestic debt / GDP	Output (Y)	2	1.407	1.183	0.913	-0.494
Domestic debt / GDP	Output (Y)	3	1.287	1.066	0.799	-0.488
Domestic debt / GDP	Output (Y)	4	1.343	0.991	0.565	-0.778
Domestic debt / GDP	Output (Y)	5	1.431	0.953	0.373	-1.057
Domestic debt / GDP	Output (Y)	6	1.615	0.973	0.194	-1.420
Domestic debt / GDP	Output (Y)	7	1.711	0.967	0.065	-1.646
Domestic debt / GDP	Output (Y)	8	1.692	0.914	-0.029	-1.722

State variable	Outcome	Horizon	P10	Mean	P90	High−Low
Domestic debt / GDP	Output (Y)	avg h=1-4	1.347	1.093	0.784	-0.564
Domestic debt / GDP	Output (Y)	avg h=1-8	1.480	1.022	0.467	-1.013
Domestic debt / GDP	Consumption (C)	1	0.124	-0.086	-0.340	-0.464
Domestic debt / GDP	Consumption (C)	2	0.128	-0.151	-0.490	-0.618
Domestic debt / GDP	Consumption (C)	3	0.136	-0.214	-0.638	-0.774
Domestic debt / GDP	Consumption (C)	4	0.255	-0.210	-0.774	-1.029
Domestic debt / GDP	Consumption (C)	5	0.397	-0.191	-0.904	-1.301
Domestic debt / GDP	Consumption (C)	6	0.485	-0.185	-0.997	-1.482
Domestic debt / GDP	Consumption (C)	7	0.525	-0.192	-1.060	-1.585
Domestic debt / GDP	Consumption (C)	8	0.510	-0.217	-1.098	-1.608
Domestic debt / GDP	Consumption (C)	avg h=1-4	0.161	-0.165	-0.560	-0.721
Domestic debt / GDP	Consumption (C)	avg h=1-8	0.320	-0.181	-0.788	-1.108
Domestic debt / total debt	Output (Y)	1	3.077	1.494	0.503	-2.574
Domestic debt / total debt	Output (Y)	2	3.302	1.592	0.521	-2.781
Domestic debt / total debt	Output (Y)	3	3.045	1.471	0.486	-2.559
Domestic debt / total debt	Output (Y)	4	2.867	1.355	0.409	-2.458
Domestic debt / total debt	Output (Y)	5	2.849	1.309	0.345	-2.504
Domestic debt / total debt	Output (Y)	6	2.809	1.311	0.373	-2.436
Domestic debt / total debt	Output (Y)	7	2.672	1.268	0.388	-2.284
Domestic debt / total debt	Output (Y)	8	2.422	1.173	0.392	-2.030
Domestic debt / total debt	Output (Y)	avg h=1-4	3.073	1.478	0.480	-2.593
Domestic debt / total debt	Output (Y)	avg h=1-8	2.880	1.371	0.427	-2.453
Domestic debt / total debt	Consumption (C)	1	2.373	0.839	-0.120	-2.493
Domestic debt / total debt	Consumption (C)	2	2.514	0.868	-0.163	-2.676
Domestic debt / total debt	Consumption (C)	3	2.538	0.858	-0.193	-2.731
Domestic debt / total debt	Consumption (C)	4	2.591	0.850	-0.240	-2.831
Domestic debt / total debt	Consumption (C)	5	2.725	0.859	-0.310	-3.035
Domestic debt / total debt	Consumption (C)	6	2.698	0.851	-0.305	-3.003
Domestic debt / total debt	Consumption (C)	7	2.538	0.787	-0.309	-2.847
Domestic debt / total debt	Consumption (C)	8	2.318	0.710	-0.296	-2.615
Domestic debt / total debt	Consumption (C)	avg h=1-4	2.504	0.854	-0.179	-2.683

State variable	Outcome	Horizon	P10	Mean	P90	High−Low
Domestic debt / total debt	Consumption (C)	avg h=1-8	2.537	0.828	-0.242	-2.779
Household debt / GDP	Output (Y)	1	2.558	1.172	0.203	-2.354
Household debt / GDP	Output (Y)	2	2.609	1.222	0.252	-2.357
Household debt / GDP	Output (Y)	3	2.525	1.161	0.207	-2.317
Household debt / GDP	Output (Y)	4	2.567	1.104	0.081	-2.486
Household debt / GDP	Output (Y)	5	2.730	1.092	-0.053	-2.784
Household debt / GDP	Output (Y)	6	2.944	1.138	-0.125	-3.068
Household debt / GDP	Output (Y)	7	3.030	1.145	-0.174	-3.204
Household debt / GDP	Output (Y)	8	2.971	1.102	-0.204	-3.174
Household debt / GDP	Output (Y)	avg h=1-4	2.564	1.164	0.186	-2.379
Household debt / GDP	Output (Y)	avg h=1-8	2.742	1.142	0.023	-2.718
Household debt / GDP	Consumption (C)	1	1.808	0.036	-1.202	-3.010
Household debt / GDP	Consumption (C)	2	1.819	0.046	-1.194	-3.013
Household debt / GDP	Consumption (C)	3	1.780	0.036	-1.184	-2.964
Household debt / GDP	Consumption (C)	4	1.905	0.060	-1.231	-3.135
Household debt / GDP	Consumption (C)	5	2.153	0.102	-1.332	-3.485
Household debt / GDP	Consumption (C)	6	2.234	0.129	-1.341	-3.575
Household debt / GDP	Consumption (C)	7	2.135	0.092	-1.336	-3.471
Household debt / GDP	Consumption (C)	8	2.054	0.070	-1.316	-3.370
Household debt / GDP	Consumption (C)	avg h=1-4	1.828	0.044	-1.203	-3.031
Household debt / GDP	Consumption (C)	avg h=1-8	1.986	0.071	-1.267	-3.253
Household debt / total debt	Output (Y)	1	2.948	1.232	0.096	-2.852
Household debt / total debt	Output (Y)	2	2.714	1.202	0.201	-2.513
Household debt / total debt	Output (Y)	3	2.300	1.061	0.240	-2.060
Household debt / total debt	Output (Y)	4	1.792	0.873	0.264	-1.527
Household debt / total debt	Output (Y)	5	1.452	0.735	0.259	-1.193
Household debt / total debt	Output (Y)	6	1.182	0.660	0.314	-0.868
Household debt / total debt	Output (Y)	7	0.974	0.589	0.334	-0.640
Household debt / total debt	Output (Y)	8	0.668	0.484	0.361	-0.307
Household debt / total debt	Output (Y)	avg h=1-4	2.438	1.092	0.200	-2.238
Household debt / total debt	Output (Y)	avg h=1-8	1.754	0.854	0.259	-1.495

State variable	Outcome	Horizon	P10	Mean	P90	High−Low
Household debt / total debt	Consumption (C)	1	0.730	-0.173	-0.771	-1.501
Household debt / total debt	Consumption (C)	2	0.481	-0.250	-0.733	-1.215
Household debt / total debt	Consumption (C)	3	0.300	-0.318	-0.728	-1.029
Household debt / total debt	Consumption (C)	4	0.027	-0.400	-0.682	-0.709
Household debt / total debt	Consumption (C)	5	-0.327	-0.524	-0.654	-0.327
Household debt / total debt	Consumption (C)	6	-0.473	-0.567	-0.630	-0.157
Household debt / total debt	Consumption (C)	7	-0.711	-0.651	-0.611	0.100
Household debt / total debt	Consumption (C)	8	-1.021	-0.744	-0.561	0.460
Household debt / total debt	Consumption (C)	avg h=1-4	0.384	-0.285	-0.729	-1.113
Household debt / total debt	Consumption (C)	avg h=1-8	-0.124	-0.453	-0.671	-0.547

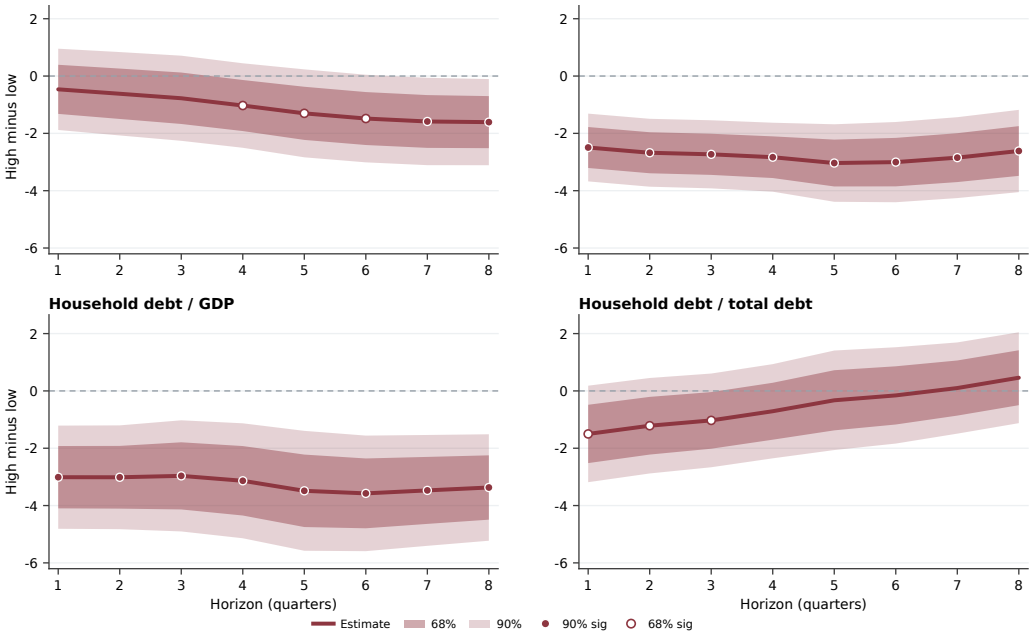


Figure 28: U.S. fiscal consumption multiplier gaps across all four state-variable measures. Same layout and design as Figure 27: high-minus-low differences in cumulative consumption multipliers evaluated at P90 and P10 for household debt / GDP, domestic debt / total debt, domestic debt / GDP, and household debt / total debt. All four measures deliver a negative gap, consistent with weaker consumption responses when household or domestic debt shares are high. Dark bands denote 68% confidence intervals; light bands denote 90% confidence intervals.

B Full model parameters Calibration Description

B.1 Calibration Explanation

For the calibration exercises, to have two different steady-state with different levels of debt, I set the level of government bonds for the steady-state with low-debt level to 40% of GDP, and I set the one for the high-debt steady state to 80%. This value matches the value of internal public debt held by private investors in the US.

Parameter	Description	Value
Household		
β_1	Discount factor 1	0.972
ϕ	Disutility of labor	1.7
	Inverse IES	
0.5		
$\underline{b}$	Borrowing constraint	0.0
η	Frisch Elasticity	1
ρ_ε	Autocorrelation of earnings	0.95
σ_ε	Cross-sectional std of log earnings	0.50
Government		
θ_0	Income tax level	0.788
θ_1	Income tax progressivity	0.137
G	Government spending	0.16
B^g	Bond supply	1.6
ϕ_π	Taylor rule coefficient on inflation	1.5
Grid Parameters		
n_ε	Points in Markov chain for ε	7
n_A	Points on liquid asset grid	100
Other Parameters		
κ_w	Slope Wage NKPC	0.2

C New-Keynesian Wage Phillips Curve derivation

The derivation of the wage new-Keynesian Phillips curve follows Auclert et al. (2024) which follows Erceg et al. (2000) but in a heterogeneous agents model. At any time t, the union k sets its wage W_{kt} to maximize, on behalf of all the workers it employs:

$$\max_{W_{kt}} \sum_{s=0}^{\infty} \left[\frac{c_t^{(1-\sigma)}}{1-\sigma} - \phi \frac{n^{(1+\eta)}}{1+\eta} - \frac{\psi}{2} \left(\frac{W_{kt+\tau}}{W_{kt+\tau-1}} \right)^2 \right] \text{s.to} \quad N_{kt} = \left(\frac{W_{kt}}{W_t}^{-\epsilon} \right) N_t \tag{30}$$

Unions take as given the initial distribution of households over idiosyncratic states. The price index for the aggregate employment services:

$$W_t = \left(W_{kt}^{1-\epsilon} dk \right)^{\frac{1}{1-\epsilon}} \tag{31}$$

From 30 it follows households real earnings are:

$$z_{it} = \int_0^1 \frac{W_k t}{P_t} N_{kt} dk = \frac{1}{P_t} \int_0^1 W_{kt} \left(\frac{W_{kt}}{W_t} \right)^{-\epsilon} N_t dk_t \tag{32}$$

The derivative of the household i total hours worked N are given by:

$$\frac{\delta n_{it}}{\delta W_{kt}} = -\epsilon \frac{N_{kt}}{W_{kt}} \tag{33}$$

Using the 32 and 33, the first order condition of the union with respect to W_{kt} is:

$$c_t^{-\sigma}(1-\epsilon)\frac{1}{P_t}N_{kt} + \epsilon\phi N_t^v \frac{N_{kt}}{W_{kt}} - \phi \frac{1}{W_{kt-1}}\left(\frac{W_{kt}}{W_{kt-1-1}}\right) + \beta\phi \frac{W_{kt+1}}{W_k t^2}\left(\frac{W_{kt+1}}{W_{kt}} - 1\right) = 0 \tag{34}$$

In equilibrium, all unions set the same wage, so $W_{kt} = W_t$ and $N_{kt} = N_t$. Moreover, wage inflation is defined as $\pi_t^w = \frac{W_t}{W_{t-1}} - 1$, so it follows:

$$c_t^{-\sigma}(1-\epsilon)\frac{1}{P_t}N_t + \epsilon\phi N_t^v \frac{N_t}{W_t} - \beta\phi(\pi_t^w + 1) + \beta\phi\pi_t(\pi_{t+1}^w) = 0 \tag{35}$$

Rearranging we get the wage New-Keynesian Phillips Curve:

$$\pi_t^w = k_w\left(\phi N_t^v - \frac{\epsilon - 1}{\epsilon}\frac{W_t}{P_t}c_t^{-\sigma}\right) + \beta(\pi_{t+1}^w) \tag{36}$$

D Theoretical Appendix: Proofs

This appendix provides self-contained proofs for the theoretical results stated in Section 6. It also clarifies which steps are identities versus calibration-specific quantitative findings.

D.1 Proof of Proposition 1

Proof. Rearranging (16) yields

$$(\mathbf{I} - \mathbf{M})\, d\mathbf{Y} = d\mathbf{G} - \mathbf{M}\, d\mathbf{T}.$$

Under Assumption G.1, $\rho(\mathbf{M}) < 1$ and $\mathbf{M}$ is bounded. The Neumann series $\sum_{k=0}^{\infty} \mathbf{M}^k$ converges in operator norm and satisfies

$$(\mathbf{I} - \mathbf{M}) \sum_{k=0}^{\infty} \mathbf{M}^k = \mathbf{I} \quad \text{and} \quad \sum_{k=0}^{\infty} \mathbf{M}^k (\mathbf{I} - \mathbf{M}) = \mathbf{I}.$$

Hence $(\mathbf{I} - \mathbf{M})$ is invertible with inverse given by (18). Multiplying both sides of the linear system by $(\mathbf{I} - \mathbf{M})^{-1}$ yields (17). Uniqueness follows from invertibility. □

D.2 Proof of Lemma 6.1

Proof. For $j \in \{1, 2\}$, the Neumann series gives

$$(\mathbf{I} - \mathbf{M}^{(j)})^{-1} = \sum_{k=0}^{\infty} (\mathbf{M}^{(j)})^k.$$

Because $\mathbf{M}^{(1)}$ and $\mathbf{M}^{(2)}$ are nonnegative and $\mathbf{M}^{(2)} \leq \mathbf{M}^{(1)}$ elementwise, an induction on k implies $(\mathbf{M}^{(2)})^k \leq (\mathbf{M}^{(1)})^k$ elementwise for all $k \geq 1$ (and it holds trivially for $k = 0$ since $(\mathbf{M}^{(j)})^0 = \mathbf{I}$). Summing over k preserves the inequality:

$$\sum_{k=0}^{\infty} (\mathbf{M}^{(2)})^k \;\leq\; \sum_{k=0}^{\infty} (\mathbf{M}^{(1)})^k.$$

Multiplying both sides by $\mathbf{X} \geq 0$ elementwise yields

$$(\mathbf{I} - \mathbf{M}^{(2)})^{-1}\mathbf{X} \;\leq\; (\mathbf{I} - \mathbf{M}^{(1)})^{-1}\mathbf{X},$$

which is (20). □

D.3 Proof of Lemma 6.2

Proof. Starting from (17),

$$d\mathbf{Y} = (\mathbf{I} - \mathbf{M})^{-1}d\mathbf{G} - (\mathbf{I} - \mathbf{M})^{-1}\mathbf{M}d\mathbf{T}.$$

Use the identity

$$(\mathbf{I} - \mathbf{M})^{-1}\mathbf{M} = (\mathbf{I} - \mathbf{M})^{-1} - \mathbf{I},$$

which follows from multiplying both sides by $(\mathbf{I} - \mathbf{M})$:

$$(\mathbf{I} - \mathbf{M})\big((\mathbf{I} - \mathbf{M})^{-1} - \mathbf{I}\big) = \mathbf{I} - (\mathbf{I} - \mathbf{M}) = \mathbf{M}.$$

Therefore

$$-(\mathbf{I} - \mathbf{M})^{-1}\mathbf{M}d\mathbf{T} = -\big((\mathbf{I} - \mathbf{M})^{-1} - \mathbf{I}\big)d\mathbf{T} = -(\mathbf{I} - \mathbf{M})^{-1}d\mathbf{T} + d\mathbf{T}.$$

Substituting into the expression for $d\mathbf{Y}$ yields (21). □

D.4 Proof of Lemma 38

Proof. By Definition G.2,

$$\mathrm{MPC}_{agg}(B) = \int \mathrm{MPC}_B(a,e)\, d\Psi_B(a,e).$$

Under Assumption G.1, the map $B \mapsto \int f\, d\Psi_B$ is differentiable for bounded f, and derivatives can be interchanged with integration. Applying the product rule for parameter-dependent integrals yields

$$\frac{d}{dB}\mathrm{MPC}_{agg}(B) = \int \frac{\partial\, \mathrm{MPC}_B(a,e)}{\partial B}\, d\Psi_B(a,e) + \int \mathrm{MPC}_B(a,e)\, d\Psi'_B(a,e),$$

which is (25). □

D.5 Proof of Lemma 6.4 and Corollary 6.4.1

Proof of Lemma 6.4. Write

$$\mathrm{MPC}^H_{agg} - \mathrm{MPC}^L_{agg} = \int \mathrm{MPC}^H \, d\Psi^H - \int \mathrm{MPC}^L \, d\Psi^L.$$

Add and subtract $\int \mathrm{MPC}^H \, d\Psi^L$:

$$\int \mathrm{MPC}^H \, d\Psi^H - \int \mathrm{MPC}^L \, d\Psi^L = \left(\int \mathrm{MPC}^H \, d\Psi^H - \int \mathrm{MPC}^H \, d\Psi^L \right) + \left(\int \mathrm{MPC}^H \, d\Psi^L - \int \mathrm{MPC}^L \, d\Psi^L \right)$$

which equals

$$\int \mathrm{MPC}^H \, d(\Psi^H - \Psi^L) + \int (\mathrm{MPC}^H - \mathrm{MPC}^L) \, d\Psi^L.$$

This is (26). □

Proof of Corollary 6.4.1. Apply Lemma 6.4 twice: once in the order "evaluate policy change at Ψ^L" and once in the order "evaluate policy change at Ψ^H". Average the two identities. The resulting decomposition is exactly the pair $(\Delta^{pol}, \Delta^{dist})$ stated in the corollary, and their sum equals $\mathrm{MPC}^H_{agg} - \mathrm{MPC}^L_{agg}$. □

D.6 Proof of Lemma 6.5

Proof. Differentiate the market-clearing identity (27) with respect to B:

$$\frac{d}{dB} \int a \, d\Psi_B(a, e) = \frac{d}{dB} B = 1.$$

Under Assumption G.1, $\frac{d}{dB} \int a \, d\Psi_B = \int a \, d\Psi'_B$, which yields (28). Since $\int a \, d\Psi'_B = 1$, Ψ'_B cannot be the zero measure. □

D.7 Optional: differentiability of the stationary distribution via an implicit-function argument

This subsection is *optional*. It provides one sufficient set of conditions under which the derivative object Ψ'_B invoked in Assumption G.1 exists and admits a standard

representation.

[Fixed-point representation and local stability] For each B, the stationary distribution Ψ_B solves the fixed point

$$\Psi_B = \Gamma_B(\Psi_B),$$

where Γ_B maps probability measures into probability measures. Assume Γ_B is Fréchet differentiable in (B, Ψ) in a neighborhood of (B, Ψ_B) and that $(\mathbf{I} - D_\Psi \Gamma_B)$ is invertible as a linear map on signed measures (e.g. because Γ_B is a contraction in a suitable norm).

Lemma D.1 (Derivative of the invariant distribution)**.** *Under Assumption D.7, the derivative Ψ'_B exists and satisfies*

$$\Psi'_B = (\mathbf{I} - D_\Psi \Gamma_B)^{-1} \partial_B \Gamma_B(\Psi_B),$$

where $D_\Psi \Gamma_B$ is the derivative of Γ_B with respect to Ψ.

Proof. Define $F(B, \Psi) \equiv \Psi - \Gamma_B(\Psi)$. The fixed point condition is $F(B, \Psi_B) = 0$. Assumption D.7 gives Fréchet differentiability and invertibility of $D_\Psi F(B, \Psi_B) = \mathbf{I} - D_\Psi \Gamma_B$. The implicit function theorem in Banach spaces implies existence and differentiability of the map $B \mapsto \Psi_B$ locally, with derivative solving

$$D_\Psi F(B, \Psi_B)\Psi'_B + \partial_B F(B, \Psi_B) = 0.$$

Since $\partial_B F(B, \Psi_B) = -\partial_B \Gamma_B(\Psi_B)$, rearranging yields the stated formula. □

E Numerical Resolution of the IKC

For Proposition 1, to compute Jacobians and assess the impact of the matrix I follow the method of Auclert et al. (2024) and Auclert et al. (2021), I calculate Jacobians truncating to a horizon of T, so that $\mathbf{M}$ is a $T \times T$ matrix, and $\mathbf{dG}, \mathbf{dT}$ are $T \times 1$ vectors. Truncating $\mathbf{M}$ generally implies that $\mathbf{q}'(\mathbf{I} - \mathbf{M}) \neq 0$, since the "tents" corresponding to the final columns of $\mathbf{M}$ (see figure 3) are incomplete.

The approach I choose is to directly solve for the multiplier matrix $\mathbf{M}$, numerically computing $\mathbf{M} = \mathbf{A}^{-1}\mathbf{K}$, where $\mathbf{A}$ is the asset Jacobian, whose elements are given by $A_{ts} = \frac{\partial A_t}{\partial Z_s}$. After obtaining $\mathbf{A}$ either directly using the methods from Auclert et al. (2021), or indirectly from $\mathbf{M}$ using $\mathbf{A} = \mathbf{K}(\mathbf{I} - \mathbf{M})$. Then, given $\mathbf{M}$, form

$$\mathbf{dY} = \mathbf{M}(\mathbf{dG} - \mathbf{MdT}) \tag{A.21}$$

F Formalization of the relationship between fiscal multipliers and the level of government debt.

To formally derive the relationship between fiscal multipliers and the level of public debt in the HANK model described in the paper, I start by considering how the household sector's consumption and savings decisions interact with government debt. As government debt increases, it introduces more bonds into the economy, which can alter households' consumption behavior via their MPC. The key mechanism at play is how higher levels of debt influence interest rates and asset holdings, which in turn affect fiscal multipliers.

F.1 Household Optimization Problem

Households maximize utility over consumption and labor. The household problem is given by:

$$V_t(e_{it}, a_{it-1}) = \max_{c_{it}, a_{it}} \left\{ \frac{c_{it}^{1-\sigma}}{1-\sigma} - \varphi \frac{n_{it}^{1+\eta}}{1+\eta} + \beta \mathbb{E}_t V_{t+1}(e_{it+1}, a_{it}) \right\}$$

subject to the budget constraint:

$$c_{it} + a_{it} = (1 + r_t)a_{it-1} + e_{it}\frac{W_t}{P_t}N_t - \tau_t$$

Given the recursive structure of the problem, the consumption function $c_t = C(a_{t-1}, e_t)$ can be derived as a function of past asset holdings a_{t-1}, labor income e_t, and interest rates r_t.

F.2 Intertemporal Marginal Propensity to Consume (iMPC)

The marginal propensity to consume (MPC) is defined as the derivative of consumption with respect to income:

$$iMPC_{it} = \frac{\partial c_{it}}{\partial y_{it}} \tag{37}$$

In the HANK framework, households face idiosyncratic risk and income heterogeneity, so the iMPC varies across households based on their asset holdings and income. Crucially, as public debt increases and more bonds are held by households, aggregate savings rise, and the distribution of wealth shifts. In general, wealthier households (those with more bonds) tend to have lower iMPCs due to the diminishing marginal utility of consumption: iMPC decreases as a_{it} increases.

Thus, when government debt increases, leading to more bonds (assets) in the economy, the aggregate MPC declines.

Consider a bounded shock $\{dG_t, dT_t\}$ to government spending G_t and taxes T_t. The impulse response of output $d\mathbf{Y}$ is governed by:

$$d\mathbf{Y} = dG - \mathbf{M} \cdot d\mathbf{T} + \mathbf{M} \cdot d\mathbf{Y}$$

where $\mathbf{M} \equiv [M_{ts}]$ is the infinite matrix of partial derivatives:

$$M_{ts} = \frac{\partial C_t}{\partial Y_s}$$

Solving for $d\mathbf{Y}$:

$$d\mathbf{Y} = (I - \mathbf{M})^{-1} (dG - \mathbf{M} \cdot d\mathbf{T})$$

F.3 Government Budget Constraint and Debt

The government's budget constraint is given by:

$$\tau_t = (1 + r_t)B_{t-1} + G_t - B_t.$$

In a deficit-financed fiscal expansion, government spending G_t increases, and this is matched by an increase in debt B_t. The fiscal multiplier measures the effect of this increase in government spending on output. Specifically, the **fiscal multiplier** is defined as the change in output (ΔY) in response to a change in government spending (ΔG):

$$\text{Impact Multiplier} = \frac{\Delta Y_0}{\Delta G_0}.$$

F.4 Interest Rates and Asset Demand

As government debt increases, the real interest rate r_t adjusts. In the model, the steady-state real interest rate r^* increases with higher debt levels because more bonds in the economy raise the demand for assets. The steady-state asset demand function is increasing in the real interest rate:

$$\frac{\partial A(r^*)}{\partial r^*} > 0,$$

where $A(r^*)$ is the aggregate demand for assets as a function of the real interest rate.

F.5 Concavity of Consumption Function and Declining MPC

The consumption function $C(a_{t-1}, e_t)$ is concave in income due to diminishing marginal utility, which implies that the marginal propensity to consume (MPC) decreases as asset holdings increase. Mathematically, the MPC is given by:

$$\text{MPC}(e_t, a_{t-1}) = \frac{\partial C(a_{t-1}, e_t)}{\partial e_t}.$$

Given that $C(a_{t-1}, e_t)$ is concave in e_t, the second derivative of consumption with

respect to income is negative:

$$\frac{\partial^2 C(a_{t-1}, e_t)}{\partial e_t^2} < 0.$$

This implies that as a_{t-1} (asset holdings) increases, the MPC decreases. In other words, wealthier households have a lower MPC because they consume a smaller fraction of additional income:

$$\text{MPC}(e_t, a_{t-1}) \quad \text{decreases as} \quad a_{t-1} \quad \text{increases.}$$

Formal Statement and Proof Let B be the level of government debt in a heterogeneous-agent model, potentially altering both

1. The factor price $r(B)$, which affects individual MPCs, and
2. The wealth distribution $\Psi_B(a, e)$.

Then, if the distribution does not shift significantly at first order ($\partial \Psi_B / \partial B \approx 0$), changes in B mostly change the aggregate MPC $_{\text{agg}}(B)$ *through* the factor-price channel, i.e. via $\partial r / \partial B$, rather than through reweighting Ψ.

Proposition 5. From (**??**), I have

$$MPC_{\text{agg}}(B) \;=\; \int MPC(a, e; B)\, \Psi_B(a, e).$$

Take a total derivative with respect to B, using the product rule:

$$\frac{d}{dB} MPC_{\text{agg}}(B) = \int \frac{\partial\, MPC(a, e; B)}{\partial B}\, \Psi_B(a, e) \;+\; \int MPC(a, e; B)\, \frac{\partial\, \Psi_B(a, e)}{\partial B}.$$

The first term is the *policy function (factor-price) channel*; the second is the *distribution (insurance) channel*. If $\partial\, \Psi_B(a, e) / \partial B$ is zero at first order, the second term vanishes and only the factor-price effect remains. Because raising B typically increases r, it thus directly lowers individual MPCs and the aggregate MPC, dominating the multiplier response to debt. □

Recall from the main text that the aggregate MPC in equilibrium with debt B is

$$MPC_{\text{agg}}(B) \;=\; \int_{\mathcal{A}\times\mathcal{E}} MPC(a,e;B)\;\Psi_B(a,e)\,da\,de\,.$$

When differentiating with respect to B, I obtain the decomposition:

$$\frac{d}{dB}\Big[MPC_{\text{agg}}(B)\Big] \;=\; \underbrace{\int_{\mathcal{A}\times\mathcal{E}} \frac{\partial\,(a,e;B)}{\partial B}\,\Psi_B(a,e)\,da\,de}_{\text{Policy-Function / Factor-Price Channel}} \;+\; \underbrace{\int_{\mathcal{A}\times\mathcal{E}} MPC(a,e;B)\;\frac{\partial\,\Psi_B(a,e)}{\partial B}\,da\,de}_{\text{Distribution (Insurance) Channel}}. \tag{38}$$

I claim that, under certain conditions, the second integral (the "distribution channel") is negligible at first order (i.e. of smaller order than the factor-price term).

F.6 Formal Argument via an Envelope/Approximate Invariance Condition

To see why $\partial\Psi_B/\partial B$ can be zero (or very small) at first order, it is convenient to think of $\Psi_B(a,e)$ as the *stationary distribution* arising from households' optimal saving choices under equilibrium factor prices (interest rate $r(B)$, wages $w(B)$) and equilibrium tax policy (lump-sum taxes $\tau(B)$, etc.). I then show that as B changes *slightly*, the induced shift in the distribution must be of *second order* (or zero), provided the model setup satisfies certain smoothness and "approximate invariance" conditions.

Step 1: Households' Value Function & Policy Rules. Let $v(a,e;B)$ be the stationary (or steady-state) value function when the government debt is B. Households' individual policy function for assets next period, $\alpha(a,e;B)$, and the consumption function $c(a,e;B)$ solve the usual Bellman equation.

Because $r(B)$, $w(B)$, and $\tau(B)$ are *smooth* in B, small changes in B only induce *small* changes in the household's Bellman equation. As a result,

$$\alpha(a,e;B+\Delta B) \;=\; \alpha(a,e;B) \;+\; O(\Delta B), \quad c(a,e;B+\Delta B) \;=\; c(a,e;B) \;+\; O(\Delta B),$$

where $O(\Delta B)$ denotes terms of order ΔB or higher. Hence the *policy functions* (including $(a,e;B)$) change *at first order* in B.

Step 2: Stationary Distribution as a Fixed Point. The cross-sectional distribution $\Psi_B(a, e)$ solves a fixed-point or stationary condition (e.g. a Fokker-Planck equation in continuous time, or a law of motion under Markov transition in discrete time). Symbolically,

$$\Psi_B \;=\; \Gamma_B(\Psi_B),$$

where Γ_B is the operator that maps any trial distribution into the next period's (or next instant's) distribution given the policy rule $\alpha(\cdot, \cdot; B)$ and the Markov transitions for e. For small ΔB, I consider the new fixed point $\Psi_{B+\Delta B}$:

$$\Psi_{B+\Delta B} \;=\; \Gamma_{B+\Delta B}\Big(\Psi_{B+\Delta B}\Big).$$

Because $\Gamma_{B+\Delta B}$ is a *continuous* mapping in B and Ψ_B is already a fixed point of Γ_B, it follows (under typical Lipschitz or contraction conditions) that the *change* $\Psi_{B+\Delta B} - \Psi_B$ is of *order at most* ΔB. In practice, it may be *strictly smaller at first order* if there is an "approximate invariance" or "envelope" property, as I now detail.

Step 3: The Envelope/Approximate Invariance Argument. In many heterogeneous-agent models calibrated to match empirical wealth dispersion, two ingredients often imply *minimal shifts* in Ψ_B when B changes:

- *Lump-Sum Tax Adjustments:* Any additional interest cost from higher B is financed via a small, lump-sum tax $\Delta\tau$ on every individual. Lump-sum taxes do not fundamentally re-rank households in the cross-section; they shift everyone's budget constraint slightly.
- *Smooth Saving Motives:* Agents' saving rules $\alpha(a, e; B)$ adjust somewhat with r and τ, but these adjustments can offset each other in such a way that the overall wealth accumulation distribution changes little (at least to first order).

Under these conditions, one can show (technically via an "envelope theorem" argument at the distribution level) that the linear (first-order) term in $\partial\Psi_B/\partial B$ vanishes or is extremely small.[13]

[13] In continuous-time models, one can write the stationary distribution as the solution to a differential equation (the Fokker-Planck equation). A small change in (r, τ) that keeps average saving rates roughly unchanged may shift Ψ_B only at second order. In discrete-time Markov chain settings, a similar argument applies by approximating transition kernels in a Taylor expansion around $\Delta B = 0$.

Step 4: Conclusion of the Argument. Thus, for small ΔB, I have

$$\Psi_{B+\Delta B}(a,e) \;=\; \Psi_B(a,e) \;+\; O\big((\Delta B)^2\big),$$

and hence,

$$\frac{\partial \Psi_B(a,e)}{\partial B} \;=\; 0 \;+\; \text{(possible second-order terms)}.$$

This justifies the statement that at first order,

$$\int_{\mathcal{A}\times\mathcal{E}} MPC(a,e;B)\,\frac{\partial\,\Psi_B(a,e)}{\partial B}\,da\,de \;\approx\; 0.$$

Consequently, the second term in (38) —the "distribution channel"—is negligible at first order, so the effect of changes in B on MPC_{agg} is *dominated* by the first term, i.e. by changes in factor prices (the "policy-function channel").

Suppose:

1. Factor prices (r, w) and lump-sum taxes (τ) depend smoothly on B,
2. Households' policy functions $a(a,e;B)$ and $MPC(a,e;B)$ are continuous and differentiable in B,
3. The stationary distribution Ψ_B is determined by a contraction mapping Γ_B (or continuous Markov transition) in the usual way,
4. Small changes in lump-sum tax $\tau(B)$ and factor prices $r(B)$ generate a *second-order* or negligible first-order change in Ψ_B, e.g. by an envelope argument.

Then, to first order in ΔB,

$$\Psi_{B+\Delta B}(a,e) \;=\; \Psi_B(a,e) \;+\; O\big((\Delta B)^2\big), \quad \text{so} \quad \frac{\partial \Psi_B(a,e)}{\partial B} \;=\; 0 \;+\; \text{(higher order terms)}.$$

Consequently, the distribution channel

$$\int_{\mathcal{A}\times\mathcal{E}} MPC(a,e;B)\,\frac{\partial \Psi_B(a,e)}{\partial B}\,da\,de$$

is negligible at first order, and the principal effect of B on the aggregate MPC comes through the *policy function (factor-price) channel*.

G Formal Structural Derivation of Proposition 6.6

In this appendix, I formally derive Proposition 6.6, clearly establishing the dominance of the factor-price channel over the wealth-distribution channel in determining how public debt influences aggregate marginal propensities to consume (MPCs) and consequently fiscal multipliers.

G.1 Setup and Assumptions

Consider an economy populated by heterogeneous households facing idiosyncratic productivity shocks and making optimal intertemporal consumption-savings decisions.

[Household Problem] Each household solves the infinite-horizon optimization problem:

$$v(a, e; B) = \max_{c, a'} u(c) + \beta \mathbb{E}[v(a', e'; B)],$$

subject to the budget constraint:

$$a' + c = (1 + r(B))a + w(B)e - \tau(B),$$

where:

- $a \in \mathcal{A} \subseteq \mathbb{R}$ denotes household assets.
- $e \in \mathcal{E}$ denotes idiosyncratic productivity with finite support.
- B denotes the aggregate government debt level.
- $r(B)$, $w(B)$, and $\tau(B)$ represent equilibrium real interest rates, wages, and lump-sum taxes.

[Equilibrium Existence and Smoothness] An equilibrium consists of policy functions $c(a, e; B)$, $a'(a, e; B)$, factor prices $r(B), w(B)$, lump-sum taxes $\tau(B)$, and a stationary distribution $\Psi_B(a, e)$ that are continuously differentiable with respect to B.

[Stationary Distribution Stability] The stationary distribution $\Psi_B(a, e)$ is a stable fixed point solution of the Markov transition operator Γ_B induced by the household

policy function $a'(a, e; B)$. Specifically,

$$\Psi_B = \Gamma_B(\Psi_B),$$

with Γ_B continuously differentiable and having a stable inverse around equilibrium.

G.2 Definitions

[Individual MPC] Given household consumption $c(a, e; B)$, define individual marginal propensity to consume (MPC) as:

$$MPC(a, e; B) \equiv \frac{\partial c(a, e; B)}{\partial y},$$

where y is disposable household income.

[Aggregate MPC] Define aggregate MPC as:

$$MPC_{\text{agg}}(B) \equiv \int_{\mathcal{A}\times\mathcal{E}} MPC(a, e; B)\, \Psi_B(a, e)\, da\, de,$$

where $\Psi_B(a, e)$ is the stationary equilibrium distribution at debt level B.

G.3 Main Proposition

Proposition 3 (Dominance of Factor-Price Channel)**.** *Under Assumptions G.1-G.1, the first-order effect of an increase in government debt B on the aggregate MPC is dominated by changes in factor prices (specifically the real interest rate), while the distribution channel is negligible. Formally:*

$$\frac{d\, MPC_{agg}(B)}{dB} \approx \int_{\mathcal{A}\times\mathcal{E}} \frac{\partial MPC(a, e; r)}{\partial r} \frac{\partial r(B)}{\partial B} \Psi_B(a, e)\, da\, de,$$

with the distribution channel:

$$\int_{\mathcal{A}\times\mathcal{E}} MPC(a, e; B) \frac{\partial \Psi_B(a, e)}{\partial B}\, da\, de \approx 0.$$

G.4 Proof of Proposition 6.6

The proof proceeds in explicit steps:

Step 1: Total derivative decomposition. By Definition G.2, differentiating aggregate MPC explicitly yields:

$$\frac{dMPC_{\text{agg}}(B)}{dB} = \underbrace{\int_{\mathcal{A}\times\mathcal{E}} \frac{\partial MPC(a,e;B)}{\partial B}\Psi_B(a,e)\,da\,de}_{\text{Factor-price channel}} + \underbrace{\int_{\mathcal{A}\times\mathcal{E}} MPC(a,e;B)\frac{\partial \Psi_B(a,e)}{\partial B}\,da\,de}_{\text{Distribution channel}}.$$

Step 2: Characterizing factor-price effects. Under Assumption G.1, differentiability and the chain rule imply:

$$\frac{\partial MPC(a,e;B)}{\partial B} = \frac{\partial MPC(a,e;r)}{\partial r}\frac{\partial r(B)}{\partial B},$$

focusing on real interest rates as the primary factor-price influence on MPC.

Step 3: Approximating the distribution channel. Under Assumption G.1, the stationary distribution satisfies:

$$\Psi_B = \Gamma_B(\Psi_B).$$

Implicit differentiation around equilibrium yields:

$$\frac{\partial \Psi_B}{\partial B} = (I - D_\Psi \Gamma_B)^{-1}\frac{\partial \Gamma_B}{\partial B}.$$

Given lump-sum tax adjustments and stability (Assumption G.1 and G.1), changes in debt cause minimal first-order reshuffling of households. Hence, we impose a realistic economic condition (approximate invariance):

$$\frac{\partial \Gamma_B}{\partial B} \approx 0 \quad \text{(first order)},$$

implying:

$$\frac{\partial \Psi_B(a,e)}{\partial B} \approx 0.$$

Consequently, the distribution channel vanishes at first order:

$$\int_{\mathcal{A}\times\mathcal{E}} MPC(a,e;B)\frac{\partial \Psi_B(a,e)}{\partial B}\,da\,de \approx 0.$$

Step 4: First-order approximation. Collecting results from steps 1-3:

$$\frac{dMPC_{\text{agg}}(B)}{dB} \approx \int_{\mathcal{A}\times\mathcal{E}} \frac{\partial MPC(a,e;r)}{\partial r} \frac{\partial r(B)}{\partial B} \Psi_B(a,e)\, da\, de,$$

completing the proof. ■

G.5 Interpretation of Structural Result

The structural derivation explicitly demonstrates that equilibrium shifts in public debt influence aggregate MPC primarily through changes in factor prices (especially the equilibrium real interest rate). In contrast, equilibrium adjustments in wealth distribution are structurally negligible at first order due to the stationary stability conditions and lump-sum neutrality.

Thus, Proposition 6.6 provides a precise, formal foundation for understanding the economic channels underlying the relationship between public debt and state-dependent fiscal multipliers in heterogeneous-agent New Keynesian models.

H Robustness and Further Analysis

H.1 Taxes or Government Bonds Prices?

The main result of this paper is that higher government debt tends to push up the real interest rate (r), which lowers the fiscal multiplier by diminishing households' marginal propensity to consume. Intuitively, when r is higher, households find saving more attractive than spending each additional unit of income, so their MPC declines. Lower MPC weakens the transmission of any given fiscal stimulus, translating into a smaller multiplier. In economies with relatively large public debt, interest rates exhibit stronger upward pressure in response to additional government borrowing, reducing households' willingness to consume. The result is that fiscal expansions in such economies produce smaller effects on output—hence, a lower multiplier. However in the exercise above, in steady-state taxes also increase after the increase in government bonds. Someone might argue that an increase in taxes might lead to a decrease in the consumption choice of households. Starting the analysis from the poorest households (lowest level of the income grid) the increase in r raises returns on saving, shifting

consumption for asset holders (especially at higher levels of assets a) as in figure 30. At the same time, the increase in T lowers disposable income, shifting consumption down for each asset level, but quantitatively this effect is minimal compared to the increase in r. If we also check households at a higher level of the income grid, the higher r yields to a more noticeable consumption shift at higher a, as these households significantly benefit from higher returns, while the higher T, lowers consumption for each level of asset, but marginally. Overall, at a higher income level, households hold more assets and thus the interest-rate shift strongly affects their consumption plan, i.e. the bond-price changes dominate over tax changes. Raising r significantly changes the consumption policy function, especially for asset-rich, higher-productivity households. On the other hand, raising T does affect consumption shifting it downward by reducing net labor income, but is often less impactful than the interest-rate channel in lowering MPCs. These findings parallel the same previous message: with higher B in general equilibrium, the rising real rate is the primary driver that reduces fiscal multipliers by lowering MPC.

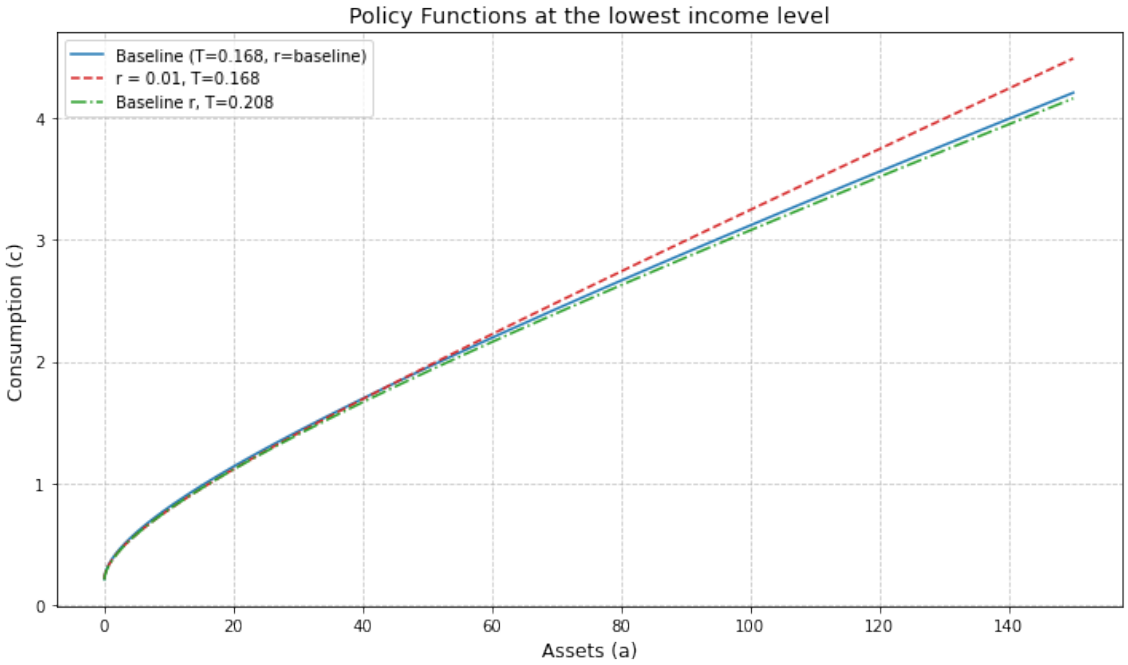


Figure 29: Policy functions for a change in r and T from the baseline level, for the agent with the lowest level of income

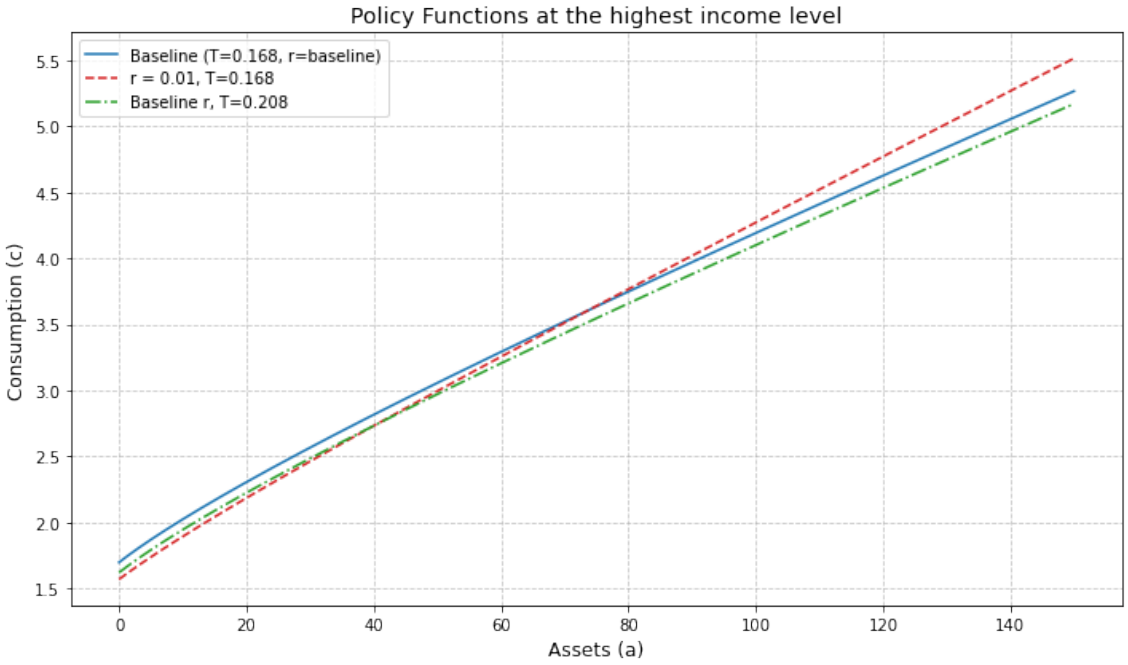


Figure 30: Policy functions for a change in r and T from the baseline level, for the agent with the highest level of income

H.2 Monetary - Fiscal Interaction: decreasing interest rates the central bank can help to maintain active the fiscal stimulus.

From the decomposition illustrated above, there is another straightforward result, that might need more (empirical) research in the future. The economy with higher debt suffers more from a potential increase in interest rates by the central bank. The decrease in multipliers is quantitatively stronger than the economy with lower debt. From this it is possible to conclude that higher rates are more recessive for fiscal policy for the economy with high debt. To study this, I allow the role of the central bank to become active. Let's suppose that in a state with high level of government debt, the central bank decreases the level of interest rates. Through this the central bank is able to satisfy two objectives at the same time: to help the government to sustain the high level of debt, and to improve the response of households to the fiscal stimulus. In fact, according to the previous main result, with a lower level of interest rate, for the same level of public debt, the response to the fiscal stimulus will be higher. Since what matters is the level of the real rate, when the rate decreases the response of households will go back to the one the one of the low - debt economy. This creates a classic monetary - fiscal policy interaction with its following implications: in times

with high debt, decreasing the interest rate helps to maintain the fiscal stimulus active, while if the central bank needs to increase the rates, this leads to the total burden of high public debt, reducing the response of household to potential increase in income, or higher transfers. Higher rates are more recessive for fiscal policy for the economy with high debt.

H.3 Aggregate or individual MPC?

Proposition 1 establishes that the iMPC matrix is a sufficient statistic for fiscal transmission in the IKC sense. Since fiscal multipliers also depend on the level of debt—through iMPCs—a natural question is whether the change in aggregate iMPCs across debt levels is driven by changes in individual policy functions or by changes in the wealth distribution. The result is that the change is primarily driven by the policy-function response to higher real interest rates: with more debt, the real rate rises and individual consumption functions shift, leading to a lower aggregate iMPC and a smaller fiscal multiplier.

Proposition **??** show how relevant are iMPCs in deficit-financed fiscal policies: there is a sufficient statistics which can express fiscal multipliers as its function. In the intertemporal Keynesian cross, the matrix iMPCs $\mathbf{M}$ is a sufficient statistic for the output response to fiscal policy. Proposition **??** and **??** show how iMPCs depend on the level of government debt, for a deficit-financed fiscal policy. The fact that iMPCs change, depends on the aggregate distribution. This leads to the following proposition:

Proposition 4. *(Aggregate Distribution). The response of output after a fiscal shock in government expenditure is a function of MPCs:*

$$d\boldsymbol{Y} = \hat{\mathcal{M}} \cdot (d\boldsymbol{G} - \boldsymbol{M}d\boldsymbol{T}) + G. \tag{39}$$

where the multiplier $\hat{\mathcal{M}}$ is the aggregate iMPCs across individuals.

This result follows directly from the decomposition. The factor price channel, due to the policy function change, dominates: the individual MPC of one agent is relevant in explaining the different responses in output. When we aggregate, the MPC of

a single household stays the same, but the distribution over which the aggregation happens, changes. Higher government debt changes individuals' MPCs.

I Additional Quantitative Results

This appendix documents a set of robustness exercises that complement the quantitative analysis in the main text. All experiments are conducted in the same one–asset HANK model with sticky wages presented in Section 3, keeping the calibration of preferences, wage rigidity and monetary policy fixed. The focus is on how the transmission of fiscal policy depends on the level of public debt, on the fiscal financing rule, on the nature of the shock (government spending versus taxes), and on the persistence of the spending disturbance.

Throughout, I denote by B the real stock of government debt in units of quarterly output Y, so that the conventional debt–to–annual–GDP ratio is

$$\frac{B}{Y_{\text{annual}}} = \frac{B}{4Y}.$$

For each steady state with a different B, I recompute the stationary equilibrium of the full HANK model and then solve for the transition dynamics following small unanticipated fiscal shocks.

I.1 Baseline deficit-finance rule

In the baseline specification used in Section 5, government purchases G_t follow an AR(1) process around their steady-state value G^{ss} and are financed through a combination of debt issuance and a gradual adjustment of lump-sum taxes. Linearizing the government budget constraint around the steady state implies

$$\Delta T_t \approx r^{ss}\Delta B_{t-1} + \phi_\tau\big(B_{t-1} - B^{ss}\big), \tag{40}$$

where T_t denotes lump–sum taxes, r^{ss} is the steady-state real interest rate, and $\phi_\tau > 0$ governs the speed of fiscal consolidation. Equation (40) corresponds exactly to the deficit–finance rule implemented in the code via the block `fiscal_df_3`.

For each B on a grid between roughly 12.5% and 105% of annual GDP, I recompute

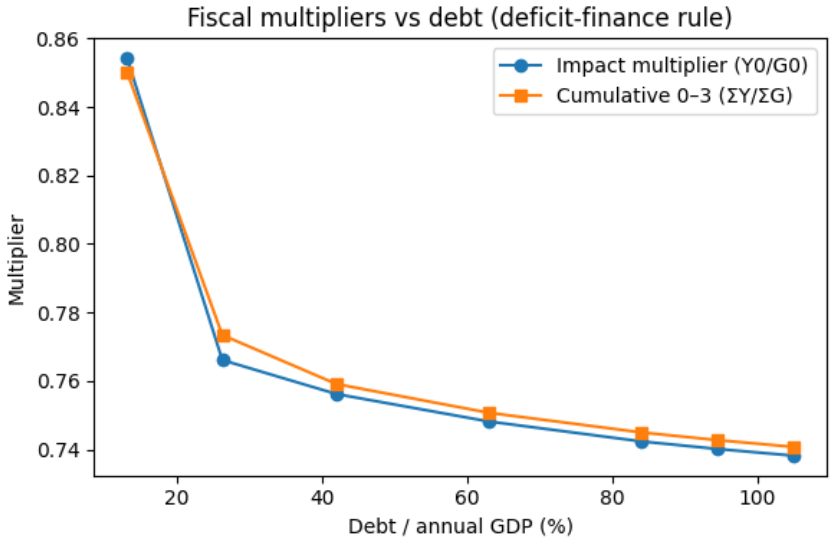


Figure 31: Impact and short-run cumulative spending multipliers as a function of the debt-to-annual-GDP ratio under the baseline deficit-finance rule.

the steady state and then simulate the impulse response to a small positive shock to G_t with persistence $\rho_G = 0.9$. For a given experiment, I define the impact and short-run cumulative spending multipliers as

$$m_G^{\text{impact}}(B) = \frac{\Delta Y_0}{\Delta G_0}, \qquad m_G^{0\text{–}3}(B) = \frac{\sum_{t=0}^{3} \Delta Y_t}{\sum_{t=0}^{3} \Delta G_t}. \tag{41}$$

Figure 31 shows that both the impact and the 0–3 cumulative multipliers decline monotonically with B/Y_{annual}. Moving from low to high public debt substantially reduces the potency of government spending shocks. This behaviour is precisely the state dependence emphasized in the main text.

To connect these multipliers to household behaviour, it is useful to contrast the simple cross-sectional marginal propensity to consume (MPC) in the steady state with "effective" MPCs inferred from the fiscal experiment. Let $\text{MPC}^{ss}(B)$ denote the average impact MPC out of a small, one-period transfer in the stationary equilibrium with debt B. For the spending experiment I define

$$\text{MPC}^{G,\text{impact}}(B) = \frac{\Delta C_0}{\Delta G_0}, \qquad \text{MPC}^{G,0\text{–}3}(B) = \frac{\sum_{t=0}^{3} \Delta C_t}{\sum_{t=0}^{3} \Delta G_t}. \tag{42}$$

Figure 32 documents two facts. First, the simple steady-state MPC $\text{MPC}^{ss}(B)$ declines sharply with the level of debt, reflecting the wealth-insurance mechanism de-

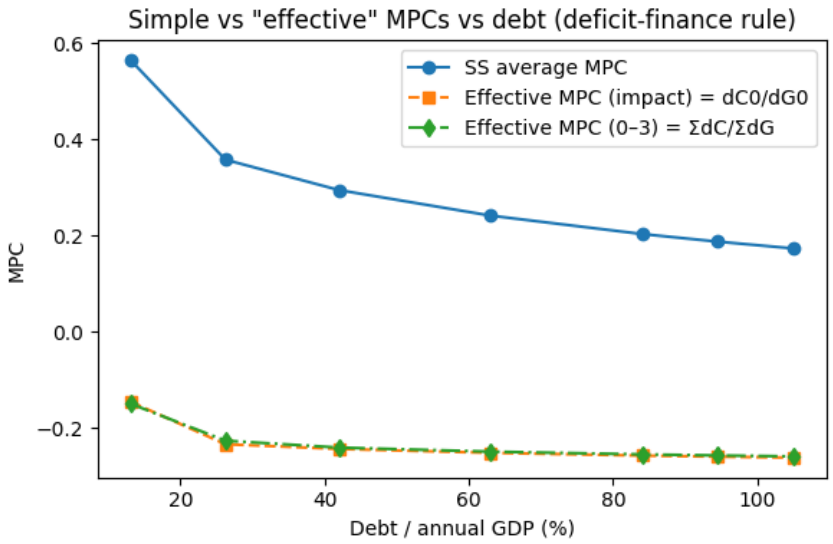


Figure 32: Simple steady-state MPC and effective MPCs (impact and 0–3 cumulative) associated with a G-shock, as a function of the debt-to-annual-GDP ratio.

scribed in the main text: richer households are less constrained and have lower iMPCs. Second, the effective MPCs associated with the G-shock are negative and exhibit only a modest dependence on B. This is not a coding artefact: the G-shock in this environment eventually raises lump–sum taxes and depresses the present value of disposable income, so that the net path of consumption is slightly below the baseline even though output increases in the short run. In other words, the G-shock is not a pure transfer to households; it combines demand and wealth effects.

The main implication for the paper is that the strong decline in $\text{MPC}^{ss}(B)$ is only partially reflected in the sensitivity of $m_G(B)$ with respect to debt. The level of public debt changes the wealth distribution and the cross-sectional MPCs sharply, but general-equilibrium forces—notably the response of interest rates and taxes—muted the effect on the output multiplier.

I.2 Balanced-budget rule and alternative consolidation profiles

To gauge the role of the fiscal rule itself, I consider three alternative ways of financing the same spending shock.

First, I impose a strict balanced-budget rule under which the government adjusts taxes period by period to keep the stock of debt constant,

$$T_t = (1 + r_t)B_{t-1} + G_t - B_t, \qquad B_t = B^{ss}. \tag{43}$$

In this case the markup of taxes over steady state is more front-loaded, and the resulting multipliers are uniformly lower than under the baseline deficit rule. The decline of $m_G(B)$ with the level of debt remains present and of similar magnitude. This confirms that the state dependence emphasized in the main text is not an artefact of a particular calibration of ϕ_τ.

Second, I study a "long" debt-finance rule in which the government keeps taxes constant for ten years and only starts consolidating thereafter. Formally, I specify

$$T_t = \begin{cases} T^{ss} & \text{for } t < T_{\text{DF}}, \\ r^{ss}B^{ss} + G^{ss} + \phi_\tau\big(B_{t-1} - B^{ss}\big) & \text{for } t \geq T_{\text{DF}}, \end{cases} \tag{44}$$

with $T_{\text{DF}} = 40$ quarters. Relative to the baseline, this rule shifts the fiscal adjustment far into the future and therefore raises the impact and short-run multipliers for any given B. However, the shape of $m_G(B)$ as a function of debt is almost unchanged.

Third, I consider a "short" debt-finance rule in which the government allows debt to absorb the entire contemporaneous deficit but fully adjusts taxes one year later. The tax rule is

$$T_t = r^{ss}B^{ss} + G^{ss} + \phi_\tau\big(B_{t-4} - B^{ss}\big), \tag{45}$$

so that the consolidation occurs with a four-quarter lag. This rule produces multipliers that are intermediate between the baseline and the long debt-finance case. Once again, the dependence of $m_G(B)$ on the level of debt remains remarkably stable.

Taken together, these experiments suggest that the central state-dependent result of the paper—that higher public debt is associated with lower government-spending multipliers through the wealth/MPC channel—is robust to a range of reasonable assumptions about how quickly fiscal policy consolidates after a stimulus.

I.3 Tax shocks and fiscal consolidation

The main text focuses on spending expansions. To mimic the consolidation experiments of Brinca et al. (2021) and the tax-shock analysis in **?**, I also consider shocks to taxes.

I define a small unanticipated increase in lump–sum taxes ΔT_t with persistence ρ_T, leaving G_t unchanged. For a given steady state with debt B, the impact and

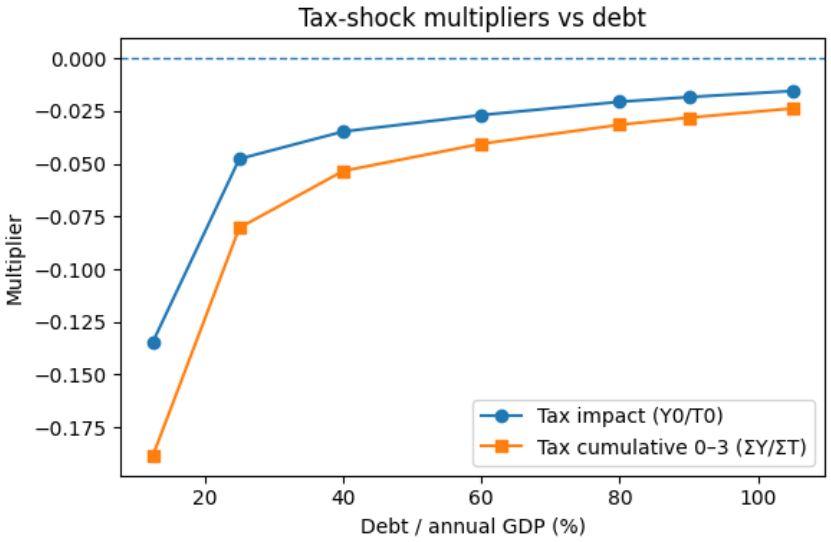


Figure 33: Impact and short-run cumulative tax multipliers as a function of the debt-to-annual-GDP ratio.

cumulative *tax multipliers* are

$$m_T^{\text{impact}}(B) = \frac{\Delta Y_0}{\Delta T_0}, \qquad m_T^{0-3}(B) = \frac{\sum_{t=0}^{3} \Delta Y_t}{\sum_{t=0}^{3} \Delta T_t}. \tag{46}$$

By convention, these multipliers are negative when tax increases are contractionary.

Figure 33 shows that tax hikes are strongly contractionary at low levels of debt, with relatively large negative multipliers in absolute value. As B rises, the magnitude of the tax multipliers declines. This pattern is consistent with the fact that average MPCs are higher in low-debt economies: given a unit increase in taxes, consumption of constrained agents must fall more when MPCs are large. The state dependence of tax multipliers thus mirrors, but with opposite sign, the one reported for spending shocks.

The effective MPCs associated with tax hikes, defined in analogy with (42) but using ΔT_t instead of ΔG_t, are positive and display moderate variation with B. This corroborates the idea that, for tax shocks, the simple cross-sectional MPC is a better sufficient statistic for the output effect, in line with the sufficient-statistic logic in Auclert et al. (2024).

I.3.1 Speed of fiscal consolidation

In the benchmark deficit-financed experiment in Section **??** the government chooses taxes according to the feedback rule

$$T_t \;=\; r^* B^* + G^* + \phi_\tau \big(B_{t-1} - B^*\big), \tag{47}$$

combined with the one–period budget constraint

$$B_t \;=\; (1 + r_t) B_{t-1} + G_t - T_t. \tag{48}$$

Linearising (47)–(48) around the steady state yields the approximate law of motion

$$B_t - B^* \;\approx\; \big(1 + r^* - \phi_\tau\big)\,(B_{t-1} - B^*), \tag{49}$$

so that the effective persistence of government debt is given by

$$\rho_B \;\simeq\; 1 + r^* - \phi_\tau.$$

A larger feedback coefficient ϕ_τ therefore corresponds to *less* persistent debt and faster fiscal consolidation, whereas a smaller ϕ_τ implies a highly persistent debt process that is close to a unit root.

To assess how the speed of consolidation interacts with the level of debt, I recompute steady states and impulse responses for the deficit-finance experiment under five alternative values of the feedback parameter,

$$\phi_\tau \in \{0.05, 0.20, 0.50, 0.70, 0.90\},$$

keeping all other parameters fixed and maintaining the benchmark persistence of the government-spending shock, $\rho_G = 0.9$. For each value of ϕ_τ and each initial steady-state debt level, I solve an impulse response to a 1% AR(1) spending shock and compute the impact and four–quarter cumulative multipliers

$$M_0 = \frac{\Delta Y_0}{\Delta G_0}, \qquad M_4 = \frac{\sum_{t=0}^{3} \Delta Y_t}{\sum_{t=0}^{3} \Delta G_t}.$$

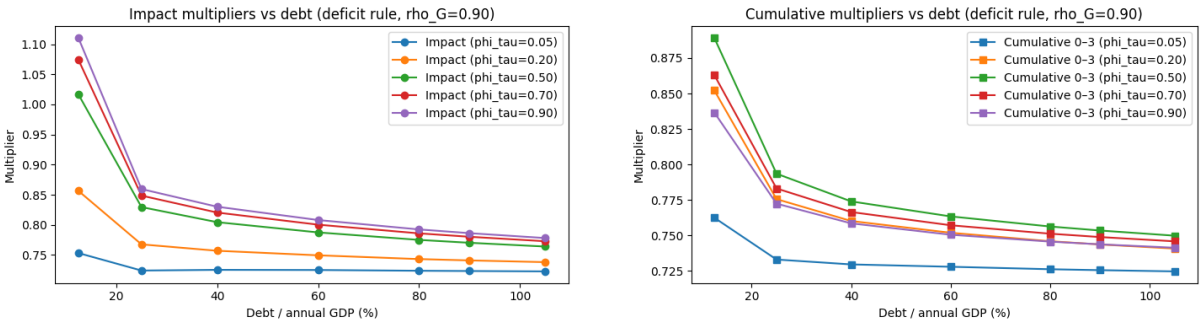


Figure 34: Impact and four–quarter cumulative multipliers as a function of the initial public-debt-to-GDP ratio for different values of the fiscal-feedback coefficient ϕ_τ.

Figure 34 shows that, for any given initial debt-to-GDP ratio, a very passive rule with $\phi_\tau = 0.05$ (implied persistence $\rho_B \approx 0.96$) generates the lowest multipliers. Increasing ϕ_τ from 0.05 to 0.20 or 0.50 shifts both the impact and cumulative multipliers upward, while further increases to $\phi_\tau = 0.70$ or 0.90 mainly generate small level changes. In all cases, however, the slope of the multiplier with respect to the initial debt ratio remains negative and of similar magnitude.

The intuition is that a sluggish rule which lets additional debt linger for very long periods raises the effective real interest rate faced by households and shifts the wealth distribution towards richer, low-MPC agents, thereby dampening the demand response to the spending shock. More active rules stabilise debt more rapidly and prevent this additional crowding-out channel from operating, so the multiplier is slightly larger. At the same time, the cross-sectional response to a given spending shock is still governed mainly by the steady-state distribution of wealth; for each value of ϕ_τ the average MPC declines sharply with the level of debt, whereas the fiscal multiplier declines much more slowly.

This robustness exercise confirms that the main result of the paper, namely, that higher public debt lowers the spending multiplier primarily through its effect on the distribution of MPCs—does not hinge on a particular choice for the speed of fiscal consolidation.

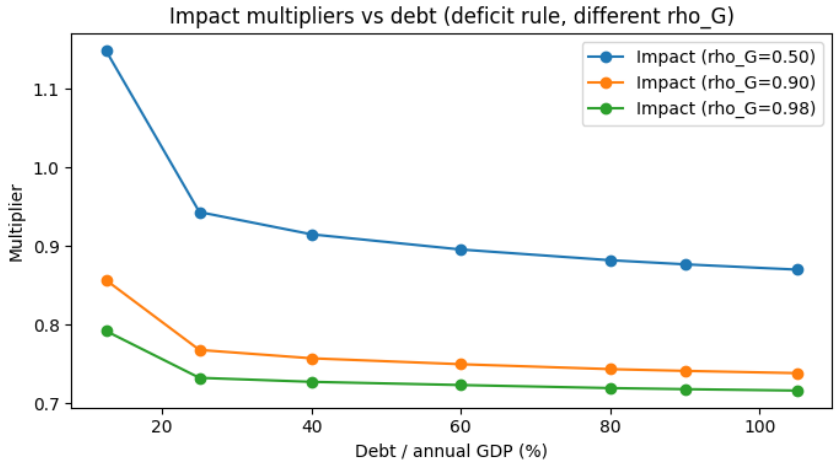


Figure 35: Impact spending multipliers for different levels of debt and different persistence parameters ρ_G of the spending shock.

I.4 Shock persistence and interaction with debt

Finally, I experiment with different degrees of persistence of government spending shocks while keeping the fiscal rule fixed. Let

$$\Delta G_t = \Delta G_0 \rho_G^t$$

with $\rho_G \in \{0.5,\ 0.9,\ 0.98\}$. For each ρ_G I recompute the impact and 0–3 cumulative multipliers along the grid of debt levels.

Figure 35 shows that higher persistence raises the level of the multipliers for any given B, as expected: a more persistent shock has a larger present value and generates a stronger response of demand and of the marginal utility of income. However, even when ρ_G is close to unity, the slope of $m_G(B)$ remains negative. When combined with the fiscal rule (40), this result suggests that both the stock of debt and the consolidation parameters shape the state dependence of multipliers, but the qualitative pattern emphasized in the main text is robust to plausible changes in shock persistence.

I.5 Discussion

The exercises in this appendix reinforce the main mechanisms of the paper. Higher public debt lowers cross-sectional MPCs through a wealth-insurance channel and, in the model, this translates into substantially smaller spending and tax multipliers. Alternative fiscal rules, long or short debt-finance horizons, and different shock

processes change the level of the multipliers but have limited impact on the way multipliers vary with the stock of debt. At the same time, the comparison between spending and tax shocks clarifies the conditions under which simple iMPCs are sufficient statistics for the output response, and when general-equilibrium feedbacks (via interest rates and future taxes) break this sufficiency.

I.6 Comparative Statics in the EIS

Finally, we vary the intertemporal elasticity of substitution (EIS) around the baseline value of 0.5 (corresponding to risk aversion $\gamma = 2$) and recompute the Auclert impact IMPC and the decomposition above.

For lower EIS (higher risk aversion), the adjustment in the real interest rate required to absorb additional public debt is larger and the factor–price channel accounts for a larger share of the change in the impact IMPC. As we increase the EIS towards values closer to one, the relative importance of the distribution channel grows and the split between factor–price and distribution channels moves towards roughly 50–50. In all cases, however, the sign of the effect is robust: higher steady–state public debt *reduces* the impact IMPC.

This sensitivity analysis shows that our main mechanism—lower intertemporal MPCs at higher debt, driven by a mix of higher real interest rates and a reallocation of wealth away from constrained households—is not an artefact of a particular calibration and survives in a standard range of EIS values used in the macro literature.

J Comparative statics: EIS and Frisch elasticity

We next investigate how the impact iMPC and the factor-price versus distribution split depend on the elasticity of intertemporal substitution (EIS) and the Frisch elasticity.

J.1 Elasticity of intertemporal substitution

We vary the EIS parameter ψ (with CRRA coefficient $\sigma = 1/\psi$) while re-solving the full model at low and high debt, and we recompute the Auclert impact iMPC and the approximate factor-price/distribution shares described in Section **??**. All other parameters are held fixed.

Table 8 summarises the results for four values of the EIS.[14]

Table 8: EIS comparative statics: impact iMPC and factor-price share

EIS ψ	$\sigma = 1/\psi$	$\text{iMPC}_0^{\text{impact}}$	$\text{iMPC}_1^{\text{impact}}$	$\Delta\text{iMPC}^{\text{impact}}$	Factor-price share s_{pol}
0.3	≈ 3.3	0.159	0.071	-0.089	0.78
0.5	2.0	0.180	0.124	-0.056	0.63
0.6	≈ 1.7	0.188	0.132	-0.056	0.57
0.7	≈ 1.4	0.195	0.136	-0.058	0.51

Two patterns emerge:

1. The impact iMPC falls when moving from low to high debt for all EIS values considered.

2. The relative importance of the factor-price channel *declines* as the EIS rises: when households are more willing to intertemporally substitute (higher ψ), a given change in public debt can be accommodated by smaller changes in the real interest rate, so the distribution channel gains prominence. At $\psi = 0.3$ the factor-price channel accounts for roughly 80% of the absolute change in impact iMPC, whereas at $\psi = 0.7$ the split is close to 50–50.

These comparative statics fit naturally with the model's asset-market clearing condition: for a given change in steady-state public debt, higher EIS implies that the interest rate needs to move less to restore equilibrium, muting the factor-price channel.

J.2 Frisch elasticity of labor supply

We also vary the Frisch elasticity parameter φ in the household block. In the current implementation, the intensive labor-supply decision does not affect the construction of the intertemporal MPCs for transfers to Z, and the household Jacobian with respect to Z is effectively invariant to φ for the steady states we study.

Consistent with this, we find that for $\varphi \in \{0.2, 0.4, 0.6, 0.8\}$:

- The Auclert impact iMPCs at low and high debt are numerically unchanged (within solver precision), with $\text{iMPC}_0^{\text{impact}} \approx 0.1801$ and $\text{iMPC}_1^{\text{impact}} \approx 0.1239$.

[14] For very high EIS ($\psi \geq 0.8$) the current implementation of the full model fails to converge reliably; we therefore report only the range $\psi \in \{0.3, 0.5, 0.6, 0.7\}$.

- The factor-price and distribution shares in the approximate decomposition also remain at $(s_{\text{pol}}, s_{\text{dist}}) \approx (0.63, 0.37)$.

This invariance is therefore an expected feature of the current calibration, rather than a numerical bug: in this version of the model, the Frisch elasticity affects aggregate labor and wages in general equilibrium, but does not shift the micro consumption response to a pure Z-transfer in the way that matters for the iMPC.