The Austerity Threshold*

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Abstract

We introduce a new indicator of fiscal capacity—the "austerity threshold": the debt-to-GDP level above which the government must raise fiscal surpluses to ensure debt safety. In a model with realistic risk premia, nominal rigidities, and an intermediary sector, calibrated to the U.S., we estimate this threshold at 189%. We highlight the roles of safety premia and intermediation-driven convenience yields. The threshold varies with the source of surpluses: spending cuts reduce inflation and allow low interest rates, while tax increases distort labor supply and raise inflation. Uncertainty over the austerity regime – spending cuts or tax increases – sharply lowers fiscal capacity. The expected austerity regime affects asset prices and macro outcomes even when debt-to-GDP is well below the threshold.

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1 Introduction

The global financial crisis (GFC) and the COVID-19 pandemic triggered large fiscal expansions across advanced economies. Government spending surged, producing high deficits and sharp increases in debt-to-GDP ratios. In the U.S., government debt rose from 35% of GDP in 2007 to 103% of GDP in 2020. Rather than consolidating, fiscal policy is projected to sustain large deficits for decades to come, with the Congressional Budget Office (CBO) forecasting a debt-to-GDP ratio of 156% by 2055. Investors remain largely unfazed: despite higher nominal rates, indicators of default and inflation risk premia have stayed low and stable. Yet, the persistent rise in debt has fueled debate over the sustainability of U.S. deficits, with some pointing to real interest rates that were below real rates of growth (Blanchard, 2019), and others questioning how to rationalize the market value of U.S. debt in modern asset pricing models (Jiang et al., 2024a). It seems fair to say that the level of U.S. "fiscal capacity" remains an object of significant uncertainty.

In this paper we ask: at what debt level, if any, must the government generate surpluses — through higher taxes or lower spending — to preserve the safety of debt? We propose a new model-based measure of fiscal capacity and quantify it. In our framework, the government is committed to keeping debt risk-free but delays any fiscal adjustment until absolutely necessary. Fiscal capacity is thus defined as the maximum sustainable debt-to-GDP ratio before surpluses must rise to avert default. In our calibration, this threshold is 189% if stabilization occurs through tax increases and 174% if it occurs through government spending cuts.

To obtain these results, we build a dynamic stochastic general equilibrium model in the New Keynesian (NK) tradition with several key features. First, it generates non-trivial risk and risk premia. The economy experiences both transitory productivity shocks—standard in macroeconomics—and permanent shocks—standard in finance. Combined with a sufficiently high market price of risk, these shocks deliver a realistic output risk premium. The resulting demand for safe assets drives precautionary savings, lowering equilibrium bond yields and government financing costs. Second, the model includes an intermediation sector that uses government debt as input in producing safe, liquid assets, giving rise to a convenience yield that further reduces government borrowing costs. Third, fiscal policy does not adjust continuously to debt, consistent with postwar U.S. data. For a broad range of debt ratios, policy focuses on macroeconomic stabilization and disregards debt sustainability. Once debt crosses an endogenous threshold, however, policy shifts to austerity — either raising taxes or cutting spending to stabilize debt. This "austerity threshold" preserves debt safety: delaying adjustment beyond it would make default unavoidable under some future paths of shocks that hit the economy.

Although the model features an average risk-free rate below the rate of growth ($r^f < g$), fiscal capacity is finite. Safety premia and convenience yields erode as the debt supply rises, limiting the amount of safe debt the government can issue before raising borrowing costs and hitting the austerity threshold.

A key contribution of our analysis is an algorithm that determines the endogenous austerity threshold. Because this threshold depends on all model parameters, our calibrated framework serves as a laboratory for studying the determinants of fiscal capacity. First, we find that a higher elasticity of labor supply sharply reduces fiscal capacity when austerity relies on tax hikes, but has little effect under spending cuts. Second, risk aversion is a crucial determinant of fiscal capacity. In a counterfactual setting with low risk premia, fiscal capacity falls from 189% to 138% (from 174% to 105%) in the tax-austerity (spending-austerity) version of the model, underscoring the importance of safety premia in keeping borrowing costs low. Third, fiscal capacity can be raised either by shortening the average maturity of government debt or by requiring banks to hold more government debt through liquidity regulation, a version of financial repression. Both policies, however, expand fiscal capacity at the cost of crowding out productive investment. Fourth, monetary policy can also increase fiscal capacity, though not by lowering interest rates as one might expect, but rather by credibly committing to raise rates in the austerity region. This commitment enhances fiscal capacity by curbing inflation expectations, lowering long-term bond yields ex-ante.

The choice between tax hikes and spending cuts has distinct implications for macroeconomic outcomes and asset prices. When debt is well below the austerity threshold, the two regimes behave similarly: shocks that raise government transfers increase debt-to-GDP, push up short- and long-term yields and inflation, and crowd out investment and labor supply. Once the economy enters the austerity region, however, their effects diverge. Tax hikes depress labor supply, lowering output and fueling inflation. The central bank, constrained by the negative supply shock, must raise rates further to contain inflation. Spending cuts, by contrast, act as a negative demand shock. Because interest rates are elevated prior to austerity, the central bank can cut rates sharply once austerity begins, stabilizing both output and inflation.

Despite these differences, fiscal capacity is somewhat smaller under spending austerity in our calibration. In both regimes, the government's debt service burden rises on the path to austerity, requiring large surpluses to reduce debt. With tax austerity, capacity is ultimately limited by the distortionary effects on labor supply: once the economy reaches the peak of the Laffer curve, further tax hikes no longer raise revenue. Under spending austerity, capacity is limited by the fact that spending cannot fall below a minimum level required to maintain a functioning economy (0.1% of GDP in our calibration). Given our calibrated values for labor supply elasticity and government spending as a share of GDP, the tax-based regime delivers greater fiscal capacity.

In a final exercise, we examine uncertainty about the fiscal regime. Here, austerity can switch between tax hikes and spending cuts according to a stochastic process. We find that such policy uncertainty sharply reduces fiscal capacity. In an economy where austerity consists of spending cuts with 50% probability and of tax hikes with 50% probability, fiscal capacity shrinks to just 120% of GDP. The reason is the near-opposite effects of the two austerity policies on bond yields and debt valuation. A switch from tax hikes to spending cuts in the austerity region can trigger a sudden increase in the market value of government debt. If the debt level at which this switch occurs is already high, the jump pushes the ratio beyond the level that spending cuts can stabilize. Ruling out explosive debt dynamics requires a much lower austerity threshold. Conversely, the possibility of switching from spending cuts to tax hikes (and the resulting sudden devaluation of government bonds) generates high ex-ante bond risk premia, raising borrowing costs and making austerity more likely. If some political parties prefer tax increases and other spending cuts, uncertainty about austerity regimes could reflect uncertain future political power transitions. CBO projections suggest that the U.S. will breach the austerity threshold under uncertain austerity regimes within the next decade.

Together, these findings show that understanding fiscal capacity requires a modeling approach capable of capturing a wide range of equilibrium debt-to-GDP ratios. Our global solution method reveals the full ergodic distribution of government debt, spanning from 20% to nearly

300%. By contrast, the model's deterministic steady state lies at 75%—a point that is not even modal in the distribution. Approaches that approximate the economy around this steady state cannot quantify fiscal capacity in the sense we define it. Moreover, the U.S. has a relatively short fiscal history with limited variation in debt and surpluses. Our model provides a coherent framework that matches observed macroeconomic time series while quantifying borrowing limits, even if said limits could still be far away from the current fiscal situation.

Related Literature We contribute to the vast literature in macroeconomics that works with New Keynesian (NK) models in several directions.

Our main contribution is the endogenous regime-switching of fiscal policy between active (stabilizing the economy) and passive (stabilizing the debt) depending on the level of the debt/GDP ratio. Unlike standard models in which tax rates and government spending policies respond continuously to changes in the debt-to-GDP ratio to keep debt bounded (reviewed comprehensively by Leeper and Leith, 2016), our method allows an empirically more plausible fiscal policy that focuses on output stabilization most of the time, and only targets debt stabilization when debt/GDP reaches extreme values. Bianchi and Melosi (2019) introduce state-dependent policy targets for monetary and fiscal authorities. Our fiscal rule is also state-dependent but not event-driven. Rather, fiscal policy actively stabilizes aggregate fluctuations until the debt/GDP ratio breaches a bound. Our model is consistent with the empirical evidence in Jiang et al. (2024b) which shows that a higher debt/GDP ratio does not predict higher future surpluses in the U.S. post-war period.

We also contribute to a recent literature that studies fiscal capacity in a world where the government enjoys low borrowing costs due to convenience yields or safety premia.[1] Brunnermeier, Merkel and Sannikov (2024) show that the government can run persistent deficits if precautionary savings motives cause a large safety premium in government bond yields. Our approach considers precautionary safety premia and intermediation-driven liquidity premia, and quantifies the limits to these premia in a model with realistic fiscal policy. Payne and Szőke (2025)

[1] See Blanchard (2019), Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2024a), Barro (2020), Mian, Straub and Sufi (2025), Brunnermeier, Merkel and Sannikov (2024), Reis (2021), Mankiw and Ball (2021), Abel and Panageas (2024), Cochrane (2019a,b), Schmid, Valaitis and Villa (2021), Chen, Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2025), Kaplan, Nikolakoudis and Violante (2023), Payne, Szőke, Hall and Sargent (2024), Payne and Szőke (2025) among others.

study the expansion of fiscal capacity stemming from the hedging properties of debt for the financial sector. Mian, Straub and Sufi (2025) estimate fiscal capacity in a deterministic model with a downward-sloping demand curve for safe debt for different countries. Jiang et al. (2024a, 2025) emphasize that meaningful risk premia are necessary to understand the effect of fiscal policies on debt sustainability. In the presence of realistic output risk premia, keeping government debt risk-free requires making the tax revenue claim safer than the government spending claim. Tax rates in our model are pro-cyclical and government spending is counter-cyclical at business-cycle frequencies, so that the government helps households smooth aggregate risk. However, once the debt/GDP ratio crosses into the austerity region, tax rates increase or government spending decreases to stabilize the debt. Since household marginal utility is high in the austerity region, the tax claim becomes riskier from the households' perspective and safer from the government's perspective. Our model details how long the fiscal authority can wait to inflict austerity on taxpayers if it wants to protect bondholders at all times.

We introduce an intermediation sector which is better at providing credit to firms than households are, and produces deposits that are valued by households, contributing to the recent literature that introduces intermediation in NK models.[2] The intermediary sector provides a source of convenience yields in government debt and allows us to study the effect of financial regulation (repression) on government borrowing costs.

Our non-linear fiscal rule, the presence of non-trivial risk, and the occasionally-binding leverage constraint for intermediaries make the model non-linear and require a global solution method. The NK model becomes more difficult to solve and calibrate since the stochastic steady state is far away from the deterministic steady state. We employ state-of-the-art global projection methods to overcome this challenge. This includes the design of a computationally efficient method to pin down the austerity bound, which allow us to study how different structural parameters such as the labor supply elasticity or risk aversion as well as policy variables such as the maturity structure of government debt or the liquidity coverage ratio for banks affect fiscal capacity. Alternative models with lower risk aversion and a linear fiscal rule result in dramatically different levels of fiscal capacity, illustrating the importance of our new model

[2] Piazzesi, Rogers and Schneider (2021) study the properties of the NK model in a world with ample reserves. Wang (2020) analyzes state-dependent pass-through of monetary policy. Elenev (2020) and Faria-e-Castro (2020) evaluate policy responses during the GFC. Elenev, Landvoigt and Van Nieuwerburgh (2021) study bank capital requirements.

features and solution method.[3]

We study the interaction of a rich set of fiscal policy tools with conventional monetary policy.[4] Labor income and corporate profit taxation, transfer spending, and discretionary spending all depend on the state of the economy, producing the counter-cyclicality of spending and pro-cyclicality of tax revenues quantitatively consistent with data. Even though the large majority of households in the model are "Ricardian" savers, fluctuations in the quantity of debt caused by transfer spending shocks have substantial real effects. These effects depend non-monotonically on the level of debt-to-GDP. We show that the real effects of government debt supply are inherently linked to our model's ability to generate realistic risk premia and convenience yields.

Finally, a literature at the intersection of macro-economics and finance studies how fiscal risk manifests itself in asset prices.[5] It typically works with models where uncertainty about future taxes affects firms' incentives to invest in R&D, leading to lower long-run productivity growth through an endogenous growth mechanism. Our model focuses on the effect of fiscal policy at high level of debt/GDP and its asset pricing implications. We find that the nature of fiscal adjustment, tax increases or spending cuts, generates important differences in the behavior of short- and long-term government bond yields. The key difference is that tax austerity creates high inflation wile spending austerity does not. Inflation risk premia are different in the two cases, even well before the economy crosses into austerity.

The rest of the paper is organized as follows. Section 2 sets up the model. Section 3 describes

[3]Standard NK models typically omit permanent shocks, calibrate low shock volatilities, and standard monetary and fiscal policies remove what little remaining consumption risk households might otherwise face. As a result, the standard NK model generates trivial risk premia. Furthermore, the NK model is typically solved using log-linearization or low-order perturbation methods which mostly ignore aggregate risk premia and their time-variation. De Paoli, Scott and Weeken (2010) document that nominal rigidities combined with monetary policy following a Taylor rule greatly reduce consumption risk in a standard business cycle model. Gourio and Ngo (2020) generate meaningful risk premia in a globally solved NK model with rare disasters and a ZLB on interest rates. Isoré and Szczerbowicz (2017) adapt Gourio (2012)'s approach to perturbation methods, yet require large disaster probabilities to create non-negligible risk premia. Campbell, Pflueger and Viceira (2020) and Pflueger and Rinaldi (2021) introduce habit preferences in an NK model to produce realistically time-varying risk premia.

[4]An extensive literature studies the effects of government spending on output. See, for example Nakamura and Steinsson (2014) and the references therein. In recent work, Billi and Walsh (2021) and Mian, Straub and Sufi (2025) find that higher discretionary spending in an economic crisis can decrease the debt/GDP ratio due to a large fiscal multiplier. Another large literature studies the interaction of fiscal and monetary policy. See Sargent and Wallace (1981); Leeper (1991); Sims (1991); Woodford (1994, 2001); Cochrane (1998), Cochrane (2001); Schmitt-Grohhe and Uribe (2000); Bassetto (2002); Reis (2016); Sims (2016), among many others.

[5]See Croce, Nguyen and Schmid (2012b); Croce, Kung, Nguyen and Schmid (2012a); Pastor and Veronesi (2012); Kelly, Pastor and Veronesi (2015); Croce, Nguyen, Raymond and Schmid (2019); Liu, Schmid and Yaron (2020); Corhay, Kind, Kung and Morales (2021).

the calibration and solution method fo pinning down the austerity bound. Section 4 contains our main results describing the drivers of fiscal capacity. Section 5 studies policy uncertainty about the type of austerity. Section 6 concludes. The appendix provides details on model derivations (A), calibration (B), further quantitative results (C), and computational method (D).

2 Model

The economy is populated by two types of households: savers and hand-to-mouth consumers. The representative saver supplies labor, operates the investment technology, and owns shares in non-financial firms and banks. The saver derives utility from holding deposits issued by financial intermediaries. Hand-to-mouth (HtM) consumers supply labor and consume their wage income and transfers each period. The government issues short-term and long-term nominal debt securities to fund its deficits. Short-term debt includes both T-bills and reserves, high-powered money issued by the central bank. Intermediaries hold short-term government debt and firm capital as assets and issue deposits and equity to saver households. Savers also invest directly in firm capital and hold long-term government debt. We assume that only intermediaries hold short-term debt and only households hold long-term debt, broadly in line with the U.S. data (as discussed in the calibration section).

2.1 Production Technology

Productivity. Productivity Z_t has a permanent and a transitory component $Z_t = Z_t^p Z_t^r$, where

$$\log(Z_t^r) = z_t^r = \rho^z z_{t-1}^r + \varepsilon_t^z, \tag{1}$$

$$\log(Z_t^p) = z_t^p = z_{t-1}^p + g_t, \tag{2}$$

$$g_t = (1-\rho^g)\bar{g} + \rho^g g_{t-1} + \varepsilon_t^g. \tag{3}$$

The innovations to transitory and permanent productivity are jointly normally distributed:

$$(\varepsilon_t^z, \varepsilon_t^g) \sim \text{Normal}(\mu_t, \Sigma_t).$$

Means μ_t are chosen such that $\mathrm{E}[Z_t^r] = 1$ and $\mathrm{E}[g_t] = \bar{g}$. Productivity level and growth shocks are the first source of aggregate risk in the model. Transfer spending shocks, introduced below in Section 2.4, equation (14), are the second source of aggregate risk.

Goods production. Production follows the standard New Keynesian framework (Galí, 2015) with price rigidities. The final output good Y_t is a composite of intermediate good varieties $Y_t(i)$, $i \in [0,1]$ that are combined by a final-goods producer with elasticity of substitution parameter ϵ. Intermediate goods producers are monopolists for their varieties. They choose price $P_t(i)$ and inputs capital $k_t(i)$, labor from savers $n_t(i)$, and labor from HtM consumers $n_t^H(i)$ to maximize real profit:

$$Div_t^P(i) = \frac{P_t(i)}{P_t} Y_t(i) - \left(w_t n_t(i) + w_t^H n_t^H(i) + r_t^K k_t(i)\right) - Z_t^p \Xi^P(P_t(i)/P_{t-1}(i)), \tag{4}$$

where w_t and w_t^H are the real wage for savers and HtM consumers, respectively, and $\Xi^P(P_t(i)/P_{t-1}(i))$ is a convex menu cost for adjusting prices. Profit is paid out in the form of dividends to savers. Intermediate output is produced using a standard Cobb-Douglas technology with aggregate productivity Z_t: $Y_t(i) = Z_t k_t(i)^{1-\alpha-\alpha_H} n_t(i)^{\alpha} n_t^H(i)^{\alpha_H}$. The details are in Appendix A.

2.2 Financial Intermediaries

Financial intermediaries are firms that maximize the present value of dividends paid to their shareholders. On the asset side, intermediaries invest in $X_t^{I,K}$ units of capital at real price Q_t and buy $B_t^{I,S}$ short-term government bonds at nominal price p_t^S. On the liability side, they issue deposits D_t^I, modeled as one-period discount bonds, at nominal price p_t^D, and equity to the saver households. Intermediaries have beginning of period equity capital W_t^I and are expected to pay a fraction η of equity to their shareholders each period. When they raise new outside equity A_t, they incur a quadratic equity adjustment cost with parameter χ. The total real payout to households each period is

$$Div_t^I = \eta \frac{W_t^I}{P_t} - A_t. \tag{5}$$

Intermediaries are subject to two regulatory restrictions. First, equity capital regulation requires the following constraint on deposits D_t^I (bank debt):

$$D_t^I \leq \nu \left(B_t^{I,S} + \nu_K P_t Q_t X_t^{I,K} \right), \tag{6}$$

where ν restricts the total leverage of the intermediary, and ν_K reflects the higher risk weight on capital relative to short-term government bonds. The overall maximum leverage ratio ν reflects the Supplementary Leverage Ratio (SLR) constraint in real-world bank capital regulation.[6]

The second regulatory restriction banks face captures the Liquidity Coverage Ratio (LCR) in U.S. bank regulation. Banks incur a liquidity cost per unit of deposits issued:

$$\varrho_t = \varrho_0 \zeta_\varrho \left(\frac{B_t^{I,S}}{\zeta_\varrho D_t^I} \right)^{1-\varrho_1}, \tag{7}$$

where ζ_ϱ is the fraction of deposits a particular bank's depositors can be expected to withdraw per period, and ϱ_0 scales the liquidity cost. We assume that exponent $\varrho_1 > 1$, such that the cost is decreasing in short-term bonds/reserves.

In summary, financial intermediaries solve:

$$\max_{X_t^{I,K}, B_t^{I,S}, D_t^I, A_t} \sum_{k=0}^{\infty} \mathcal{M}_{t,t+k} Div_{t+k}^I$$

subject to the budget constraint:

$$(1-\eta) W_t^I + P_t A_t + (p_t^D - P_t \varrho_t) D_t^I + \text{Rebates}_t^I \geq p_t^S B_t^{I,S} + P_t Q_t X_t^{I,K} + P_t Z_t^P \frac{\chi}{2} \left(\frac{A_t}{Z_t^p} \right)^2,$$

no-shorting constraints $X_t^{I,K} \geq 0$, $B_t^{I,S} \geq 0$, and the regulatory constraint (6). Intermediaries discount dividend payouts with the saver household discount factor $\mathcal{M}_{t,t+k}$. Liquidity costs are rebated lump-sum: $\text{Rebates}_t^I = P_t \varrho_t D_t^I$.

[6]The price level P_t appears in the expression because D_t^I and B_t^I are nominal quantities, while $Q_t X_t^{I,K}$ is the real value of capital.

The transition law for bank equity W_t^I is given by

$$W_t^I = P_t \left(r_t^K + (1-\delta)Q_t\right) X_{t-1}^{I,K} + B_{t-1}^{I,S} - D_{t-1}^I.$$

with r_t^K the marginal product of capital and δ the capital depreciation rate.

2.3 Household Sector

There are two types of households: savers and hand-to-mouth households.

Savers. Savers consume C_t of the final output good and supply labor N_t to intermediate goods producers. They invest D_t^S in intermediary deposits, which they value for their liquidity services in addition to their pecuniary payoff. Savers also value government services provided through discretionary government spending G_t, giving rise to the intra-period utility function:

$$u(C_t, D_t^S, N_t) = \frac{\left(C_t^{1-\psi}(D_t^S)^\psi\right)^{1-\varphi}}{1-\varphi} + \psi_G \frac{G_t^{1-\varphi}}{1-\varphi} - (Z_t^p)^{1-\varphi}\omega_0 \frac{N_t^{1+\omega_1}}{1+\omega_1}$$

Labor supply is endogenous and ω_1 controls the Frisch elasticity.

Savers have recursive preferences with subjective time discount factor β, inter-temporal elasticity of substitution $1/\varphi$, and risk aversion parameter γ, such that their value function is:[7]

$$V_t^S = (1-\beta)u(C_t, D_t^S, N_t) + \beta \mathrm{E}_t \left[(V_{t+1}^S)^{\frac{1-\gamma}{1-\varphi}}\right]^{\frac{1-\varphi}{1-\gamma}}. \tag{8}$$

In addition to deposits, savers purchase $X_t^{S,K}$ units capital at real price Q_t and $B_t^{S,L}$ long-term government bonds at nominal price p_t^L.[8]

Savers further operate the economy's investment technology, which creates I_t units of capital from $I_t + \Phi(I_t, K_t)$ units of the consumption good.

[7]This definition of the value function requires $\varphi < 1$. A constant may have to be added to intra-period utility to ensure that the value function has the same sign for all feasible choices, see Appendix A. Separable utility over consumption and labor within Epstein-Zin preferences generally implies that γ is not equal to relative risk aversion, see Appendix D.2.

[8]We could allow for costs associated with capital holdings to capture the comparative disadvantage that households have relative to banks in terms of lending directly to firms. However, it turns out that we do not need such costs to generate the fact that most intermediation occurs through the intermediary sector.

In summary, each period savers choose consumption, investment, deposits, capital, and long-term bond holdings to maximize (8) subject to the budget constraint:

$$\begin{aligned} &P_tC_t + P_t(I_t + \Phi(I_t, K_t)) + p_t^D D_t^S + p_t^L B_t^{S,L} + P_tQ_tX_t^{S,K} \\ &\quad \leq W_t^S + P_t(1-\tau_t^w)w_tN_t + P_tQ_tI_t + P_t(1-\tau_t^{div})(Div_t^I + Div_t^P) + P_t\Theta_t + \text{Rebates}_t, \end{aligned} \quad (9)$$

where W_t^S is saver financial wealth at the beginning of t. Additional resources for savers are labor income w_tN_t, which gets taxed at rate τ_t^w (equation (16) below), profits of intermediate-goods producers and financial intermediaries, which get taxed at rate τ_t^{div} (equations (4) and (5)), value of investment goods $P_tQ_tI_t$, transfer payments from the government Θ_t (equation (15) below), and lump-sum rebates of menu costs from producers and equity issuance costs from banks:[9]

$$\text{Rebates}_t = Z_t^p P_t \Xi^P(P_t(i)/P_{t-1}(i)) + \frac{P_t}{Z_t^p}\frac{\chi}{2}A_t^2. \quad (10)$$

The transition law for saver wealth is:

$$W_t^S = P_t\left(r_t^K + (1-\delta)Q_t\right)X_{t-1}^{S,K} + D_{t-1}^S + (c + 1 - \delta^B + \delta^B p_t^L)B_{t-1}^{S,L}. \quad (11)$$

The payoff to each long-term bond in (11) consists of the coupon c, amortization of old debt $1-\delta^B$, and the market value of remaining debt $\delta^B p_t^L$.

Hand-to-Mouth Households. HtM households (Campbell and Mankiw, 1989; Bilbiie, 2008) do not hold savings and each period consume their full income, which consists of labor earnings and transfers. They maximize the same period utility function as the savers (absent deposits since they do not save):

$$u(C_t^H, N_t^H) = \frac{\left(C_t^H\right)^{1-\varphi}}{1-\varphi} + \psi_G\frac{G_t^{1-\varphi}}{1-\varphi} - (Z_t^p)^{1-\varphi}\omega_0\frac{(N_t^H)^{1+\omega_1}}{1+\omega_1},$$

[9] As is standard, investment adjustment costs $\Phi(I_t, K_t)$ are not rebated and thus represent resource losses. Equity issuance costs are paid by banks but are rebated to households. While the rebate ensures that they are not aggregate resource losses, the fact that they are paid out of an intermediary's limited funds contributes to the frictional nature of equity issuance.

subject to the budget constraint

$$C_t^H = (1 - \tau_t^H) w_t^H N_t^H + \Theta_t^H.$$

2.4 Government

2.4.1 Fiscal Policy

The fiscal authority raises revenue by taxing firm and bank payouts (T_t^{div}) and labor earnings of both types of households ($T_t^w + T_t^{w,H}$). Their uses of funds are transfers ($\Theta_t + \Theta_t^H$) and discretionary spending (G_t). We define further below how these fiscal quantities depend on the aggregate state. The primary surplus is:

$$S_t = T_t^w + T_t^{w,H} + T_t^{div} - G_t - \Theta_t - \Theta_t^H. \tag{12}$$

The government follows fiscal rules to determine taxation and spending. All fiscal rules may depend on the level of output relative to the economy's productivity trend, $\hat{Y}_t = Y_t / Z_t^p$, which we refer to as cyclical output. Further, fiscal rules depend on the level of government debt relative to GDP,

$$\Delta_t = W_t^G / Y_t,$$

with W_t^G denoting the market value of government bonds at the beginning of t.

Finally, fiscal rules depend on the **fiscal regime** F_t, a binary random variable that follows a Markov chain with transition matrix Π_F. If $F_t = 0$, the fiscal regime is *spending austerity*, while $F_t = 1$ indicates *tax austerity*. We explain below how the fiscal regime affects spending and taxation.

Spending. Discretionary spending is a fraction of GDP γ_t, such that $G_t = \gamma_t Y_t$. The spending share is a function $\gamma_t = \gamma(\hat{Y}_t, \Delta_t, F_t)$, which can be further factorized into

$$\gamma(\hat{Y}_t, \Delta_t, F_t) = \begin{cases} \gamma_0 \hat{\gamma}(\hat{Y}_t) f_\gamma^P(\Delta_t, F_t) & \text{if } \Delta_t < \underline{\Delta} \\ \gamma_0 \hat{\gamma}(\hat{Y}_t) & \text{if } \overline{\Delta} > \Delta_t \geq \underline{\Delta} \\ \gamma_0 \hat{\gamma}(\hat{Y}_t) f_\gamma^A(\Delta_t, F_t) & \text{if } \Delta_t \geq \overline{\Delta}. \end{cases} \tag{13}$$

The first component is the steady state spending share γ_0. The second component $\hat{\gamma}(\hat{Y}_t)$ is concerned with macroeconomic stabilization, $\hat{\gamma}'(\hat{Y}_t) < 0$, meaning the government raises spending relative to GDP during an economic downturn and vice versa. The third component, consisting of functions $f_\gamma^P(\Delta_t, F_t)$ and $f_\gamma^A(\Delta_t, F_t)$, is concerned with debt stabilization. When the debt/GDP ratio Δ_t falls below the threshold $\underline{\Delta}$, the fiscal authority enters "profligacy" and depending on the fiscal regime state F_t, may increase spending according to function $f_\gamma^P(\Delta_t, F_t) \geq 1$. Similarly, when Δ_t rises above $\overline{\Delta}$, the fiscal authority enters "austerity" and may cut spending according to $f_\gamma^A(\Delta_t, F_t) \leq 1$ depending on the fiscal regime F_t.

Transfer spending depends on the exogenous aggregate transfer spending shock ϑ_t that follows a Markov chain with transition matrix Π_ϑ. Transfer spending to both types of households is also a time-varying fraction of GDP. Transfer spending is subject to low frequency shocks, represented by ϑ_t, which captures factors such as demographics or political trends that are outside of the model. Along with productivity and fiscal regime shocks, shocks to ϑ_t are a source of aggregate risk in the model. Per-period transfer spending is defined as:

$$\Theta_t = \vartheta_t \theta_t Y_t, \quad \Theta_t^H = \vartheta_t \theta_t^H Y_t. \tag{14}$$

The transfer spending function for savers $\theta_t = \theta(\hat{Y}_t, \Delta_t, F_t)$ is defined analogous to the discretionary spending function

$$\theta(\hat{Y}_t, \Delta_t, F_t) = \begin{cases} \theta_0 \hat{\theta}(\hat{Y}_t) f_\theta^P(\Delta_t, F_t) & \text{if } \Delta_t < \underline{\Delta} \\ \theta_0 \hat{\theta}(\hat{Y}_t) & \text{if } \overline{\Delta} > \Delta_t \geq \underline{\Delta} \\ \theta_0 \hat{\theta}(\hat{Y}_t) f_\theta^A(\Delta_t, F_t) & \text{if } \Delta_t \geq \overline{\Delta}, \end{cases} \tag{15}$$

with steady state transfer share θ_0, cyclical component $\hat{\theta}(\hat{Y}_t)$ that satisfies $\hat{\theta}'(\hat{Y}_t) < 0$, and profligacy and austerity adjustment function $f_\theta^P(\Delta_t, F_t) \geq 1$ and $f_\theta^A(\Delta_t, F_t) \leq 1$, respectively. The transfer spending rule for HtM consumers $\theta^H(\hat{Y}_t, \Delta_t, F_t)$ is identical to the rule for savers, with the only difference being a different steady state level of transfers θ_0^H.

Taxation. Tax rates of labor earnings for savers are given by the tax function $\tau_t^w = \tau^w(\hat{Y}_t, \Delta_t, F_t)$ which is defined as

$$\tau^w(\hat{Y}_t, \Delta_t, F_t) = \begin{cases} \tau_0^w \hat{\tau}(\hat{Y}_t) f_\tau^P(\Delta_t, F_t) & \text{if } \Delta_t < \underline{\Delta} \\ \tau_0^w \hat{\tau}(\hat{Y}_t) & \text{if } \overline{\Delta} > \Delta_t \geq \underline{\Delta} \\ \tau_0^w \hat{\tau}(\hat{Y}_t) f_\tau^A(\Delta_t, F_t) & \text{if } \Delta_t \geq \overline{\Delta}, \end{cases} \tag{16}$$

where as for spending, τ_0^w specifies the steady state tax rate, $\hat{\tau}_w(\hat{Y}_t)$ governs the pro-cyclicality of tax revenues out of labor income with $\hat{\tau}_w'(\hat{Y}_t) > 0$, and $f_\tau^P(\Delta_t, F_t) \leq 1$ and $f_\tau^A(\Delta_t, F_t) \geq 1$ govern adjustments to tax rates in profligacy or austerity. The tax function for HtM consumers $\tau^{w,H}(\hat{Y}_t, \Delta_t, F_t)$ is identical except for a different steady state tax rate $\tau_0^{w,H}$. With these tax rates defined, labor income tax revenue collected from savers and HtM consumers is $T_t^w = \tau_t^w w_t N_t$ and $T_t^{w,H} = \tau_t^{w,H} w_t^H N_t^H$.

The tax rule for corporate payouts τ_t^{div} incorporates macro stabilization, but is not subject to debt stabilization for simplicity:

$$\tau_t^{div}(\hat{Y}_t, \Delta_t, F_t) = \begin{cases} \tau_0^{div} \hat{\tau}_{div}(\hat{Y}_t) f_\tau^P(\Delta_t, F_t) & \text{if } \Delta_t < \underline{\Delta} \\ \tau_0^{div} \hat{\tau}_{div}(\hat{Y}_t) & \text{if } \overline{\Delta} > \Delta_t \geq \underline{\Delta} \\ \tau_0^{div} \hat{\tau}_{div}(\hat{Y}_t) f_\tau^A(\Delta_t, F_t) & \text{if } \Delta_t \geq \overline{\Delta}, \end{cases} \tag{17}$$

with $\hat{\tau}_{div}'(\hat{Y}) > 0$. Corporate tax revenue collections are $T_t^{div} = \tau_t^{div}(Div_t^I + Div_t^P)$.

Profligacy and Austerity. Rules (13), (15) and (16) allow a flexible response of fiscal policy to the level of debt/GDP Δ_t and the fiscal regime F_t. We consider empirically relevant cases characterized by specific forms for the adjustment functions $f_j^P(\Delta_t, F_t)$ and $f_j^A(\Delta_t, F_t)$, for $j \in \{\gamma, \theta, \tau\}$. First, we assume that fiscal adjustments that prevent Δ_t from becoming very low, always occur through low tax rates. This assumption is broadly consistent with the experience of the U.S. as well as other countries. In terms of our model, this means $f^P_\gamma(\Delta_t, F_t) = f^P_\theta(\Delta_t, F_t) = 1$ and

$$f^P_\tau(\Delta_t, F_t) = \left(\frac{\Delta_t}{\underline{\Delta}}\right)^{\tau_P}. \tag{18}$$

Combined, the profligacy adjustment functions imply that spending does not change in profligacy, but tax rates decline with an elasticity parameterized by τ_P in (18).

Unlike profligacy, whether austerity is implemented as spending cuts or tax increases depends on the fiscal regime. Spending and transfers are scaled down when $\Delta_t > \overline{\Delta}$ and the tax regime is $F_t = 0$:[10]

$$f^A_\gamma(\Delta_t, F_t) = (1 - \mathbb{1}_{[F_t=0]}) + \mathbb{1}_{[F_t=0]}\gamma_A \left(\ln(\Delta_t) - \ln(\overline{\Delta})\right), \tag{19}$$

$$f^A_\theta(\Delta_t, F_t) = (1 - \mathbb{1}_{[F_t=0]}) + \mathbb{1}_{[F_t=0]}\theta_A \left(\ln(\Delta_t) - \ln(\overline{\Delta})\right), \tag{20}$$

with $\gamma_A \leq 0$ and $\theta_A \leq 0$. The tax adjustment factor is activated when the austerity regime is $F_t = 1$:

$$f^A_\tau(\Delta_t, F_t) = \left(\frac{\Delta_t}{\overline{\Delta}}\right)^{\mathbb{1}_{[F_t=1]}\tau_A}. \tag{21}$$

while spending adjustment factors f^A_γ and f^A_θ are both equal to 1 in that case. The key elasticities are the parameters $(\gamma_A, \theta_A, \tau_A)$.

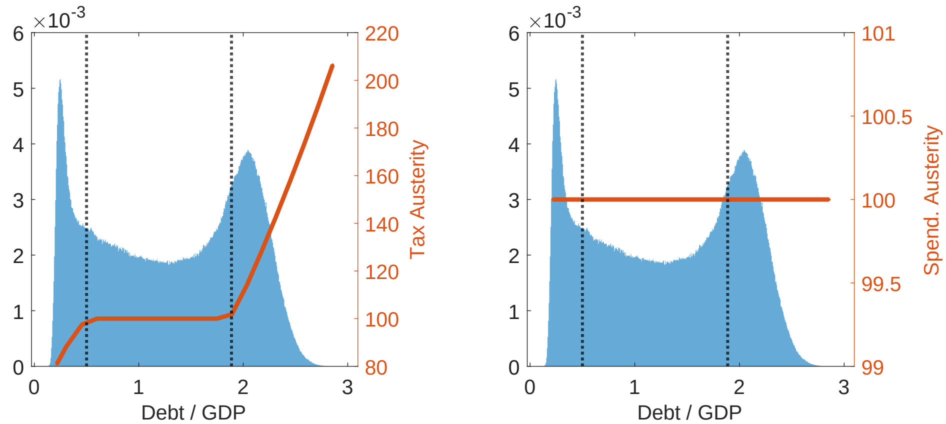
The fiscal rules and their adjustments in profligacy and austerity are depicted in Figure 1, which is based on the calibrated model detailed in Section 3.1. Panel (a) shows a histogram (in blue) of the debt/GDP ratio from a long simulation of the model that is permanently in the tax austerity regime, $\text{Prob}(F_t = 1) = 1$. The dashed vertical line on the left with debt/GDP around 0.5 is the profligacy threshold $\underline{\Delta}$ and the vertical line on the right for debt/GDP around 2 is the austerity threshold $\overline{\Delta}$. The tax adjustment factor (in red) is plotted against the right axis. Tax rates are scaled down in profligacy, but rise sharply in austerity. The spending adjustment in the top right panel is constant at 1 in the tax austerity regime.

Panel (b) shows the histogram for certain spending austerity, $\text{Prob}(F_t = 0) = 1$. The tax

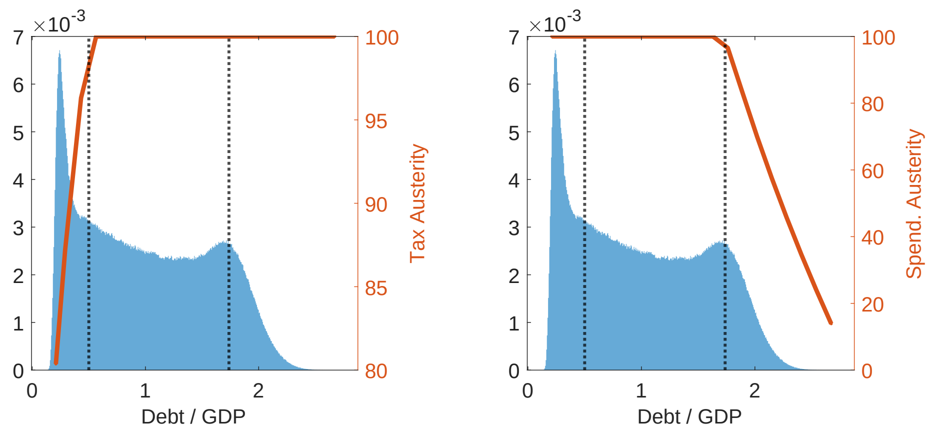
[10] We assume that if government spending hits zero, the economy stops producing any output. While this assumption governs behavior off the equilibrium path, it helps rule out a situation where spending languishes at zero until favorable shocks hit the economy.

adjustment factor in the left panel cuts tax rates in profligacy, but does not respond to austerity. Rather, spending is scaled down rapidly in the austerity region, as can be seen in the bottom right graph.

Figure 1: Fiscal Adjustment Factors



(a) Tax Austerity



(b) Spending Austerity

Note: This figure shows the histogram of debt/GDP from the calibrated simulated model under certain tax austerity, Prob$(F_t = 1) = 1$ in top panel (a) and under certain spending austerity, Prob$(F_t = 0) = 1$, in bottom panel (b). The histograms are overlaid with the conditional means of the tax and spending adjustment factors (f^P_τ, f^A_τ), (f^P_γ, f^A_γ), and (f^P_θ, f^A_θ) defined in (18) – (21) and plotted against the right axes. We impose $f^A_\gamma = f^A_\theta$, so there is one adjustment factor for both categories of spending, and set $f^P_\gamma = f^P_\theta = 1$.

Debt issuance. Given the surplus in (12) and beginning of period debt W^G_t, the government budget constraint dictates how much new debt must be issued:

$$W^G_t = S_t + p^S_t B^{G,S}_t + p^L_t B^{G,L}_t, \tag{22}$$

where $B_t^{G,m}$ is the quantity of nominal bonds issued at market price p_t^m of maturity $m \in \{S, L\}$.

The fiscal authority keeps the maturity composition of newly issued government debt constant in book value terms, with a fraction $\bar{\mu}$ of debt being long-term. Then constant issuance in book values for debt requires:

$$\frac{B_t^{G,S}}{B_t^{G,L}} = \frac{1-\bar{\mu}}{\bar{\mu}}.$$

The total issuance required to satisfy the budget constraint, $W_t^G - S_t$, must be met in market value terms, implying:

$$B_t^{G,S} = \frac{(1-\bar{\mu})(W_t^G - S_t)}{(1-\bar{\mu})p_t^S + \bar{\mu}p_t^L}, \quad B_t^{G,L} = \frac{\bar{\mu}(W_t^G - S_t)}{(1-\bar{\mu})p_t^S + \bar{\mu}p_t^L}. \tag{23}$$

The transition law for the market value of the government debt portfolio is then

$$W_{t+1}^G = B_t^{G,S} + (c + 1 - \delta^B + \delta^B p_{t+1}^L)B_t^{G,L}. \tag{24}$$

2.4.2 Monetary Policy

The central bank chooses the interest rate on short-term government debt $i_t^S = 1/p_t^S - 1$. This is consistent with the central bank directly setting the interest rate on reserves, as in the current policy regime. It is also compatible with a central bank that has a small balance sheet and uses open-market operations to target the rate in the inter-bank market. In both cases, absence of arbitrage ensures the policy rate set by the central bank coincides with yield on short-term debt and reserves.

We consider a standard monetary policy rule of the form:

$$\frac{1}{p_t^S} = \frac{1}{\bar{p}^S}\left(\frac{\Pi_t}{\bar{\Pi}}\right)^{\phi^\pi}\left(\frac{\hat{Y}_t}{\bar{Y}}\right)^{\phi^y}, \tag{25}$$

where we denote gross inflation as $\Pi_t = P_t/P_{t-1}$. The central bank's inflation target is $\bar{\Pi}$ and its target level for cyclical output is $\bar{Y}$. The rule specifies deviations from the average gross interest rate $1/\bar{p}^S$.

2.5 Market Clearing

Short-term and long-term government debt, deposit, labor, firm capital, and goods market must clear in equilibrium. Appendix A contains the market clearing conditions.

3 Solution and Calibration

We solve the model using a global non-linear solution method, and calibrate parameters by matching model moments from a long simulation to corresponding data moments. We first discuss the calibration, and then provide an overview how the model is solved and simulated. We further describe the algorithm to determine the austerity threshold as maximum upper bound to the government's inaction region for debt stabilization.

3.1 Calibration

Appendix B contains a detailed discussion of the extensive model calibration work. In the interest of space, the main text summarizes the key points. Our calibration matches data moments from the post-WW2 era. To compute moments from the model, we use a conditional simulation sample with debt/GDP ratios of 103% or smaller, which was the peak of marketable debt/GDP in the data reached in 2020. Thus, debt/GDP ratios in the model span the same range of debt/GDP as the post-war sample.[11]

Productivity parameters directly target real consumption growth and moments of the TFP series of Fernald (2012). To help the model produce an upward-sloping term structure of interest rates, permanent and transitory shocks are perfectly positively correlated. Production and adjustment cost parameters are standard. The elasticity of substitution for the final goods producer matches average markups and the Rotemberg adjustment cost targets the volatility of the labor share through its effect on labor demand.

Intermediary sector parameters match regulatory features such as the maximum leverage ratio (ν in the SLR constraint) and equity requirement for capital (the risk weight ν_K). The

[11] The baseline calibration assumes tax austerity with probability one. Since the austerity threshold is far above 103% of GDP, the choice of austerity regime exerts only a modest influence on the calibration.

equity payout η targets intermediary leverage and the equity issuance cost χ targets the net payout ratio of the financial sector. The fraction of deposits ζ_ρ a particular bank's depositors can be expected to withdraw per period and is set to 0.05 following BIS (2013). The LCR parameter ρ_1 targets the spread between short-term debt and deposits of 0.20% quarterly.

Hand-to-mouth consumers' share of labor, $\alpha_H = 6.8\%$, is set based on the share of labor income received by households with low net worth to income in the Survey of Consumer Finances. This data source also informs the share of transfers received by these households. We assume they pay no taxes.

Both types of households, savers and HtM consumers, share the same preferences. The coefficient of risk aversion γ targets the risk premium on a claim to GDP of 1.0% per quarter. The corresponding Arrow-Pratt measure of relative risk aversion is around 3. We set the elasticity of inter-temporal substitution to 1/0.7 to target the volatility of the consumption to GDP ratio. The subjective discount factor of households β targets the average quarterly real rate of 0.42% quarterly. The Frisch elasticity of labor supply is set to 0.5 ($\omega_1 = 2$), a standard value in NK HANK models. Households' utility benefit from deposits ψ targets the term spread of 0.33% quarterly. Finally, household utility from government spending is set to $\psi_G = 0.213$. At this value, the utility benefit from government spending is exactly offset by the utility loss due to lower consumption caused by higher taxation needed to finance this amount of spending.[12]

Our fiscal policy rules $(\tau^w, \tau^H, \tau^{div}, \gamma, \theta)$ are calibrated to match the unconditional average and cyclical properties of transfer spending, discretionary spending, and tax revenue, with $\tau^H_t = 0$, i.e. HtM households paying no taxes. The transfer spending shock ϑ_t follows a two-state Markov chain with values $[\vartheta_l, \vartheta_h]$ chosen to match average transfer spending to GDP before 1990 (low) and after 1990 (high). We choose the diagonal entries of the transition matrix Π_ϑ to match the high persistence of demographic and political cycles governing transfer spending.

To calibrate the transition matrix Π_F of the fiscal regime cycle F_t, we fix the unconditional probability of being in the tax austerity regime $\Pr(F_t = 1)$, and the first-order autocorrelation of the process. Given these two restrictions, the entries of the matrix are uniquely determined.

[12] We find the value of ψ_G for which the observed level of spending in the data maximizes utility in the economy's steady state.

We are not aware of good data that would allow to pin down the parameter $\Pr(F_t = 1)$; instead, we use our model as testing ground for different values. We set the autocorrelation implied by Π_F to match the autocorrelation of the U.S. presidential cycle since 1920.

The parameter $\overline{\mu}$ is set to match the observed fraction of debt longer than one year maturity (67%). We set δ^B to match the maturity of long-term government debt to 7.76 years. A novel feature of our model is the endogenous regime-switching of fiscal policy based on profligacy and austerity regions. We describe how we choose the thresholds $\underline{\Delta}$ and $\overline{\Delta}$ in the next section 3.2.

The Taylor rule coefficient on inflation ϕ^π is set to 1.6, targeting the volatility of inflation in the model to the volatility of deviations from the inflation target in the data, using a $\bar{\Pi}$ =2% inflation target and the core PCE price index.[13] The coefficient on output ϕ^y is set to 0.125, a standard value in the literature.[14]

We assume that households hold all of the long-term debt and the intermediary holds all of the short-term debt in our model. For short-term bonds, this assumption follows Lenel et al. (2019). To assess the assumption on long-term bonds, we look at Treasury holdings from the Financial Accounts of the United States. The broadly defined financial sector (insurance companies, money market funds, mutual funds, and depository institutions) only holds 5.8% of long-term debt on average over the period 1953–2020.

3.2 Solution Method

The model's exogenous state variables are productivity, transfer spending, and fiscal regime shocks. The endogenous aggregate state variables are capital, intermediary wealth, the market value of outstanding government debt, and household wealth. Appendix D discusses the solution method used to solve the model. As is common for global methods, the numerical algorithm involves finding the right interpolation grid for endogenous state variables.

The histogram from the simulated model in Figure 1 shows that government debt has a wide support, with the lowest debt/GDP ratios close to 20% (in profligacy), and the highest close to 300% (in austerity). The distribution of debt/GDP is bimodal, without a clear notion of a

[13]We choose deviations from the inflation target as our data target since raw inflation volatility in the data is largely driven by low frequency movements in the inflation target, whereas the target is constant in the model.

[14]Qualitatively, results would be unchanged if we set this coefficient to zero.

"steady state." A key contribution of this paper is to determine the endogenous bounds, and the austerity threshold, of the government debt state variable. Unlike modeling approaches that use fiscal rules to center government debt around some deterministic steady state value, our approach uncovers the widest permissible range of government debt realizations subject to the premise that debt remains without risk of default.

Profligacy threshold. First, we set the profligacy threshold $\underline{\Delta}$ such that the lowest value of debt/GDP in the simulation equals the lowest value we observe in the post-WW2 data. This implies a value of $\underline{\Delta} = 50\%$. A lower threshold does not substantially change the results of our quantitative experiments, which are mainly concerned with interactions of monetary and fiscal policy at high debt/GDP.[15] We set the lowest point of the government debt grid, $\hat{\underline{\Delta}}$, such that all simulated paths are interior.

Austerity threshold. The austerity threshold $\overline{\Delta}$, the key object in this paper, is determined endogenously, as function of all other model parameters. Our algorithm to determine the threshold introduces another endogenous model parameter: the upper bound of the government debt grid, $\hat{\overline{\Delta}}$. The algorithm parameterizes the upper bound as multiple of the austerity threshold

$$\hat{\overline{\Delta}} = \overline{\Delta} e^{m_\Delta}, \tag{26}$$

with $m_\Delta > 0$ setting the distance $[\overline{\Delta}, \hat{\overline{\Delta}}]$.

We can view the austerity threshold $\overline{\Delta}$ as a function of all model parameters Θ and the distance parameter m_Δ, $\overline{\Delta} = h(m_\Delta, \Theta)$, with the property

$$h_m(m_\Delta, \Theta) = \frac{\partial h(m_\Delta, \Theta)}{\partial m_\Delta} \geq 0.$$

The threshold is weakly increasing in the distance parameter. Raising m_Δ leads to a larger distance between threshold and upper bound of the grid and thus a larger austerity adjustment region, in which the government raises tax rates or cuts spending to rein in the debt. Increasing

[15] Setting the profligacy threshold at lower levels while recalibrating model parameters to match the same data targets for interest rates and inflation, has little economic effects, other than allowing the model to generate even smaller realizations of debt/GDP.

the size of this region allows the adjustment process to start at a (weakly) higher threshold. However, at some point the returns to increasing m_Δ vanish; in case of tax increases, the economy reaches the peak of the Laffer curve, and in the case of spending cuts, it reaches the point where all spending has been eliminated. The basic idea of the algorithm is thus to keep increasing m_Δ until $h_m(m_\Delta, \Theta) = 0$.

Our criterion for safety of the debt is simulation-based. An alternative approach is to check all possible exogenous and endogenous Markov transitions of the model, and verify that they map the state variables back to the interior of the state space. While it is possible to apply this criterion to the model, we found it overly strict, since it imposes interior transitions in areas of the state space that are not in the ergodic distribution of the model. These transitions need not be interior to guarantee debt safety, since they only occur "off equilibrium."[16]

Meta parameters for the algorithm are the size of the simulation, two step sizes ι_Δ and ι_m, and a termination criterion *tol*. We simulate the model for 50,000 paths of 3,320 model periods (quarters), discarding the initial 3,000 period as burn-in. Thus, we essentially consider 50,000 alternative 80-year (320 quarter) histories for which government debt must remain safe. We set the step sizes $\iota_\Delta = 0.1$ and $\iota_m = 0.01$. To decide when to terminate the algorithm, we calculate the fraction of paths in the simulation that violate the upper bound of the grid

$$fv\left(\overline{\Delta}, m_\Delta\right) = \frac{\#\text{explosive paths}}{\#\text{all paths}}.$$

The termination criterion is $tol = 1/50,000$.[17]

Algorithm: Start with an initial guess $\left(\overline{\Delta}^{(0)}, m_\Delta^{(0)}\right)$. Compute the model at this guess.

1. Determine maximum threshold $\overline{\Delta}^{(i)}$ for current guess $m_\Delta^{(i)}$. Set $\overline{\Delta}^{(i,j)} = \overline{\Delta}^{(0)}$.

   a. Compute the model using $\left(\overline{\Delta}^{(i,j)}, m_\Delta^{(i)}\right)$, i.e. setting the grid upper bound according

[16] Computing the numerical solution to the model requires choosing sufficiently wide boundaries for all endogenous state variables, not only government debt. However, it is impossible to know the ergodic distribution of the state variables until computing the model solution. The ergodic distribution can be learned either by simulation or inspecting the Markov transition matrix of the full model. Judd, Maliar and Maliar (2011) compare these approaches.

[17] An alternative algorithm accepts the largest possible threshold with zero violations. Increasing this threshold by an infinitesimal amount would cause one violating path. Our algorithm is a computationally faster approximation of this approach yielding essentially identical numerical results.

to (26).

b. Simulate and compute the ratio $fv^{(i,j)} = fv\left(\overline{\Delta}^{(i,j)}, m_\Delta^{(i)}\right)$. Set

$$\overline{\Delta}^{(i,j+1)} = \begin{cases} \overline{\Delta}^{(i,j)} - \iota_\Delta & \text{if } fv^{(i,j)} > tol \\ \overline{\Delta}^{(i,j)} + \iota_\Delta & \text{if } fv^{(i,j)} = 0 \\ \overline{\Delta}^{(i,j)} & \text{if } fv^{(i,j)} \in [0, tol]. \end{cases}$$

c. If $\overline{\Delta}^{(i,j+1)} = \overline{\Delta}^{(i,j)}$, set $\overline{\Delta}^{(i)} = \overline{\Delta}^{(i,j)}$ and go to 2. Otherwise, go back to step a.

2. If $\overline{\Delta}^{(i)} > \overline{\Delta}^{(i-1)}$, set $m_\Delta^{(i+1)} = m_\Delta^{(i)} + \iota_m$ and go to step 1. Otherwise, stop.

The algorithm has an inner and outer loop. The inner loop, consisting of steps a.-c., determines the highest possible austerity threshold $\overline{\Delta}^{(i)}$ for a given guess of the distance parameter $m_\Delta^{(i)}$. This inner loop accepts a threshold that causes upper bound violations for at most *tol* paths as fraction of the total. Since we simulate 50,000 paths and set $tol = 1/50,000$, we accept the threshold that leads to exactly one violation. The outer loop raises the distance parameter m_Δ until no further increase in $\overline{\Delta}^{(i)}$ can be achieved.

We choose 80 years as simulation path length, since this is roughly the length of the post-WW2 sample, but the results are not sensitive to longer paths. We use a wide simulation with many paths to determine the safety of the debt. The simulation used to calibrate the model and generate the histogram plots has fewer but longer paths, with 400 paths of 10,000 periods. We found that a greater number of paths is a stricter criterion for the threshold algorithm, while longer simulation paths are more reliable for computing model calibration moments. Increasing the number of paths beyond 50,000 does not cause higher $fv\left(\overline{\Delta}, m_\Delta\right)$. Thresholds with one violating path in the 50,000/320 simulations, are fully interior with zero violating paths in the 400/10,000 simulations for all experiments we computed.

4 Drivers of Fiscal Capacity

In this section, we present three sets of results. First, we study how different implementations of austerity, either through tax increases or spending cuts, differentially affect macroeconomic outcomes and asset prices. Second, we study determinants of fiscal capacity under each austerity type. We consider the effects of higher labor supply elasticity, lower risk aversion, tighter liquidity regulation, a greater share of HtM consumers, and a shorter average maturity of government debt on fiscal capacity. Third, we analyze why debt/GDP is such a strong driver of macro dynamics and asset prices in our model. We show that the model is "non-Ricardian" in several dimensions, causing increased government borrowing to crowd out investment and labor supply. We demonstrate that uncertainty about the fiscal regime greatly reduces fiscal capacity and explore the economics behind this result.

We solve the baseline economy under the two special cases of the general model: tax austerity with certainty, $\text{Prob}(F_t = 1) = 1$, and spending austerity with certainty, $\text{Prob}(F_t = 0) = 1$. In these economies, agents know that once the debt/GDP ratio crosses the austerity threshold, surpluses will be raised either solely through tax hikes or spending cuts.

4.1 Implications of Fiscal Stabilization

4.1.1 Tax Austerity

Figure 2 shows histogram plots of the debt/GDP ratio under tax austerity. Vertical dashed lines indicate the profligacy and austerity bounds, respectively. The austerity threshold $\overline{\Delta}$ is found to be 189% of debt/GDP.The austerity threshold is determined as the maximum level of debt/GDP at which surpluses must be increased in order to guarantee that government debt is a safe asset. If the tax increases were to begin only later, at levels of debt/GDP above this bound, then there does not exist a sequence of tax rate increases that can prevent government debt/GDP from exploding for any possible path of exogenous shocks. Put simply, if austerity kicks in "too late" in terms of debt/GDP, then government debt is not guaranteed to remain stationary and is therefore no longer truly risk-free.

Since debt/GDP is in the interior region most of the time, the model generates long time paths with changes in debt/GDP, but no adjustments in tax rates or spending in response. This is a realistic feature of the model. Appendix C.2 shows that in the post-war sample, we do not observe tax increases prompted by higher debt/GDP ratios. If anything, increases in debt/GDP coincide with decreases in tax revenue/GDP. Our model replicates this behavior.

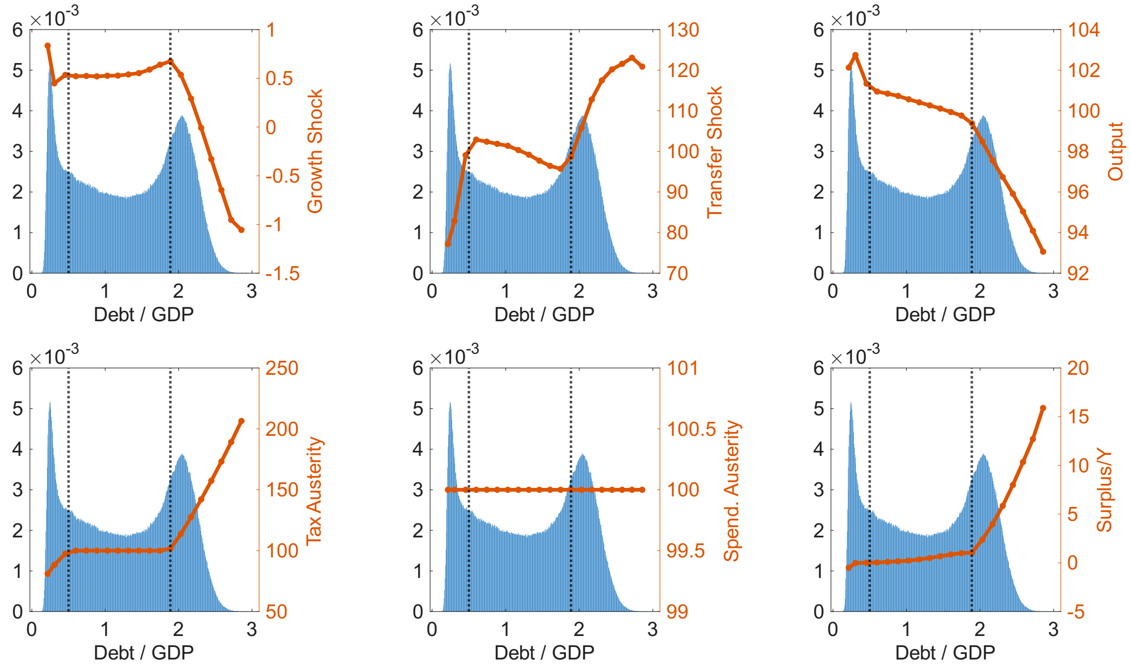
Finally, both in model and data, debt/GDP is highly persistent: the quarterly auto-correlation coefficient of the data debt/GDP ratio is 0.995, while in the model it is 0.998. Therefore, our model demonstrates that lack of responsiveness in fiscal policy to changes in debt/GDP is still consistent with stationary debt dynamics in the long-run. This is because fiscal adjustments are triggered by debt/GDP reaching extreme levels, which we have not observed in the history of U.S. fiscal policy. While the economy is between thresholds, fiscal policy does not respond to changes in debt/GDP.

The top panels of Figure 2 uncover which combination of shocks cause an economy to end up in the austerity region: a combination of low growth and high transfer spending. The opposite holds for the profligacy region. When the economy moves past one of the thresholds, fiscal policy endogenously switches to debt stabilization as described in Section 2.4, meaning that the fiscal authority now chooses tax rates in order to stabilize the debt/GDP ratio. The bottom left panel shows that relatively small decreases in tax rates are sufficient to halt a further decline of the ratio in profligacy. However, large tax hikes are required to stem the rise of debt/GDP in austerity: tax rates double as the debt/GDP ratio approaches 300%. As a result, primary surpluses (bottom right panel) increase to 15% of GDP.

These tax adjustments are successful in reigning in debt/GDP. However, the figure reveals a clear asymmetry with respect to profligacy and austerity. This asymmetry is caused by the distortionary effect of labor income taxation, resulting in a concave "Laffer" curve of tax revenue generated from tax increases. Thus, consecutive marginal increases in tax rates yield smaller marginal increases in tax revenue in the austerity region. In contrast, consecutive tax rate decreases will yield greater marginal reductions in revenue in the profligacy region. The detrimental effects of large tax hikes on the economy are evident in the top right panel. Output rapidly declines in austerity, with GDP dropping over 5% between debt/GDP ratios of 200% and 250%. A direct implication of this Laffer curve effect is that the model features a maximum austerity threshold. Due to the asymmetry of the effect, the model does not imply an analogous minimum profligacy threshold at positive levels of debt/GDP.

Government debt is a state variable and its value is a key determinant of all endogenous objects. Figure 3 shows the asset pricing implications of the model's wide range of debt/GDP ratios. Inflation is strongly increasing in debt/GDP (top left panel).Conversely, tax hikes in

Figure 2: Tax Austerity: Shocks and Adjustments

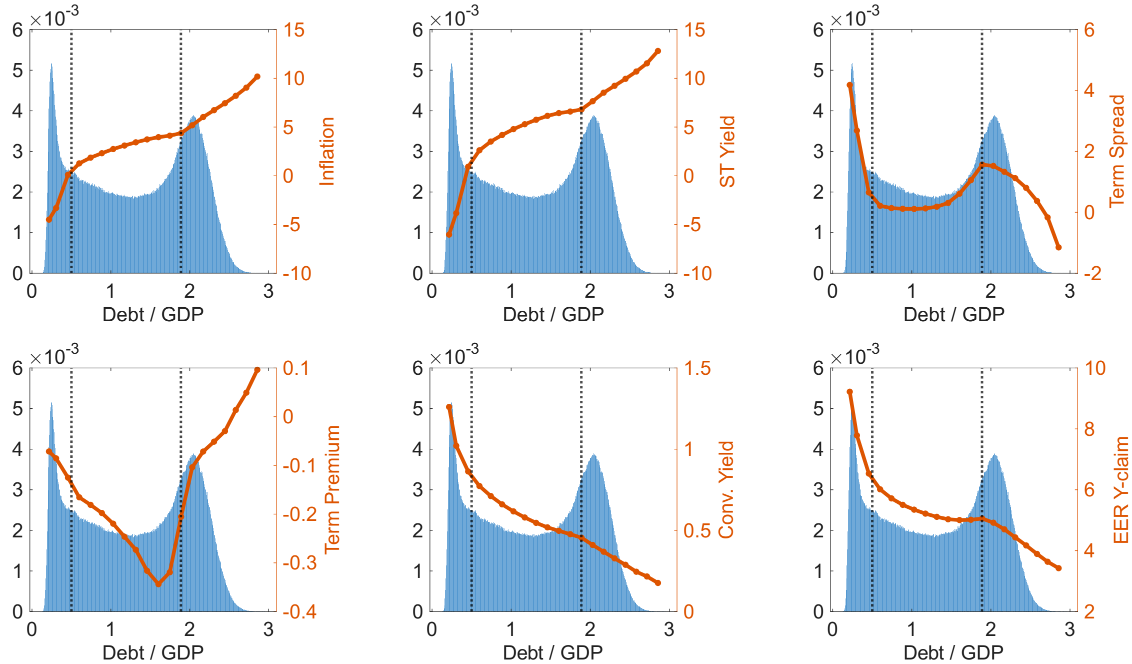


Note: This figure shows the histogram of debt/GDP from the simulated model under *tax austerity* overlaid with conditional means of the growth rate shock g_t (top left), the transfer spending shock Θ_t (top middle), GDP Y_t (top right) relative to the balanced growth path, the tax profligacy f^P_τ and austerity f^A_τ factors (bottom left), the spending austerity factor f^A_γ (bottom middle), and surplus/GDP S_t/Y_t (bottom right). All variables are in percent. Vertical dashed lines indicate profligacy and austerity bounds respectively.

austerity constitute a highly inflationary negative supply shock. Inflation is also increasing in debt/GDP in the no-adjustment region between both thresholds. In this area of the state space, higher government debt crowds out investment and labor supply, an effect we explore in greater detail in Section 4.3. Yields on short term debt are set by monetary policy and closely track inflation (top middle). The term spread exhibits strong non-monotonic variation in debt/GDP (top right). High convenience yields on ST debt (bottom middle) cause a strongly upward-sloping term structure at low level of debt/GDP. The term structure flattens at intermediate levels of debt/GDP, as convenience yields decline in debt/GDP (consistent with the empirical evidence in empirical pattern Krishnamurthy and Vissing-Jorgensen, 2012). Inflation risk premia drive up LT yields as the economy approaches austerity (bottom left). Within the austerity region, the inflation premium on LT bonds becomes smaller than the ST inflation premium as agents expect to re-emerge from austerity.[18] This causes an inverted yield curve.

[18]We compute the inflation premium as the expected excess return of the nominal long-term bond issued by the government minus the expected excess return on a hypothetical real long-term bond of the same maturity

Figure 3: Tax Austerity: Asset Prices



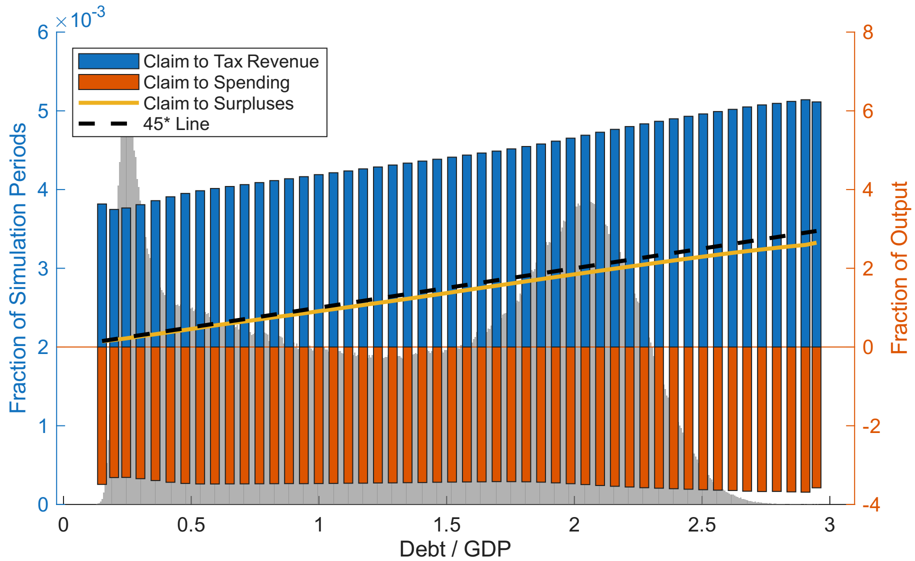
Note: This figure shows the histogram of debt/GDP from the simulated model under *tax austerity* overlaid with conditional means of inflation π_t (top left), the yield on short-term debt i_t^S (top middle), the term spread $i_t^L - i_t^S$ (top right), the term premium (bottom left), the aggregate convenience yield (bottom middle), and the expected excess return on a claim to GDP (bottom right). All variables are in percent. Vertical dashed lines indicate profligacy and austerity bounds respectively.

Finally, the expected excess return on a claim to GDP over the ST yield (bottom right) is strongly declining in debt/GDP, a pattern that is partially driven by declining convenience yields in ST debt and by variation in risk premia (see Appendix C.1 for a detailed GDP risk premium decomposition).

Figure 4 decomposes the market value of debt into the values of claims to tax revenue and spending flows. We compute these values as prices to non-traded securities that deliver as payoff either total tax revenue or spending (discretionary and transfers), respectively. The value of the tax claim is positive and increasing in debt/GDP. As the economy approaches tax-based austerity, the NPV of tax revenue rises. The value of the spending claim is negative and roughly constant as fraction of GDP. Both values add up to the value of the claim to surpluses, discounted with the "convenience-free" stochastic discount factor of savers. The difference between the value of this surplus claim and the market value of government debt

priced using the saver's stochastic discount factor.

Figure 4: Tax Austerity: Decomposing the market value of debt



Note: This figure shows the histogram of debt/GDP from the simulated model under *tax austerity* overlaid with conditional means of the market values of the tax (blue bars), spending (red bars) and surplus (yellow line) claims as fractions of GDP. The difference between the dashed 45° line and the surplus claim is the total value of convenience yields.

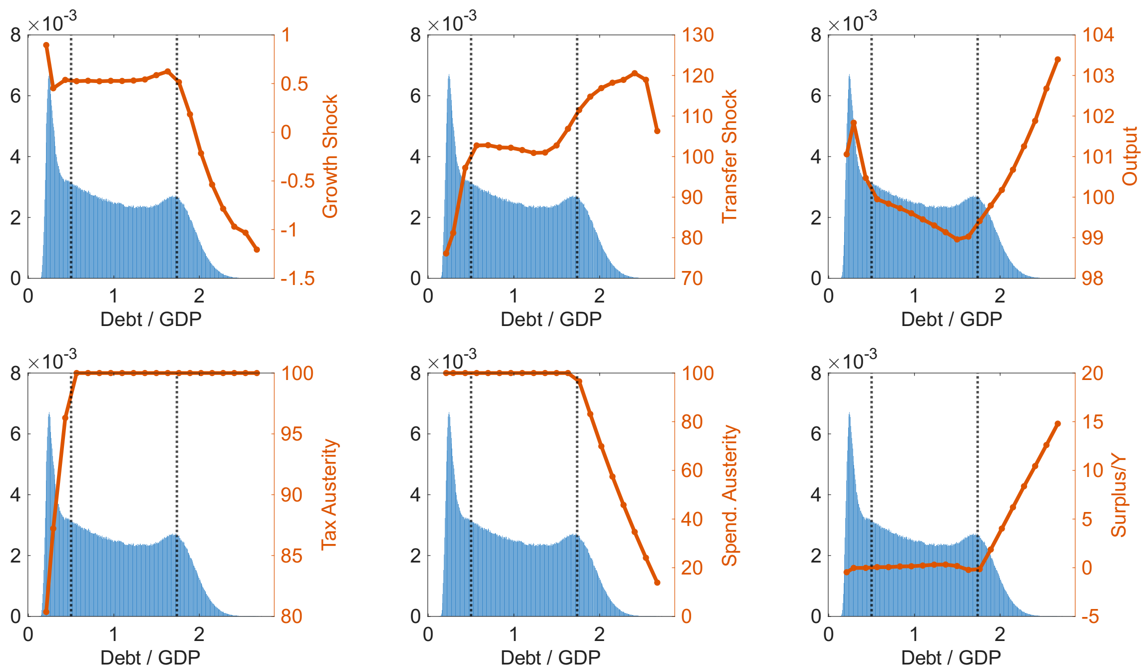
stems from convenience yields, which arise because the short-term portion of the debt is held by banks to back deposit claims. The figure shows that the total value of convenience yields – given by the difference between 45° line and surplus claim – is increasing in debt/GDP, even though the marginal convenience yield per dollar of debt declines with more debt, as shown in 3. In Appendix C.4, we demonstrate that we can understand the safety of government debt through the lens of return betas on these different fiscal claims, following Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2024a).

4.1.2 Spending Austerity

We perform the same analysis for the economy that implements austerity using spending cuts in Figure 5. The first thing to note is that the spending austerity economy has a tighter austerity bound at 174% of debt/GDP (compared to 189% for tax austerity). What limits fiscal capacity under spending austerity? Unlike the Laffer curve effect under tax austerity, fiscal capacity is naturally limited by the fact that spending can at most be reduced to zero. However, it is unrealistic that the government could reduce spending to zero without negatively affecting the productive capacity of the economy. In particular, some government presence is needed to ensure property rights, tax collection, and debt issuance, which are maintained assumptions in the model. We thus assume that spending can at most be cut to 0.1% of GDP. Any cut beyond this level causes the government and the economy to collapse.[19]

Similar to the case of tax austerity, the top left and middle panels show that a combination of slow growth and high transfer spending is needed to push the economy into spending austerity.

Figure 5: Spending Austerity: Shocks and Adjustments



Note: This figure shows the histogram of debt/GDP from the simulated model under *spending austerity* overlaid with conditional means of the growth rate shock g_t (top left), the transfer spending shock Θ_t (top middle), GDP Y_t (top right), the tax austerity factor $\vec{\tau}_t$ (bottom left), the spending austerity factor $\vec{\gamma}_t$ (bottom middle), and surplus/GDP S_t/Y_t (bottom right). All variables are in percent. Vertical dashed lines indicate profligacy and austerity bounds respectively.

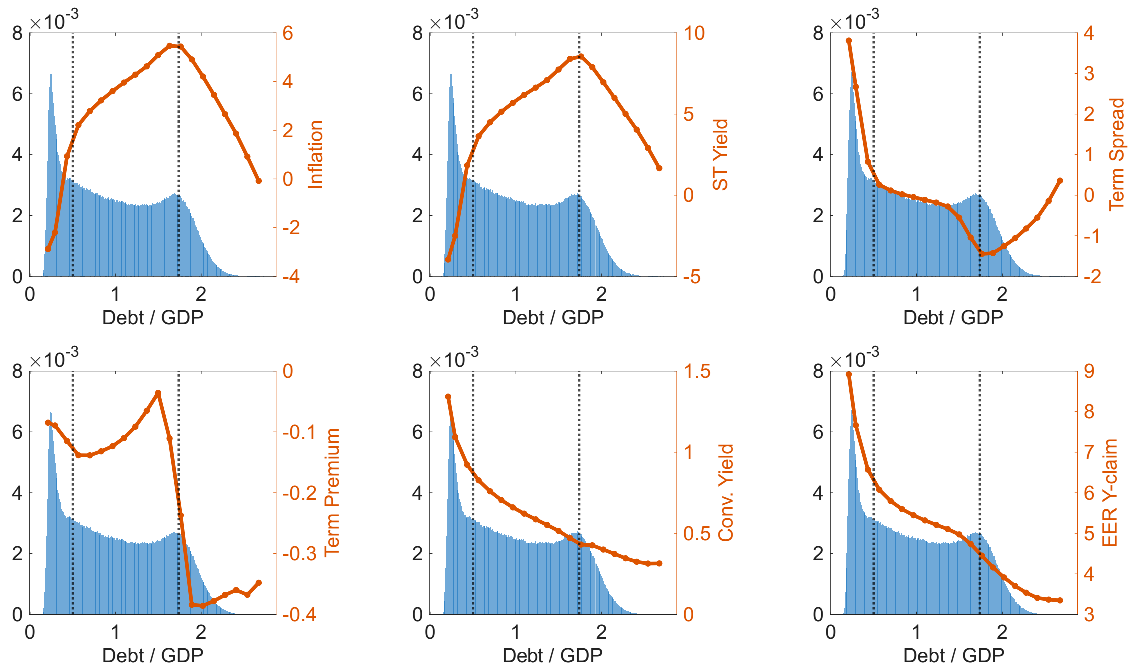
[19] Chen, Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2025) document that the lowest level of government spending on record for the U.S. over the 1793-1914 sample is 0.6% of GDP. Formally, we assume that productivity $Z_t = Z_t^p Z_t^r f_G(G_t)$ depends on government spending through the increasing function $f_G(G_t)$. In the baseline spending austerity economy, this function is

$$f_G(G_t) = \begin{cases} 1 & \text{if } G_t \geq \underline{G} \\ 0 & \text{if } G_t < \underline{G}, \end{cases} \tag{27}$$

where we set $\underline{G}$ to 0.1% of average GDP. The function in (27) immediately implies that any spending cut beyond $\underline{G}$ will cause the government to default. Hence we set the upper bound of sustainable debt levels m_Δ such that debt levels requiring greater spending cuts cannot be reached in spending austerity. All spending experiments above have $\gamma_A = \theta_A = -2$ in fiscal adjustment factors (19)–(20), implying m_Δ of approximately 0.5.

The key difference between tax and spending austerity is revealed in the top right panel of Figure 5: While tax austerity is highly contractionary, spending austerity is expansionary, with cyclical output rising 3% above its long-run mean in the austerity region. Examining the asset pricing implications of spending austerity in Figure 6 explains this difference. While tax austerity is an inflationary negative supply shock, spending austerity is a deflationary negative demand shock. The rapid decline of inflation in spending austerity allows the central bank to lower interest rates (top middle panel), neutralizing the output consequences of the negative demand shock.

Figure 6: Spending Austerity: Asset Prices

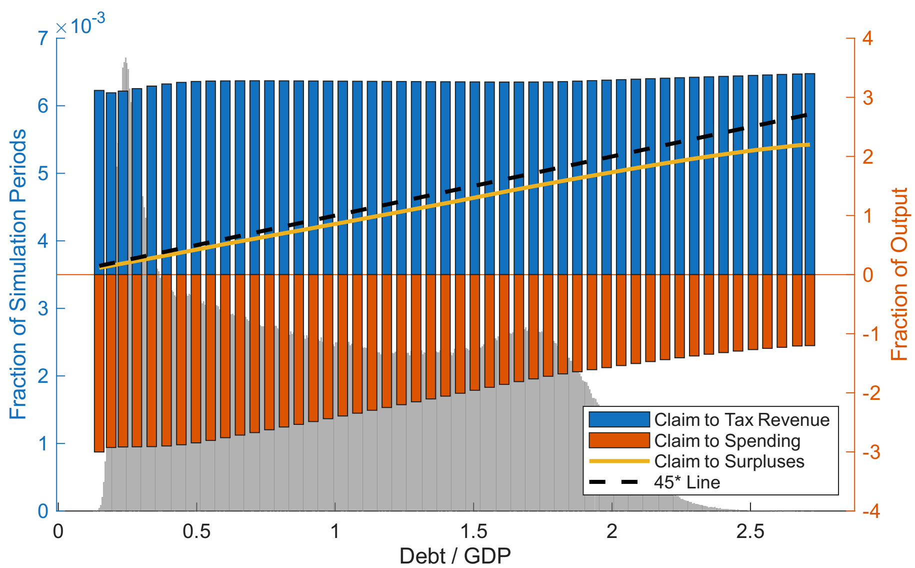


Note: This figure shows the histogram of debt/GDP from the simulated model under *spending austerity* overlaid with conditional means of inflation π_t (top left), the yield on short-term debt i_t^S (top middle), the term spread $i_t^L - i_t^S$ (top right), the term premium (bottom left), the aggregate convenience yield (bottom middle), and the expected excess return on a claim to GDP (bottom right). All variables are in percent. Vertical dashed lines indicate profligacy and austerity bounds respectively.

Convenience yields and excess returns on the output claim (bottom middle and right panels) look qualitatively and quantitatively similar as under tax austerity. However, the dynamics of the term spread and inflation risk premia look fundamentally different than under tax austerity. Under spending austerity, the term spread is strongly declining in debt/GDP (top right), and nearly reaches -2% at the austerity threshold. The decline in the term spread is driven by a sharp reduction in the inflation risk premium of long-term bonds (bottom left). As the economy approaches spending austerity, realized inflation rises but inflation risk declines as austerity (and falling inflation) becomes more likely.

Comparing tax austerity in Figure 3 to spending austerity in Figure 6 demonstrates that the type of fiscal stabilization matters for asset prices even far away from the austerity threshold. The model teaches us that even at the current debt/GDP ratio of around 100%, agent expectations about the eventual policy actions that stabilize the debt matter for current macro dynamics and asset prices.

Figure 7: Spending Austerity: Decomposing the market value of debt



Note: This figure shows the histogram of debt/GDP from the simulated model under *spending austerity* overlaid with conditional means of the market values of the tax (blue bars), spending (red bars) and surplus (yellow line) claims as fractions of GDP. The difference between the dashed 45° line and the surplus claim is the total value of convenience yields.

As for tax austerity, we can decompose the market value of debt into the values of claims to tax revenue and spending flows in Figure 7. Under spending austerity, the value of the tax claim does not vary much, but the value of the spending claim declines with higher debt/GDP. The total value of convenience yields – given by the difference between 45° line and surplus claim – is increasing in debt/GDP and larger than under tax austerity once the economy enters austerity, reflecting lower conditional discount rates in that region of the state space. Like in the tax austerity case, the total value of convenience yields rises even though the marginal convenience yield per dollar of debt declines with more debt.

4.2 Fiscal Capacity Bounds

An important output of the calibrated model is the level of the austerity bound. We view the austerity bound as a novel, natural measure of fiscal capacity. Understanding how this threshold changes as key parameters change provides insights into determinants of fiscal capacity.

4.2.1 Tax Austerity.

Column (1) of Table 1 shows averages from the same simulation of the baseline economy under tax austerity that generated Figures 2 and 3. The austerity bound in this economy is 189% debt/GDP – significantly higher than current debt levels around 100% of GDP. The calibrated model with tax austerity ($\Pr[F_t = 1] = 1$) suggests that the U.S. government can delay fiscal adjustments; according to current projections, the debt/GDP will reach 156% by 2055 (Congressional Budget Office, 2025).

While the calibration targets moments outside of austerity, Table 1 shows unconditional averages for the full simulation including from periods when the economy is in austerity, which is the case in 28.8% of period for the baseline calibration. The average debt/GDP ratio in this economy is 131%. Since tax austerity periods have high inflation, but a lower term spread, these unconditional moments are different from the (conditional) calibration targets.

Column (2) shows how the austerity bounds and simulation averages change when we increase the Frisch elasticity of labor supply from 0.5 to 1 (by lowering ω_1 from 2 to 1). The austerity threshold drops significantly, to 155%, as the distortionary effects from labor income taxation become stronger. This economy has lower average debt/GDP, yet spends more time in austerity, with a steeper term structure but lower average inflation. In terms of real outcomes, the high labor supply elasticity economy has slightly more capital (+0.44%), but lower labor supply by HtM consumers (-7.06%). The results in Column (2) show that the tax-based austerity bound depends crucially on the elasticity of labor supply.

Column (3) considers an economy with a greater labor share of HtM consumers (α_H from 6.8% to 8%), increasing the HtM consumption/GDP ratio by 16.5%. There are two offsetting effects on fiscal capacity. First, since these agents pay no labor taxes, a greater HtM share shrinks the tax base and thus fiscal capacity. Second, since HtM consumers pay no taxes they

Table 1: Fiscal Capacity with Tax Austerity

	(1) Tax Aust.	(2) Lab.Supp.	(3) HTM	(4) Low RA	(5) ST 50%	(6) Fin.Repr.	(7) MP
Austerity Bound	**189**	**155**	**198**	**138**	**217**	**220**	**210**
Debt/Y	131	113	141	153	162	155	126
Frac. Austerity	28.8	32.2	31.1	80.7	34.0	31.2	20.2
ST rate	1.70	1.54	1.80	4.35	2.48	2.13	1.60
Term spread	1.07	1.69	1.05	1.35	0.387	0.623	0.769
Inflation	2.72	2.51	2.92	7.20	4.05	3.48	2.15
Y-claim EER	5.62	5.81	5.53	2.36	4.88	5.23	5.74
Tax Rev./Y	18.8	18.9	19.0	22.4	19.3	19.3	18.4
Spending/Y	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Surplus/Y	1.29	1.36	1.48	4.91	1.80	1.76	0.925
Output (Y)	100	0.0	0.0	0.0	-2.87	-2.61	3.07
Capital (/Y)	156	0.442	-0.525	-8.49	-5.31	-6.35	3.27
Labor	60.3	0.349	0.127	2.29	-2.18	-1.55	3.03
Labor HTM	51.7	-7.06	2.08	4.92	-1.94	-1.17	2.79
Consumption (/Y)	72.2	-0.159	-1.14	1.69	-2.35	-1.82	3.03
Consump. HTM (/Y)	5.25	0.0776	16.6	0.817	-2.84	-2.58	3.19
Welfare Saver					-0.018	-0.025	0.0096
Welfare HTM					-0.004	-0.011	0.0084

Note: This table shows moments from the simulated model under *tax* austerity. The first column displays the calibrated baseline model. The other columns show moments for the following deviations from the baseline: Column (2) "Lab.Supp." – higher labor supply elasticity $\omega_1 = 1$, column (3) "HTM" – greater share of HTM agents $\alpha_H = 0.08$, column (4) "Low RA" – lower risk aversion $\sigma = 5$, column (5) "ST 50%" – 50% share of short-term debt $\bar{\mu} = 0.5$, column (6) "Fin.Repr." – higher LCR cost parameter $\varrho_0 = 0.16$, column (7) "MP" – Taylor rule with 0.25% (quarterly) higher interest rates in austerity. All variables are in percent. Columns (2)–(7) in the bottom two panels display percentage deviations relative to the baseline in column (1). Disutility from working ω_0 was recalibrated in economies (2)–(4) to normalize $\mathrm{E}[Y] = 1$. Welfare effects in columns (5)–(7) are computed as the compensating variation considering the transition path.

also do not contribute to the distortionary effects from labor income taxation. A larger HtM share leads to an economy-wide Laffer curve that is flatter (a lower aggregate labor supply elasticity), which increases fiscal capacity. On net, the austerity bound increases to 198%.

Column (4) lowers the coefficient of risk aversion ($\gamma = 5$ instead of 25). This change lowers the risk premium on the output claim by more than half from 5.6% to 2.4%. Lower risk aversion causes a dramatic decline in fiscal capacity, to 138%. At the same time, short term bond yields climb to 4.35% and the term spread to 1.35%. Average inflation becomes 7.2%. When savers become less risk averse, their precautionary savings demand drops and interest rates rise. The rise is rates leads to substantially higher interest expenses for the government, leading in turn to the sharp reduction in fiscal capacity and to the economy spending a lot more time in the austerity region. On the real side, the lower precautionary savings demand causes a 8.5% smaller capital stock. Overall, the economy with lower risk aversion reveals the importance of including realistic aggregate risk and matching risk premia. Household precautionary savings demand to insure against aggregate risk is a key source of fiscal capacity.

While columns (2)–(4) study parameter variations intended to highlight model mechanisms, columns (5) – (7) consider experiments that can be interpreted as changes in policy. Column (5) considers a different maturity structure of government debt: instead of 33% in the baseline, short-term debt now accounts for 50% of debt supply. This shortening of the average maturity of debt raises the austerity bound to 217%, primarily by reducing the average interest expense of the government.[20] The economy has higher average debt/GDP at 162% and spends more time in austerity. The higher level of debt on average crowds out capital (-5.31%) and combined with a reduction in labor supply, reduces output by 2.87%. While this policy raises fiscal capacity, it lowers welfare: savers would be willing to give up 1.8bp in consumption each period to avoid the policy change to more short-term debt.[21]

Column (6) considers "financial repression." Bank liquidity coverage regulation is stricter, implemented via a higher liquidity cost parameter $\varrho_0 = 0.16$, compared to 0.12 in the baseline. This policy reduces the government's interest expense and increases the austerity bound to 220%. However, the policy also crowds out capital (-6.35%), with overall effects similar to the shortening of debt maturity. Columns (5) and (6) highlight that policies extending fiscal capacity have the side-effect of crowding out capital investment by causing higher average debt.

Column (7) modifies the monetary policy rule to raise interest rates by 25 basis points per quarter in the austerity region, relative to what the Taylor rule prescribes. Pursuing more hawkish monetary policy in austerity raises the austerity bound to 210%. Hawkish policy in

[20]The average debt service-to-output ratio equals the average debt-to-output ratio times the weighted average interest rate (WACC) on the debt plus the covariance of debt/output ratio and the WACC. This covariance is positive and especially large when the debt/GDP ratio is high. It is this covariance, conditional on high debt levels, that is lowered when the fraction of short-term debt is higher. This is the source of the extra fiscal capacity.

[21]This measure takes into account the full transition path. Welfare effects are larger across "steady states," but households are mostly compensated for lower consumption in the high short-term debt economy by a consumption boom along the transition path.

austerity actually lowers average interest rates by curbing inflation expectations, and reducing the unconditional probability of ending up in austerity by 8% relative to the baseline. By reducing average debt/GDP, this policy crowds in capital (+3.27%) and increases consumption and welfare.

4.2.2 Spending Austerity.

Table 2 performs the same comparison for spending austerity. Fiscal capacity is smaller with spending than with tax austerity at 174%, but still far above current debt levels. The long-run average debt/GDP ratio in this economy is lower at 101%, and the economy only spends 13.5% of periods in austerity (Column 1).

Increasing the labor supply elasticity in this economy naturally has a smaller effect than in the tax austerity regime, and one that goes in the opposite direction. It increases fiscal capacity to 180% (Column 2), while it reduced capacity under tax austerity. Under spending austerity, real wages rise in the austerity region. This wage effect generates a stronger labor supply response when the labor supply elasticity is higher. The higher labor income tax revenue increases fiscal capacity.

Raising the fraction of HtM consumers significantly has little impact on fiscal capacity, which drops modestly to 172% (Column 3). On the one hand, HtM consumers' labor supply responds more strongly than that of savers to real wage fluctuations, increasing fiscal capacity. On the other hand, the tax base erodes when the share of HtM households is larger, lowering fiscal capacity.

Lower risk aversion (Column 4) has similar effects as for tax austerity: ST and LT interest rates rise by 2.3% and 3.3%, respectively, greatly limiting fiscal capacity, which drops down to 105%. Precautionary savings are a key driver of fiscal capacity, also under spending austerity.

A shorter maturity structure (Column 5) and stricter financial regulation (Column 6) both raise fiscal capacity significantly.Like for tax austerity, these policies crowd out capital investment. In the case of a higher ST share of debt, the equilibrium features substantially more government debt. In the case of financial repression, tighter liquidity coverage rules induce banks to hold more reserves (ST debt) and less firm capital. Both policies also lead to decline

Table 2: Fiscal Capacity with Spending Austerity

	(1) Sp. Aust.	(2) Lab.Supp.	(3) HTM	(4) Low RA	(5) ST 50%	(6) Fin.Repr.	(7) MP
Austerity Bound	**174**	**180**	**172**	**105**	**195**	**188**	**185**
Debt/Y	101	107	101	103	123	108	84.4
Frac. Austerity	13.5	15.2	14.2	59.1	20.0	14.1	4.99
ST rate	1.69	1.80	1.72	4.03	2.44	1.92	1.28
Term spread	0.260	0.265	0.230	1.21	-0.557	0.0541	0.201
Inflation	2.69	2.92	2.78	6.66	3.98	3.11	1.91
Y-claim EER	5.75	5.64	5.71	2.64	4.94	5.46	6.08
Tax Rev./Y	17.4	17.4	17.3	17.6	17.5	17.5	17.2
Spending/Y	17.0	16.9	17.0	14.5	16.7	17.0	17.3
Surplus/Y	0.343	0.478	0.357	3.08	0.793	0.557	-0.135
Output (Y)	100	0.0	0.0	0.0	-1.82	-1.64	-0.883
Capital (/Y)	156	-0.243	-0.311	-6.66	-3.75	-5.09	0.440
Labor	60.4	0.574	0.0716	1.83	-1.27	-0.664	-1.24
Labor HTM	51.5	-7.17	1.89	2.98	-1.15	-0.444	-1.48
Consumption (/Y)	72.5	0.0270	-1.17	2.70	-1.24	-0.896	-1.35
Consump. HTM (/Y)	5.24	0.194	16.5	-1.12	-1.98	-1.66	-0.631
Welfare Saver					-0.012	-0.020	-0.002
Welfare HTM					0.0025	-0.004	0.0081

Note: This table shows moments from the simulated model under *spending* austerity. The first column displays the calibrated baseline model. The other columns show moments for the following deviations from the baseline: Column (2) "Lab.Supp." – higher labor supply elasticity $\omega_1 = 1$, column (3) "HTM" – greater share of HTM agents $\alpha_H = 0.08$, column (4) "Low RA" – lower risk aversion $\sigma = 5$, column (5) "ST 50%" – 50% share of short-term debt $\bar{\mu} = 0.5$, column (6) "Fin.Repr." – higher LCR cost parameter $\varrho_0 = 0.16$, column (7) "MP" – Taylor rule with 0.25% (quarterly) higher interest rates in austerity. All variables are in percent. Columns (2)–(7) in the bottom two panels display percentage deviations relative to the baseline in column (1). Disutility from working ω_0 was recalibrated in economies (2)–(4) to normalize $E[Y] = 1$. Welfare effects in columns (5)–(7) are computed as the compensating variation considering the transition path.

in the term premium, and for the case of greater ST debt, and inversion of the yield curve, as they limit average convenience yields on short-term debt.

Finally, stricter monetary policy in the austerity region (Column 7) raises fiscal capacity. As for tax austerity, setting higher rates in austerity reduces inflation expectations. Both short-term and long-term yields are lower, which reduces the government's debt servicing costs. However, the promise of hawkish policy in austerity is less powerful than under tax austerity. This is because inflation is naturally low in the spending austerity region, requiring the central bank to respond with low rates. While curbing inflation expectations ex-ante, setting high rates in austerity is counterproductive in fighting low aggregate demand when spending is cut.

4.3 Crowding-out Effects of Higher Transfer Spending

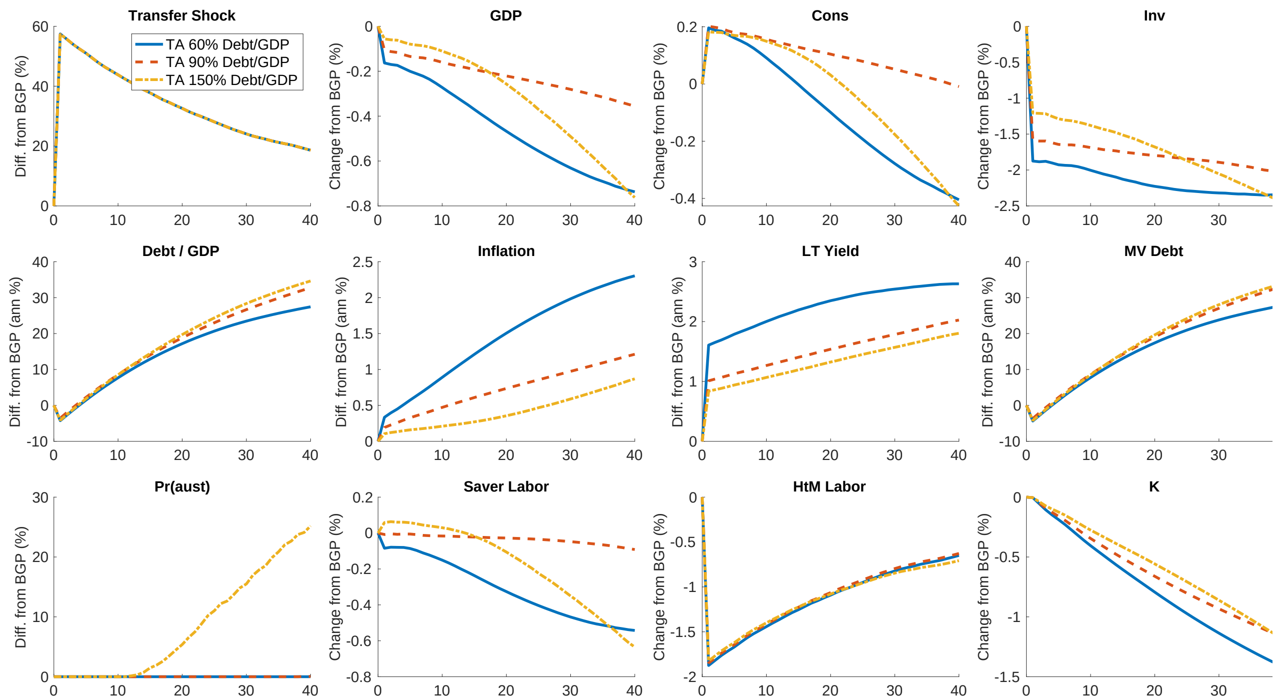
Even though the majority of households in the model are "Ricardian" savers, fluctuations in the quantity of debt caused by transfer spending shocks have substantial real effects. In this section, we show that the real effects of government debt supply are inherently linked to our model's ability to generate realistic risk premia and convenience yields.

The key exogenous driver of debt dynamics in the model is the transfer spending shock in (14). The top row of Figure C.2 shows the impulse responses of macro aggregates to a transfer spending shock. The three lines in each graph condition on different starting points in debt/GDP space. On impact of the shock, GDP, consumption, and investment decline for all three starting points. The impact on GDP and investment is largest at low levels of debt/GDP (blue solid line, 60%) and smallest at high levels (dash-dotted line, 150%). This is also the case for the initial effect on inflation and LT bond yields (middle row). On impact, the latter variables jump up, causing an initial decline in the market value of government debt (middle row, right panel), before persistently high transfer spending causes a long-run accumulation of debt. When the transfer shock hits at already high levels of debt/GDP, such as 150% in the graph, the likelihood that the economy ends up in austerity rises sharply (bottom left). Austerity causes a decline in savers' labor supply and in all macro aggregates in the long-run.

The model contains two distinct channels through which high debt/GDP crowds out labor supply and investment. The first channel is common and caused by the presence of hand-to-mouth consumers. Transfers make up a considerable fraction of these agents' income, yet they pay no taxes. Thus, increased transfers cause HtM agents to work less due to a positive income effect, explaining part of the decline in GDP and aggregate consumption. The initial state of the economy at the time of the shock (the level of debt/GDP) is irrelevant for this channel.

The starting point for debt/GDP is critical for understanding the second channel, which is a wealth effect on savers that crowds out investment and savers' labor supply. This wealth effect may seem surprising when considering the forward-looking, "Ricardian" nature of savers. Why is an increase in transfers not neutral for these agents? Savers are risk-averse and face

Figure 8: Increased Transfer Spending: Macro Effects and Crowding Out



Note: This figure shows generalized impulse response graphs after the economy experiences a high transfer spending shock in the model with tax austerity ($F_t = 1$). The three lines correspond to different initial states of debt/GDP. The lines plot the average path of the economy from a sample of 10,000 paths of 40 quarters, with the starting point set to the respective ergodic mean of the state variables. The paths are relative to the unconditional transition of an economy with the same starting point (the balanced growth path, BGP).

substantial macro and fiscal risks. They accumulate precautionary savings to insure against such risks. The experiments with decreased risk aversion in column (4) of Tables 1 and 2 showed the importance of precautionary asset demand for creating fiscal capacity. When the government increases transfers, it also raises the supply of debt. The IRFs in Figure C.2 illustrate how, by providing more safe debt, the government increasingly satisfies this precautionary demand, and partially crowds out the precautionary demand for capital from savers. The bottom right panel plots the capital stock in the economy and shows the crowd-out. This effect is stronger, the further the economy is away from austerity. At 60% debt/GDP, the probability of reaching austerity in the next 40 quarters is zero. The increased supply of government debt is persistent and unlikely to be offset by higher taxes in the medium future. However, at 150% of debt/GDP, the increased debt supply likely pushes the economy into austerity, meaning tax increases are imminent and the increased debt supply for savers is transient. Appendix C.3 discusses the precautionary crowding out channel under spending austerity.

This "precautionary crowding out" channel arises in our model due to realistic aggregate risks and risk premia, but it is also present in environments that emphasize idiosyncratic risks, such as Brunnermeier, Merkel and Sannikov (2024). More generally, transfers and taxes occur in different states of the world with different prices of risk, leading to real effects even in a world with forward-looking rational agents.

5 Fiscal Regime Uncertainty

In the previous sections, we have focused on versions of the model that assume certainty about the fiscal regime governing austerity. Here, we relax this assumption and instead configure the fiscal regime process Π_F such that the unconditional regime probability takes on interior values, $\Pr(F_t = 1) = \mu_F$. To discipline the persistence of the regime, we calibrate the transition matrix Π_F such that the first-order autocorrelation of F_t matches the persistence of the U.S. presidential political cycle since 1920.[22] Table 3 shows the two polar cases studied in the prior section in the first and last columns, and intermediate cases for μ_F in columns (2)–(4). The main new insight is that fiscal capacity declines dramatically when there is uncertainty about the austerity regime. It is lowest at a relatively high likelihood of tax austerity, $\mu_F = 75\%$. Compared to the case of certain tax austerity, $\mu_F = 100\%$, the austerity threshold drops from 189% to 115%. The latter bound will be breached within the next decade according to CBO projections.

Economies closer to spending austerity, such as $\mu_F = 25\%$ in Column (2), achieve a higher bound of 130% debt/gdp, but this is still much lower than the 174% fiscal capacity in the always-spending austerity case in Column (1). The 75% economy in column (4) features the highest term spread and risk premium on the output claim, reflecting additional fiscal risk stemming from regime uncertainty. Higher required returns on risky assets lead to a lower capital stock. What drives the steep reduction in fiscal capacity with regime uncertainty?

The answer to this question can be found in Figure 9, which plots impulse-response functions

[22] Intuitively, we would associate the spending austerity regime with Republican political control and tax austerity with Democratic political control.

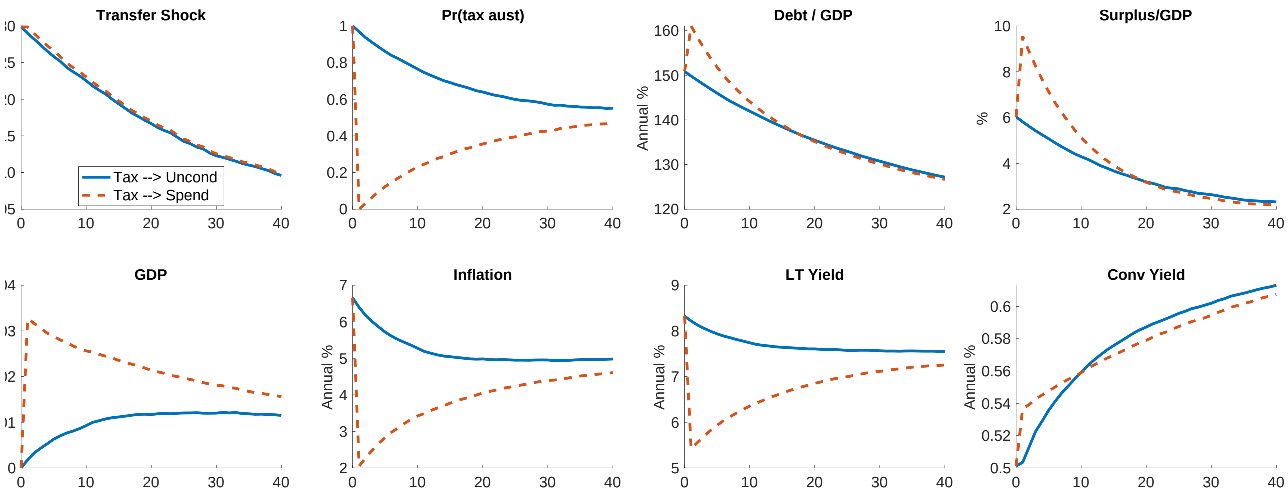
Table 3: Fiscal Capacity with Regime Uncertainty

Tax Austerity Prob (μ_F)	(1) 0%	(2) 25%	(3) 50%	(4) 75%	(5) 100%
Austerity Bound	**174**	**130**	**120**	**115**	**189**
Debt/Y	101	83.6	80.7	80.1	131
Frac. Austerity	13.4	18.7	22.2	25.4	28.8
ST rate	1.69	1.69	1.70	1.70	1.70
Term spread	0.251	0.588	0.863	1.16	1.07
Inflation	2.69	2.69	2.69	2.70	2.72
Y-claim EER	5.74	5.91	5.97	6.02	5.62
Capital (/Y)	156	155	154	154	156
Labor	60.4	60.5	60.6	60.6	60.3
Labor HTM	51.5	51.7	51.8	51.9	51.7
Consumption (/Y)	72.5	72.6	72.6	72.6	72.2
Consump. HTM (/Y)	5.24	5.24	5.24	5.24	5.25
Tax Rev./Y	17.4	17.4	17.6	17.9	18.8
Spending/Y	17.0	17.0	17.1	17.2	17.5
Surplus/Y	0.337	0.435	0.565	0.712	1.29

Note: This table shows moments from the simulated model for different levels of regime uncertainty. Columns (1) and (5) show the cases of spending and tax austerity with probability one, respectively. Columns (2)–(4) display moments of economies with increasing unconditional probability of tax uncertainty. All values are in percent. Disutility from working ω_0 was recalibrated in economies (1)–(5) to normalize $\mathrm{E}[Y] = 1$.

for the economy from column (3) with $\mu_F = 50\%$. The initial state of the economy is a debt/GDP ratio of 150%, which is deep in the austerity region (this economy has an austerity bound of 120%). Further, the economy at time 0 of the IRF is in the high transfer spending state and in the tax austerity regime $F_0 = 1$. The solid blue line plots the average path as the economy transitions back to its stochastic steady state. The transfer shock reverts to its mean of 1, and $\Pr(F_t)$ transitions back to it unconditional average of 50%. Initially, inflation and LT bond yields are high and GDP is low, characteristic features of tax austerity. As debt/GDP declines towards the interior of the state space, these variables transition back to their ergodic mean. The dashed red line instead plots the impulse to a switch to spending austerity in period 1, such that $F_1 = 0$, as can be seen in the second panel on the top. On impact, inflation and LT bond yields drop, and GDP jumps up. The decline in bond yields causes a sudden rise in the market value of government debt, as shown in the third panel in the top row. This market value jump at times of regime switches from tax to spending austerity is the source of the

Figure 9: Regime Uncertainty: Switch to Spending Austerity



Note: This figure shows generalized transition for the economy with unconditional probability of tax austerity of 50%. The initial state is at 150% debt/GDP and the tax austerity regime. The economy then either transitions back to its ergodic state (blue solid), or experiences a switch to the spending austerity regime (red dashed). The lines plot the average path of the economy from a sample of 10,000 paths of 40 quarters. The paths are relative to the unconditional transition of an economy with the same starting point (the balanced growth path, BGP).

tight austerity bound in models with regime uncertainty. If the threshold is too high, a sudden increase in government liabilities inside the austerity region at times of regime switches can raise their value beyond the point where spending cuts can rein in explosive debt dynamics. Put more generally, changes in the austerity regime cause large changes in long-term yields and bond valuations. When the outstanding debt is already large, these fluctuations greatly increase the likelihood of shock sequences that violate the safety assumption of the debt. Thus, a tighter bound is required to rule out such paths.

Table 3 and Figure 9 send a clear message: uncertainty about the type of future fiscal corrections that guarantee the safety of government debt is the largest threat to fiscal capacity, reducing our measure of capacity by 50-70% of GDP.

6 Conclusion

This paper proposes a novel definition of the fiscal capacity of a country as the maximum debt-to-GDP ratio above which surpluses must begin to increase to keep government debt default free in all future states of the world. We measure the fiscal capacity for the United States in a state-of-the-art model with realistic, non-linear macro-economic dynamics, fiscal and monetary policy rules, and asset prices. As long as there is certainty over *how* surpluses will be increased once the debt-to-GDP threshold is crossed, the fiscal capacity bound is 189% (174%) of GDP when surpluses are increased via tax hikes (spending cuts). Uncertainty over the type of austerity that will be pursued once it becomes necessary, maybe due to electoral cycles, dramatically lowers fiscal capacity to levels around 120% of GDP, levels that the Congressional Budget office expects to be breached within the next decade.

Looking ahead, this framework can be applied to other countries, historical episodes, and policy scenarios, offering a systematic way to assess how much governments can borrow before fiscal corrections become unavoidable.

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Online Appendix

A Model Appendix

A.1 Preliminary Definitions

We reformulate the problems of households, wholesaler, retailer, and intermediary to ensure stationarity. For nominal quantities, define for any variable J_t real, stationary values as

$$\hat{J}_t = \frac{J_t}{Z_t^p P_t}.$$

where Z_t^p is the permanent component of productivity. For real variables, we denote stationary values as

$$\hat{J}_t = \frac{J_t}{Z_t^p}.$$

We define inflation as the gross growth rate on the price level

$$\frac{P_t}{P_{t-1}} = \pi_t,$$

and the growth rate of the permanent component of productivity as

$$\frac{Z_t^p}{Z_{t-1}^p} = \exp(g_t).$$

Finally, we let $\mathcal{S}_t = \{Z_t^r, g_t, \vartheta_t, F_t, K_t, W_t^S, W_t^I, W_t^G\}$ be the vector of aggregate state variables.

A.2 Saver Household

We write the saver problem recursively, defining real saver wealth using the payoffs to holding capital, deposits, and the long-term bond.

$$\hat{W}_t^S = \exp(-g_t)\left(\left(r_t^K + (1-\delta)Q_t\right)\hat{X}_{t-1}^{S,K} + \frac{\hat{D}_{t-1}^S}{\pi_t} + (c + 1 - \delta^B + \delta^B p_t^B)\frac{\hat{B}_{t-1}^{S,L}}{\pi_t}\right).$$

The value function needs to be divided through by $(Z_t^P)^{1-\varphi}$ to ensure stationarity

$$V^S(\hat{W}_t^S, \mathcal{S}_t) = \max_{\hat{C}_t, N_t, \hat{B}_t^{S,L}, \hat{D}_t^S} (1-\beta)u(\hat{C}_t, N_t, \hat{D}_t^S, G_t) + \beta \mathrm{E}_t\left[\exp((1-\gamma)g_{t+1})(V^S(\hat{W}_{t+1}^S, \mathcal{S}_{t+1}))^{\frac{1-\gamma}{1-\varphi}}\right]^{\frac{1-\varphi}{1-\gamma}}$$

subject to

$$\begin{aligned}\hat{C}_t = {} & \hat{W}_t^S + (1-\tau_t^w)\hat{w}_t N_t + Q_t \hat{I}_t + (1-\tau^{div})(Div_t^I + Div_t^P) + \Theta_t + \text{Rebates}_t \\ & - \hat{I}_t - \Phi(\hat{I}_t/\hat{K}_{t-1}) - p_t^D \hat{D}_t^S - p_t^L \hat{B}_t^{S,L} - Q_t \hat{X}^{S,K},\end{aligned}$$

where intra-period utility is

$$u(\hat{C}_t, N_t, \hat{D}_t^S) = \frac{\left(\hat{C}_t^{1-\psi}(D_t^S)^{\psi}\right)^{1-\varphi}}{1-\varphi} - \omega_0 \frac{N_t^{1+\omega_1}}{1+\omega_1} + \psi_G \frac{G_t^{1-\varphi}}{1-\varphi} + \bar{u}.$$

Note that the aggregate capital stock is $\hat{K}_{t-1} = K_{t-1}/Z_t^p$, since it is chosen in $t-1$ for production in t.

In our numerical work, the constant $\bar{u}$ in the utility function may be required to ensure that utility $u(\hat{C}_t, N_t, \hat{D}_t^S)$ has the same sign everywhere in the feasible choice set. If $\varphi > 1$, i.e. if the IES < 1, then both utility from consumption and labor disutility are negative, and we can set $\bar{u} = 0$. This low IES case would require to transform the value function as described in Swanson (2018) to maintain a sensible definition of the certainty equivalent. If $\varphi < 1$ such that the IES > 1, which is the relevant case for our numerical experiments, then the consumption term is positive, the labor disutility term is negative, and a $\bar{u} > 0$ may be required to ensure that $u(\hat{C}_t, N_t, \hat{D}_t^S)$ is always positive. However, for any of the parameter combinations we consider in the paper this is not necessary. The consumption term dominates in magnitude.

We define the intra-temporal marginal rate of substitution between deposits and consumption as

$$\text{MRS}_t^D = \frac{u_D}{u_C} = \frac{\psi \hat{C}_t}{(1-\psi)\hat{D}_t^S}.$$

Denote $V^S(\hat{W}_t^S, \mathcal{S}_t) \equiv V_t^S$ and the certainty equivalent.

$$CE_t = \mathrm{E}_t \left[\exp((1-\gamma) g_{t+1}) (V^S(\hat{W}_{t+1}^S, \mathcal{S}_{t+1}))^{\frac{1-\gamma}{1-\varphi}} \right]^{\frac{1-\varphi}{1-\gamma}}.$$

The partial derivative of the certainty equivalent with respect to the value function is then given by

$$\begin{aligned} \frac{\partial CE_t(V_{t+1}^S)}{\partial V_{t+1}^S} &= \exp\left((1-\gamma) g_{t+1}\right) (V_{t+1}^S)^{\frac{\varphi-\gamma}{1-\varphi}} \mathrm{E}_t \left[\exp((1-\gamma) g_{t+1}) (V_{t+1}^S)^{\frac{1-\gamma}{1-\varphi}} \right]^{\frac{1-\varphi}{1-\gamma}-1} \\ &= \exp\left((1-\gamma) g_{t+1}\right) \left(\frac{V_{t+1}^S}{CE_t} \right)^{\frac{\varphi-\gamma}{1-\varphi}} \end{aligned}$$

We denote the partial derivatives of the value function with respect to bond and capital holdings as

$$\begin{aligned} V_{B,t}^S &\equiv \frac{\partial V_t^S}{\partial \hat{B}_{t-1}^{S,L}} = \frac{\exp(-g_t)}{\pi_t} \left(c + 1 - \delta^B + \delta^B p_t^L \right), \\ V_{K,t}^S &\equiv \frac{\partial V_t^S}{\partial K_{t-1}^S} = \exp(-g_t) \left(r_t^K + (1-\delta) Q_t \right). \end{aligned}$$

A.2.1 First-order conditions

Consumption Attaching multiplier λ_t to the budget constraint, the FOC for consumption is given by

$$\lambda_t = \frac{(1-\beta)(1-\psi)\left(C_t^{1-\psi}(D_t^S)^{\psi}\right)^{1-\varphi}}{C_t}.$$

Envelope Condition The envelope condition is

$$\frac{\partial V_t^S}{\partial \hat{W}_t^S} = \lambda_t = \frac{(1-\beta)(1-\psi)\left(C_t^{1-\psi}(D_t^S)^\psi\right)^{1-\varphi}}{C_t},$$

where the last equality uses the FOC for consumption to substitute for λ_t.

Stochastic Discount Factor The saver's intertemporal marginal rate of substitution between time t and $t+1$ is given by

$$\frac{\frac{\partial V_t^S}{\partial C_{t+1}}}{\frac{\partial V_t^S}{\partial C_t}} = \frac{\partial V_t^S}{\partial V_{t+1}^S}\exp(-g_{t+1})\frac{\partial V_{t+1}^S/\partial \hat{W}_{t+1}^S}{\partial V_t^S/\partial \hat{W}_t^S}$$

$$= \beta\exp\big(-\gamma g_{t+1}\big)\left(\frac{V_{t+1}}{CE_t}\right)^{\frac{\varphi-\gamma}{1-\varphi}} \frac{\frac{1}{\hat{C}_{t+1}}(1-\beta)(1-\psi)\left(\hat{C}_{t+1}^{1-\psi}(\hat{D}_{t+1}^S)^\psi\right)^{1-\varphi}}{\frac{1}{\hat{C}_t}(1-\beta)(1-\psi)\left(\hat{C}_t^{1-\psi}(\hat{D}_t^S)^\psi\right)^{1-\varphi}},$$

using the envelope condition. Hence, we can define the saver stochastic discount factor (SDF) as

$$\mathcal{M}_{t,t+1} = \beta\exp(-\gamma g_{t+1})\left(\frac{\hat{C}_{t+1}}{\hat{C}_t}\right)^{-1}\left(\frac{\hat{C}_{t+1}^{1-\psi}(\hat{D}_{t+1}^S)^\psi}{\hat{C}_t^{1-\psi}(\hat{D}_t^S)^\psi}\right)^{1-\varphi}\left(\frac{V_{t+1}^S}{CE_t}\right)^{\frac{\varphi-\gamma}{1-\varphi}}.$$

Long-term bonds The FOC for long-term bonds, $\hat{B}_t^{S,L}$ is

$$-\lambda_t p_t^L + \mathrm{E}_t\left[\beta\frac{\partial V_{t+1}^S}{\partial \hat{B}_t^{S,L}}\frac{\partial CE_t}{\partial V_{t+1}^S}\right] = 0$$

Computing the derivatives and simplifying yields

$$p_t^L = \mathrm{E}_t\left[\beta\frac{\lambda_{t+1}}{\lambda_t}\exp\big(-\gamma g_{t+1}\big)\left(\frac{V_{t+1}^S}{CE_t}\right)^{\frac{\varphi-\gamma}{1-\varphi}}\left(\frac{c+1-\delta^B+\delta^B p_{t+1}^L}{\pi_{t+1}}\right)\right].$$

By using the definition of the SDF, we get

$$p_t^L = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\left(\frac{c+1-\delta^B+\delta^B p_{t+1}^L}{\pi_{t+1}}\right)\right]. \tag{28}$$

Deposits The FOC for the saver's purchases of deposits is given by

$$-\lambda_t p_t^D + \psi(1-\beta)\frac{(\hat{C}_t^{1-\psi}(\hat{D}_t^S)^\psi)^{1-\varphi}}{\hat{D}_t^S} + \mathrm{E}_t\left[\beta\frac{\partial V_{t+1}^S}{\partial \hat{D}_t^S}\frac{\partial CE_t}{\partial V_{t+1}^S}\right] = 0.$$

Then using the definition of the intra-temporal marginal rate of substitution between deposits and consumption, and the SDF, we have that the FOC for deposits becomes

$$p_t^D = \mathrm{MRS}_t^D + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\frac{1}{\pi_{t,t+1}}\right]. \tag{29}$$

Capital The FOC for capital is

$$-\lambda_t Q_t + \mathrm{E}_t\left[\beta\frac{\partial V_{t+1}^S}{\partial \hat{X}_t^{S,K}}\frac{\partial CE_t}{\partial V_{t+1}^S}\right] = 0.$$

Again using the definition of the SDF the FOC becomes

$$Q_t = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\left(r_{t+1}^K + (1-\delta)Q_{t+1}\right)\right]. \tag{30}$$

Investment Savers operate the economy's investment technology and optimally solve the intratemporal problem of producing I_t unites of capital from $I_t + \Phi(I_t, K_t)$ units of the consumption good. The first order condition is given by

$$Q_t = 1 + \phi\left(\frac{\hat{I}_t}{\hat{K}_{t-1}} - \delta\right). \tag{31}$$

Labor The saver FOC for labor supply is given by

$$N_t = \left((1-\psi)(\hat{C}_t)^{-1}\left(\hat{C}_t^{1-\psi}(\hat{D}_t^S)^{\psi}\right)^{1-\gamma}\frac{(1-\tau_t^w)w_t}{\omega_0}\right)^{\frac{1}{\omega_1}}. \tag{32}$$

In summary, the saver's optimality conditions are given by equations (28) – (32).

A.3 Banks

The stationarized recursive bank problem is

$$V^I(\hat{W}_t^I, \mathcal{S}_t) = \max_{\hat{X}_t^{I,K}, \hat{X}_t^{I,S}, \hat{D}_t^I, \hat{A}_t,} \eta \hat{W}_t^I - \hat{A}_t + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\exp(g_{t+1})V^I(\hat{W}_{t+1}^I, \mathcal{S}_{t+1})\right]$$

subject to

$$(1-\eta)\hat{W}_t^I + \hat{A}_t + (p_t^D - \varrho_t)\hat{D}_t^I + \mathrm{Rebates}_t^I \geq p_t^S \hat{B}_t^{I,S} + Q_t \hat{X}_t^{I,K} + \frac{\chi}{2}\hat{A}_t^2,$$

and

$$\begin{aligned} \hat{D}_t^I &\leq \nu\left(\hat{B}_t^{I,S} + \nu^K Q_t \hat{X}_t^{I,K}\right), \\ \hat{B}_t^{I,S} &\geq 0, \\ \hat{X}_t^{I,K} &\geq 0, \end{aligned}$$

where the first constraint reflects the regulatory constraint and the final two constraints reflecting no-shorting constraints for short-term bonds and capital. Bank equity evolves according to

$$\hat{W}^I_{t+1} = \exp(-g_{t+1}) \left[\left(r^K_{t+1} + (1-\delta) Q_{t+1} \right) \hat{X}^{I,K}_t + \frac{\hat{B}^{I,S}_t}{\pi_{t+1}} - \frac{\hat{D}^I_t}{\pi_{t+1}} \right].$$

The total liquidity cost is given by:

$$\varrho_t \hat{D}^I_t = \varrho_0 \zeta_\varrho \left(\frac{\hat{B}^{I,S}_t}{\zeta_\varrho \hat{D}^I_t} \right)^{1-\varrho_1} \hat{D}^I_t.$$

Bank equity We attach multiplier $\hat{\lambda}^I_t$ to the budget constraint. Then the FOC for raising new equity is given by

$$0 = \hat{\lambda}^I_t (1 - \chi A_t) - 1 \tag{33}$$

Short-term bond First, note that the partial derivative of the liquidity cost with respect to short-term debt is given by

$$\frac{\partial (\varrho_t \hat{D}^I_t)}{\partial \hat{B}^{I,S}_t} = (1-\varrho_1) \varrho_0 \left(\frac{\hat{B}^{I,S}_t}{\zeta_\varrho \hat{D}^I_t} \right)^{-\varrho_1}.$$

Attaching multipliers $\hat{\lambda}_t$ and $\hat{\sigma}^{I,S}_t$ to the leverage constraint and non-negativity constraint, respectively, we can we write the first order condition for short-term bonds as

$$0 = -\hat{\lambda}^I_t \left(p^S_t - (1-\varrho_1) \varrho_0 \zeta_\varrho \left(\frac{\hat{B}^{I,S}_t}{\hat{D}^I_t} \right)^{-\varrho_1} \right) + \mathrm{E}_t \left[\mathcal{M}_{t,t+1} (V^I)'(\hat{W}^I_{t+1}) \frac{1}{\pi_{t+1}} \right] + \hat{\lambda}_t \nu + \hat{\sigma}^{I,S}_t$$

Deposits Noting that the partial derivative of the liquidity cost with respect to deposits is given by

$$\frac{\partial (\varrho_t \hat{D}^I_t)}{\partial \hat{D}^I_t} = \varrho_0 \varrho_1 \zeta_\varrho \left(\frac{\hat{B}^{I,S}_t}{\zeta_\varrho \hat{D}^I_t} \right)^{1-\varrho_1},$$

we can write the first order condition for deposits as

$$0 = \hat{\lambda}^I_t \left(p^D_t - \varrho_0 \varrho_1 \zeta_\varrho \left(\frac{\hat{B}^{I,S}_t}{\zeta_\varrho \hat{D}^I_t} \right)^{1-\varrho_1} \right) - \mathrm{E}_t \left[\mathcal{M}_{t,t+1} (V^I)'(\hat{W}^I_{t+1}) \frac{1}{\pi_{t+1}} \right] - \hat{\lambda}_t.$$

Capital Attach multiplier $\hat{\sigma}^{I,K}_t$ to the non-negativity constraint on capital. Then the FOC for capital is

$$0 = -\hat{\lambda}^I_t Q_t + \mathrm{E}_t \left[\mathcal{M}_{t,t+1} (V^I)'(\hat{W}^I_{t+1}) \left(r^K_{t+1} + (1-\delta) Q_{t+1} \right) \right] + \hat{\lambda}_t \nu \nu^K Q_t + \hat{\sigma}^{I,K}_t.$$

Envelope condition To further simplify the bank's first order conditions, we note that the envelope condition is given by

$$(V^I)'(\hat{W}^I_t) = \eta + \hat{\lambda}^I_t (1-\eta).$$

Combining envelope condition and first FOC for new equity, $\hat{\lambda}_t^I = 1/(1-\chi\hat{A}_t)$, we can define the bank stochastic discount factor as

$$\mathcal{M}_{t,t+1}^I = \mathcal{M}_{t,t+1}(1-\chi\hat{A}_t)\left(\eta + \frac{1-\eta}{1-\chi\hat{A}_{t+1}}\right),$$

and the rescaled multipliers as

$$\begin{aligned}
\lambda_t &= \hat{\lambda}_t(1-\chi\hat{A}_t),\\
\sigma_t^{I,S} &= \hat{\sigma}_t^{I,S}(1-\chi\hat{A}_t),\\
\sigma_t^{I,K} &= \hat{\sigma}_t^{I,K}(1-\chi\hat{A}_t).
\end{aligned}$$

Then the bank FOC can be rewritten as

$$p_t^S = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^I\frac{1}{\pi_{t+1}}\right] + \lambda_t\nu + (1-\varrho_1)\varrho_0\left(\frac{\hat{B}_t^{I,S}}{\zeta_\varrho\hat{D}_t^I}\right)^{-\varrho_1} + \sigma_t^{I,S}, \tag{34}$$

$$p_t^D = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^I\frac{1}{\pi_{t+1}}\right] + \lambda_t + \varrho_0\varrho_1\zeta_\varrho\left(\frac{\hat{B}_t^{I,S}}{\zeta_\varrho\hat{D}_t^I}\right)^{1-\varrho_1}, \tag{35}$$

$$Q_t = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^I\left(r_{t+1}^K + (1-\delta)Q_{t+1}\right)\right] + \lambda_t\nu\nu^K\bar{Q}_t + \sigma_t^{I,K}. \tag{36}$$

Note that when the leverage constraint and no-shorting constraint on short-term debt are not binding, the Euler equations for short-term debt and deposits imply that the spread between the two *prices* is a static function of the liquidity coverage ratio:

$$p_t^S - p_t^D = \varrho_0\left(\frac{\hat{B}_t^{I,S}}{\zeta_\varrho\hat{D}_t^I}\right)^{-\varrho_1}\left(\varrho_1 - 1 - \frac{\hat{B}_t^{I,S}}{\zeta_\varrho\hat{D}_t^I}\zeta_\varrho\varrho_1\right)$$

At 100% LCR, this reduces to $p_t^s - p_t^d = \rho_0(\varrho_1 - 1 - \zeta_\varrho\varrho_1)$. Because $\zeta << 1$, the price spread is increasing in ϱ_1. When ϱ_1 is closer to 1, short-term bonds are cheaper than deposits and have a higher rate. When ϱ_1 is high, short-term bonds are more expensive than deposits and have a lower rate. The prices are exactly equal at 100% LCR if $\varrho_1 = \frac{1}{1-\zeta}$.

A.4 Firms

A.4.1 Final Goods Producers

Final output is

$$\hat{Y}_t = \left(\int_0^1 Y_t(i)^{1-\frac{1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}}.$$

where ϵ is the elasticity of substitution.

Final goods producers maximize profit by solving

$$\max_{\{\hat{Y}_t(i)\}} P_t\hat{Y}_t - \int_0^1 P_t(i)\hat{Y}_t(i)di.$$

where P_t is the aggregate price index and $P_t(i)$ is the price of input i.

This implies the demand functions for all i

$$\hat{Y}_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\epsilon} \hat{Y}_t.$$

Further, perfect competition and free entry among retailers requires that they make zero profit in equilibrium. This in turn means $P_t\hat{Y}_t = \int_0^1 P_t(i)\hat{Y}_t(i)di$ and

$$P_t = \left(\int_0^1 P_t(i)^{1-\epsilon}di\right)^{\frac{1}{1-\epsilon}}.$$

A.4.2 Wholesalers

We simplify notation by dropping i subscripts and writing $p_t = P_t(i)$. Then

$$y(p_t) = \left(\frac{p_t}{P_t}\right)^{-\epsilon} \hat{Y}_t.$$

The stationarized recursive problem of a wholesale firm is in real terms

$$V^W(p_{t-1}, \mathcal{S}_t) = \max_{p_t, n_t, \hat{k}_t} \frac{p_t}{P_t} y(p_t) - (\hat{w}_t n_t + \hat{w}_t^H n_t^H + r_t^K \hat{k}_t) - \frac{\xi}{2}\left(\frac{p_t}{\bar{\pi} p_{t-1}} - 1\right)^2 + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\exp(g_{t+1})V^W(p_t, \mathcal{S}_{t+1})\right],$$

subject to

$$Z_t^r n_t^\alpha (n_t^H)^{\alpha_H} \hat{k}_t^{1-\alpha-\alpha_H} \geq y(p_t).$$

We first solve the cost minimization problem for given output

$$\min_{n_t, n_t^H, \hat{k}_t} \hat{w}_t n_t + \hat{w}_t^H n_t^H + r_t^K \hat{k}_t$$

subject to

$$Z_t^r n_t^\alpha (n_t^H)^{\alpha_H} \hat{k}_t^{1-\alpha-\alpha_H} \geq \bar{y}.$$

We denote the multiplier on the output constraint as m_t. Then the FOC are

$$\begin{aligned}
\hat{w}_t &= m_t Z_t^r \alpha n_t^{\alpha-1} (n_t^H)^{\alpha_H} \hat{k}_t^{1-\alpha-\alpha_H}, \\
\hat{w}_t^H &= m_t Z_t^r \alpha_H n_t^\alpha (n_t^H)^{\alpha_H-1} \hat{k}_t^{1-\alpha-\alpha_H}, \\
r_t^K &= m_t Z_t^r (1-\alpha-\alpha_H) n_t^\alpha (n_t^H)^{\alpha_H} \hat{k}_t^{-\alpha-\alpha_H},
\end{aligned}$$

which implies

$$\begin{aligned}
(1-\alpha)\hat{w}_t n_t &= \alpha r_t^K \hat{k}_t, \\
(1-\alpha)\hat{w}_t^H n_t^H &= \alpha_H r_t^K \hat{k}_t, \\
\alpha_H \hat{w}_t n_t &= \alpha \hat{w}_t^H n_t^H,
\end{aligned}$$

and, using a binding production constraint, factor demands as functions of prices

$$n_t = \frac{\bar{y}}{Z_t^r}\left(\frac{\alpha}{\alpha_H}\right)^{\alpha_H}\left(\frac{\alpha}{1-\alpha-\alpha_H}\right)^{1-\alpha-\alpha_H}\left(\frac{\hat{w}_t^H}{\hat{w}_t}\right)^{\alpha_H}\left(\frac{r_t^K}{\hat{w}_t}\right)^{1-\alpha-\alpha_H},$$

$$n_t^H = \frac{\bar{y}}{Z_t^r}\left(\frac{\alpha_H}{\alpha}\right)^{\alpha}\left(\frac{\alpha_H}{1-\alpha-\alpha_H}\right)^{1-\alpha-\alpha_H}\left(\frac{\hat{w}_t}{\hat{w}_t^H}\right)^{\alpha}\left(\frac{r_t^K}{\hat{w}_t^H}\right)^{1-\alpha-\alpha_H},$$

$$\hat{k}_t = \frac{\bar{y}}{Z_t^r}\left(\frac{\alpha}{1-\alpha-\alpha_H}\right)^{-\alpha}\left(\frac{\alpha_H}{1-\alpha-\alpha_H}\right)^{-\alpha_H}\left(\frac{r_t^K}{\hat{w}_t}\right)^{-\alpha}\left(\frac{r_t^K}{\hat{w}_t^H}\right)^{-\alpha_H}.$$

Combining factor first order condition with the production function gives the following expression for the multiplier, which equals marginal cost

$$m_t = \frac{1}{Z_t^r}(1-\alpha-\alpha_H)^{-(1-\alpha-\alpha_H)}\alpha^{-\alpha}\alpha_H^{-\alpha_H}\hat{w}_t^{\alpha}(\hat{w}_t^H)^{\alpha_H}(r_t^K)^{1-\alpha-\alpha_H}.$$

With this solution in hand, we write the profit maximization problem

$$V^W(p_{t-1},\mathcal{S}_t) = \max_{p_t} y(p_t)\left(\frac{p_t}{P_t}-m_t\right) - \frac{\xi}{2}\left(\frac{p_t}{\bar{\pi}p_{t-1}}-1\right)^2 + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\exp(g_{t+1})V^W(p_t,\mathcal{S}_{t+1})\right].$$

The FOC for the price is

$$0 = y'(p_t)\left(\frac{p_t}{P_t}-m_t\right) + \frac{y(p_t)}{P_t} - \xi\left(\frac{p_t}{\bar{\pi}p_{t-1}}-1\right)\frac{1}{\bar{\pi}p_{t-1}} + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\exp(g_{t+1})\frac{\partial V^W(p_t,\mathcal{S}_{t+1})}{\partial p_t}\right].$$

The marginal value of today's price is given by the envelope theorem

$$\frac{\partial V^W(p_{t-1},\mathcal{S}_t)}{\partial p_{t-1}} = \xi\left(\frac{p_t}{\bar{\pi}p_{t-1}}-1\right)\frac{p_t}{\bar{\pi}p_{t-1}^2}.$$

In equilibrium, all firms choose the same price and we have $p_t = P_t$. Therefore $y(p_t) = \hat{Y}_t$, and $y'(p_t) = -\epsilon\hat{Y}_t/P_t$.

We can thus write the FOC as

$$\xi\left(\frac{\pi_t}{\bar{\pi}}-1\right)\frac{\pi_t}{\bar{\pi}} = \hat{Y}_t(1-\epsilon+\epsilon m_t) + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\exp(g_{t+1})\xi\left(\frac{\pi_{t+1}}{\bar{\pi}}-1\right)\frac{\pi_{t+1}}{\bar{\pi}}\right], \tag{37}$$

which is the New Keynesian Phillips curve.

A.5 Aggregate Capital Transition

The aggregate capital stock is a state variable of the economy contained in S_t. It is needed to compute adjustment costs, and the aggregate output of intermediate goods. Since $\hat{K}_{t-1} = \frac{K_{t-1}}{Z_t^p}$, the stationarized law of motion for capital is

$$\begin{aligned}\hat{K}_t &= \frac{Z_t^p}{Z_{t+1}^p}\left((1-\delta)\hat{K}_{t-1}+\hat{I}_t\right),\\ &= \exp(-g_{t+1})\left((1-\delta_t)\hat{K}_{t-1}+\hat{I}_t\right)\end{aligned}$$

A.6 Government

A.6.1 Cyclical Fiscal Rules

The cyclical components in fiscal rules (13) – (16) are parameterized by loadings on log cyclical output

$$\hat{y}_t = \log(\hat{Y}_t),$$

and the variance of productivity shocks σ_z^2, which we combine into the vector

$$\mathbf{x}_t = \begin{bmatrix} \hat{y}_t \\ \sigma_z^2 \end{bmatrix}.$$

We further define the coefficient matrix

$$\mathbf{F} = \begin{bmatrix} b_\gamma & -b_\gamma^2 \\ b_\theta & -b_\theta^2 \\ b_\tau & -b_\tau^2 \end{bmatrix}.$$

The latter term loading on σ_z^2 corrects the level of spending, as the nonlinearity of the cyclical loading on $\hat{y}_t$ on its own causes an upward bias (a "Jensen correction" term).

The cyclical rules are then

$$\hat{\theta}(\hat{Y}_t) = \exp\left((\mathbf{F}\mathbf{x}_t)'\mathbf{e_1}\right), \tag{38}$$

$$\hat{\gamma}(\hat{Y}_t) = \exp\left((\mathbf{F}\mathbf{x}_t)'\mathbf{e_2}\right), \tag{39}$$

$$\hat{\tau}(\hat{Y}_t) = \exp\left((\mathbf{F}\mathbf{x}_t)'\mathbf{e_3}\right), \tag{40}$$

where $\mathbf{e}_i$ is the basis vector that selects the ith element of a vector.

A.7 Market Clearing

The markets for short-term bonds, long-term bonds, deposits, labor, capital, investment goods, and final goods must clear:

$$\begin{aligned} B_t^{G,S} &= B_t^{I,S}, \\ B_t^{G,L} &= B_t^{S,L}, \\ D_t^I &= D_t^S, \\ N_t &= \int_0^1 n_t(i)di, \\ N_t^H &= \int_0^1 n_t^H(i)di, \\ K_{t-1} &= \int_0^1 k_t(i)di, \\ X_t^{I,K} + X_t^{S,K} &= (1-\delta)K_{t-1} + I_t = K_t, \\ Y_t &= C_t + I_t + G_t + \Phi(I_t, K_{t-1}). \end{aligned}$$

B Calibration

The model is solved and calibrated at a quarterly frequency. A subset of model parameters have direct counterparts in the data. The remaining parameters are calibrated to match target moments from the data within the model. To compute model-implied moments, we simulate the model for 4,000,000 periods (quarters) in total, consisting of 400 simulation runs of 10,000 periods each (with a 3,000 period burn-in).[23] While these parameters are chosen simultaneously to match all targeted moments, Tables B.1 and B.2 list for each parameter the specific moment that is most affected by this parameter.

Whenever possible, we compute calibration targets based on aggregate data for the 1957-2024 period, since many NIPA and Flow of Funds data series start becoming available then. For the mean real interest rate, we use a longer sample that starts in 1920. It is critical to calibrate level of interest rates in the model, which in turn are is key for the stationary distribution of government debt.

To compute corresponding moments from the model simulation, we use the conditional sample with debt/GDP ratios of 103% and smaller. This is the peak of debt/GDP in the data, reached in 2020. Debt/GDP ratios in the model sample thus span the full range observed in the data in the post-WW2 period.

Aggregate Productivity The aggregate productivity process has permanent and transitory components. The permanent productivity process, Z_t^p, is subject to a growth rate shock, g_t which follows an AR(1) process with mean $\bar{g} = 0.005$, persistence $\rho_g = 0.6$ and volatility $\sigma_g = 1.2\%$. The volatility of this process is chosen to match the volatility of real consumption growth for the U.S. for the period 1957-2024, which is the sample period we use for most aggregate moments. We choose the persistence of this process to match the persistence of real output growth for the same period. The mean targets an average annual growth rate of 2%. The transitory productivity process Z_t^r, is also follows an AR(1) in logs with volatility parameter $\sigma_z = 1.5\%$, taken directly from Fernald (2012). Since both shocks are persistent, they become state variables. We discretize g_t and Z_t^r into 3-state Markov chains using the Rouwenhorst (1995) method. We further assume that transitory TFP innovations and growth rate shocks are perfectly positively correlated, and hence Z_t^r inherits the persistence $\rho_z = \rho_g$ of the growth rate process. While our model admits any correlation structure between the two shocks, a strong positive correlation between the shocks is required to get a positive term spread.

Production Investment adjustment costs are quadratic and centered around the balanced growth path investment rate $\Phi(I, K) = \frac{\phi}{2}(I/K - \delta - e^{\bar{g}} + 1)^2 K$. We set the marginal cost parameter to $\phi = 10$ to match the observed volatility of (detrended) investment to GDP of 1.3%. Depreciation, δ, is set to 0.02 to match the investment to output ratio of 14.2% observed in the data. We set the sum of labor weights $\alpha + \alpha_H$ in the Cobb-Douglas production function equal to 0.78 to target the observed labor share of income of 61.9%. The elasticity of substitution for the wholesaler, ϵ, is set to 7 to target a markup of 15.7% from van Vlokhoven (2020). The Rotemberg adjustment cost ξ is set to 120 to target the volatility of the labor share, as the degree of price stickiness governs markups over marginal costs of production.

[23] See Appendix D for details on the solution method and simulation approach.

Table B.1: Parameters: Shocks, Firms, Households, and Intermediaries

Par	Description	Value	Source	Data	Model
Exogenous Shocks					
ρ_g	persistence perm. TFP	0.6	AC(1) real GDP growth (1957-2024 NIPA)	0.0597	0.107
σ_g	innovation vol. perm. TFP	1.2	Vol. real consumption growth (57-24)	1.60%	1.39%
σ_z	innovation trans. TFP	1.5	Vol. Ham. filtered TFP (Fernald (2012))	-	-
Production					
ϕ	marginal adjustment cost	10	Vol. investment-to-GDP ratio (57-24)	1.31%	0.832%
$\alpha + \alpha_H$	total weight on labor	0.78	labor share (57-24)	61.9%	61.6%
$\frac{\alpha_H}{\alpha+\alpha_H}$	hand-to-mouth share of labor	0.0686	HtM share of wage income (SCF)	-	-
δ	capital depreciation rate	0.02	investment-to-GDP ratio (57-24)	14.2%	16.0%
ξ	Rotemberg adjustment cost	120	Vol. labor share (57-24)	2.11%	1.88%
ϵ	Intermediate goods elast	7	Profits/Revenue (van Vlokhoven (2020))	15.7%	15.2%
Preferences and Household Sector					
β	discount rate	0.9876	real rate (1920-2024, Jorda et al. (2016)) excl. WWII	0.410%	0.426%
γ	risk aversion coefficient	25	ex.ret. on GDP (Chen et al. (2025)) - conv. yield (Nagel (2016))	1.02%	0.901%
φ	1/EIS	0.7	Vol. of short-term yield (57-24)	0.779%	1.08%
ψ	liquidity utility	0.08	Term spread (57-24)	0.346%	0.310%
ψ_G	utility from gov. spending	0.213	Optimal spending in steady state (see text)	-	-
ω_0	disutility of labor	2.5742	normalize $E[Y] = 1$	-	-
ω_1	inverse of Frisch elasticity	2	standard value	-	-
Intermediaries					
ϱ_0	liquidity cost level	0.12	FFR - time deposit spread (1987-2022 Call Reports)	0.199%	0.188%
ζ_ϱ	deposit run-off rate	0.05	BIS (2013)	-	-
τ	dividend target	0.08	bank leverage (87-22)	90.6%	89.9%
χ	equity issuance cost	25	bank net payout rate	5.75%	7.91%

Intermediaries Intermediaries are subject to a supplementary leverage ratio (SLR) and equity capital requirements. The SLR constraint is parameterized by $\nu = 0.97$ to reflect real-world regulation on total leverage. The additional risk weight on capital $\nu_K = 0.9588 = \frac{1-\tilde{\nu}_K}{\nu}$, where $\tilde{\nu}_K = 0.07$. Together these parameters determine the maximum leverage ratio and equity requirement for capital.

We choose the equity payout target of banks, $\eta = 0.08$ to target aggregate leverage of depository institutions, calculated as average total liabilities over total assets from 1987-2022 Call Reports and equal to 90.6%. A higher value of η, in combination with the equity issuance cost, makes equity finance more costly for banks and creates incentives for higher leverage. We further follow Elenev et al. (2021) in calibrating the equity issuance cost to target the net payout ratio of the financial sector, defined as dividends plus share repurchases minus equity issuance divided by book equity. A higher equity issuance cost makes external equity more expensive and raises the net payout ratio. Elenev et al. (2021) construct a time series of dividends, share repurchases, equity issuances, and book equity, aggregating across all publicly traded banks from $1974 - 2018$. They report an annual net payout ratio of 5.7%, which the model approximately matches with $\chi = 25$.

The liquidity cost per unit of deposits of banks, reflecting real-world liquidity coverage ratio (LCR) regulation, is determined by the parameters ζ_ϱ, ϱ_0, and ϱ_1. ζ_ϱ represents the fraction of deposits a particular bank's depositors can be expected to withdraw per period and is set to 0.05 following BIS (2013). ϱ_0 is set to 0.12 to target the cost of liquidity. The cost of liquidity captures the observed spread between the federal funds rate and aggregate deposit rate, calculated from call reports as total deposit interest expense over deposits. The parameter ϱ_1 is set to $1/(1 - \zeta_\varrho)$ for parsimony.

Households and Preferences We determine the share of HtM households based on the 2022 Survey of Consumer Finances. Following the empirical macro literature (Zeldes, 1989; Kaplan et al., 2014), we define hound-to-mouth households in the data as those with a ratio of net worth to monthly income below 2. Using SCF sampling weights, we find that the population share of these households is 15.2%, while their share of labor income (wages and salaries) is 6.8%. Households in this group only hold 0.3% of total net worth, justifying the assumption that they do not accumulate savings in the model. Based on these data, we set $\alpha_H = 0.068$.

The coefficient of risk aversion, γ, targets the unlevered risk premium on a claim to the GDP. Chen, Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2025) calculate a return on a claim to GDP of 4.5% per year in excess of the risk-free rate. A portion of this excess return is due to the convenience yield on short-term, risk-free debt, calculated from Nagel (2016)'s data to be 40 bps per year. We set γ to 25 so that the model produces a risk premium, i.e. negative covariance between the saver's SDF and the return on a GDP claim, of 4.1% annually or 1.02% quarterly. The Arrow-Pratt measure of relative risk aversion is not equal to 25 since households supply labor elastically.(Swanson, 2018) The average Arrow-Pratt measure of risk aversion in simulation is 3.1 (see Appendix D.2).

We set the elasticity of inter-temporal substitution to $\varphi = 1/0.7$ to target the volatility of the short-term bond yield. The subjective discount factor of households $\beta = 0.9877$ targets the average quarterly real rate of 0.41%, based on the 1920-2024 sample from Jorda et al. (2016), leaving out the WW-II years.

The coefficient on the disutility of labor, ω_0, is set to 2.65 to normalize the unconditional mean of output to 1. Monetary policy and fiscal rules in the model are parameterized with the implicit assumption that average output is 1. Since the unconditional mean of output in a long-simulation of the nonlinearly solved model is far away from the model's deterministic "steady-state", this normalization leads to a fixed-point: ω_0 needs to be set such that jointly with all other parameters, $\mathrm{E}[Y_t] = 1$ in the stationarized model.

Table B.2: Parameters: Government

Par	Description	Value	Source	Data	Model
Government: Fiscal Policy Rules					
ϑ_l	low transfer mult.	0.66667	transfers/GDP low state (< 1990) 7.0%	-	-
ϑ_h	high transfer mult.	1.2095	transfers/GDP high state ($\geq$ 1990) 12.7%	-	-
p_θ^{hh}	Prob. stay in ϑ_h	0.985	persistence of high transfers	-	-
p_θ^{ll}	Prob. stay in ϑ_l	0.99057	normalization $\mathrm{E}[\vartheta_t] = 1$	-	-
τ_0^π	base corp. tax rate	0.155	BEA corp tax to GDP (57-24)	2.94%	3.11%
τ_w^0	base labor tax rate, savers	0.2362	BEA personal tax to GDP (57-24)	13.6%	13.8%
$\tau_0^{w,H}$	base labor tax rate, HtM	0	progressivity of tax system	-	-
γ_0	base spending/output	0.07	BEA govt consumption to GDP (57-24)	6.96%	7.00%
$\theta_0 + \theta_0^H$	base total transfers/output	0.105	BEA transfers to GDP (57-24)	10.3%	9.9%
$\frac{\theta_0^H}{\theta_0+\theta_0^H}$	HtM share of transfers	0.0686	pro-rata allocation of transfers	-	-
b_τ	tax cyclicality	0.37	ols coef g(tax revenue) on g(GDP) (57-24)	1.73	1.58
b_γ	spending cyclicality	-0.45	ols coef g(spending) on g(GDP) (57-24)	0.196	0.182
b_θ	transfers cyclicality	-0.77	ols coef g(transfers) on g(GDP) (57-24)	-0.447	-0.459
$\bar{\mu}$	share of long-term debt	0.67	share of LT treasuries (47-08)	67.0%	67.0%
δ_B	duration of long-term debt	0.97	duration of LT debt (00-20)	7.76	7.69
c	long-term debt fixed coupon	0.01248	normalization $p^L = 1$ in st.st.	-	-
$\underline{\Delta}$	Profligacy threshold	2	min(debt/GDP) (1974)	16.4%	15.3%
τ_A	Austerity adj. coef., tax	1.75	half life austerity	-	-
τ_P	Profligacy adj. coef., tax	0.25	half life profligacy	-	-
γ_A	Austerity adj. coef., spending ($= \theta_A$)	-2	same aust. region size as tax aust.	-	-
Government: Monetary Policy Rule					
$\bar{\Pi}$	inflation target	1.005	Fed inflation target (2% p.a.)	-	-
ϕ_Π	weight on inflation	1.6	Vol of inflation (core PCE)	0.661%	0.796%
ϕ_Y	weight on output	0.125	standard value	-	-
$\bar{p}^S$	natural interest rate	0.99177	normalization	-	-
Government: Financial Regulation					
ν	max. intermediary leverage	0.97	Basel regulation	-	-
ν_K	addl. risk weight on capital	0.95876	Basel regulation	-	-

The Frisch elasticity of labor supply is set to 0.5, a standard value in the literature, implying an exponent $\omega_1 = 2$.

Saver households benefit from holding deposits. The utility over deposits is modulated by ψ, which is set to 0.08 to target the average term spread. The latter is 35 bps per quarter in the data. Since banks need short-term bonds to back deposits due to the liquidity cost, short-term debt inherits a fraction of the convenience yield of deposits. This convenience of short-term over long-term government debt increases the slope of the yield curve in the model, in addition to the perfect positive correlation between productivity level and growth shocks.

Finally, household utility from government spending is set to $\psi_G = 0.213$. At this value, the utility benefit from government spending is exactly offset by the utility loss due to lower consumption caused by higher taxation. To calculate this value, we vary government spending in the deterministic steady state of the model, for different levels of ψ_G. As we vary spending, we adjust taxation to maintain a constant stock of government debt – implying that taxes need to rise when spending increases to keep debt constant. We then find the value of ψ_G for which the observed level of spending in the data maximizes utility. Having government spending enter household utility avoids assuming that government spending is wasted, which would mean that cutting government spending is always welfare-improving.

Government Parameters Our fiscal policy rules are calibrated to match the unconditional average and cyclical properties of transfer spending, discretionary spending (government consumption), and tax revenue. The exact functional forms of the fiscal policy rules in equations (38) and (39) for transfers and spending are given in A.6. These rules are parameterized by a cyclicality coefficient b_j, $j = \theta, \gamma, \tau$, that governs the correlation with the cyclical component of output.

The parameters τ_0^π, τ_0^w, $\tau_0^{w,H}$ and b_τ control the base corporate tax rate, base tax rate on wages, and their cyclicalities, respectively. τ_0^π is set to 15.5% to target the observed corporate tax revenue of 2.94% of GDP and τ_0^w is set to 23.62% to match the observed tax revenue from wages to GDP of 13.6%. Wage taxation of HtM agents is set to zero, $\tau_0^{w,H} = 0$, since these agents have low incomes. To determine b_τ, we run a regression of tax revenue growth on GDP growth in model simulated data and in the 1953-2020 sample (the regression allows for a linear trend). The model matches the data coefficient with a value of $b_\tau = 0.37$.

The unconditional averages of government spending and transfers are controlled by the parameters γ_0, θ_0, and θ_0^H, respectively. We set γ_0 to 7.0% to target the observed average government spending to GDP of 7.0%. The cyclicality of spending is governed by b_γ, which we set to match regression coefficients in model and data of spending growth on GDP growth. Average transfers/GDP of 10.3% are matched by total transfers to both types of households $\theta_0 + \theta_0^H$ of 10.5%. HtM consumers receive a share of the total transfer spending proportional to their share of income of 6.8%, implying a corresponding value for θ_0^H. In the 2022 SCF, HtM consumers received 6.7% of total transfers, approximately the same fraction. The cyclicality of transfer spending is again chosen to match model to data regression coefficients, yielding $b_\theta = -0.77$. Transfers are strongly countercyclical.

We calibrate the transfer spending shock ϑ_t as a two-state Markov chain. The realizations of the shock – low and high spending – the scale parameters $\vartheta_l = 0.67$ and $\vartheta_h = 1.21$ – are chosen such that transfer spending to GDP in the low state is 7.0%, which is the average from 1947-1990, and in the high state it is 12.7% of GDP, the 1990-2024 average. We set the probability of remaining in the high state to 98.5%, reflecting the high persistence of government spending cycles. Since the shock must satisfy $\mathrm{E}[\vartheta_t] = 1$, the low transfer state must be even more persistent with a staying probability of 99.7%.

In the model with uncertainty about the austerity regime, the fiscal regime F_t follows a two-state Markov chain with values 0 (spending austerity) and 1 (tax austerity). Depending on the experiment μ_F, we set the entries of the transition matrix Π_F such that the unconditional probability of tax austerity $\Pr(F_t = 1) = \mu_F$. If μ_F is interior, $\mu_F \in (0, 1)$, we calibrate the autocorrelation of the process to equal the autocorrelation of the U.S. presidential cycle since 1920, which we estimate to be 0.769 annually (.9365 quarterly). The baseline experiment of certain tax austerity has $\mu_F = 1$ and thus Π_F is degenerate.

We allow for the government to issue both short-term and long-term debt. The parameter $\bar{\mu} = 0.67$ determines the constant fraction of debt being long-term. This parameter is chosen to reflect the average reported maturity distribution of outstanding marketable treasuries before the expansion of the Federal Reserve's treasury holdings in 2008. The average share of long-term debt (greater than one year in maturity) of this series from 2000-2020 is 66.98%. The maturity of long-term government debt is 7.76 years, which we match in our model by setting δ^B to 0.97. (If y is the target annual yield of the long-term bond, and d is the targeted duration in years, then the duration parameter δ^B is implied by the formula $d = 0.25/(1 - \delta^B \exp(-y/4))$.)

The profligacy threshold $\underline{\Delta}$, below which the government lowers taxes, is set to 2 (an annual debt/GDP ratio of 50%) so that the model matches the minimum level of marketable debt/GDP, observed in the data of 16.4% set in 1974.

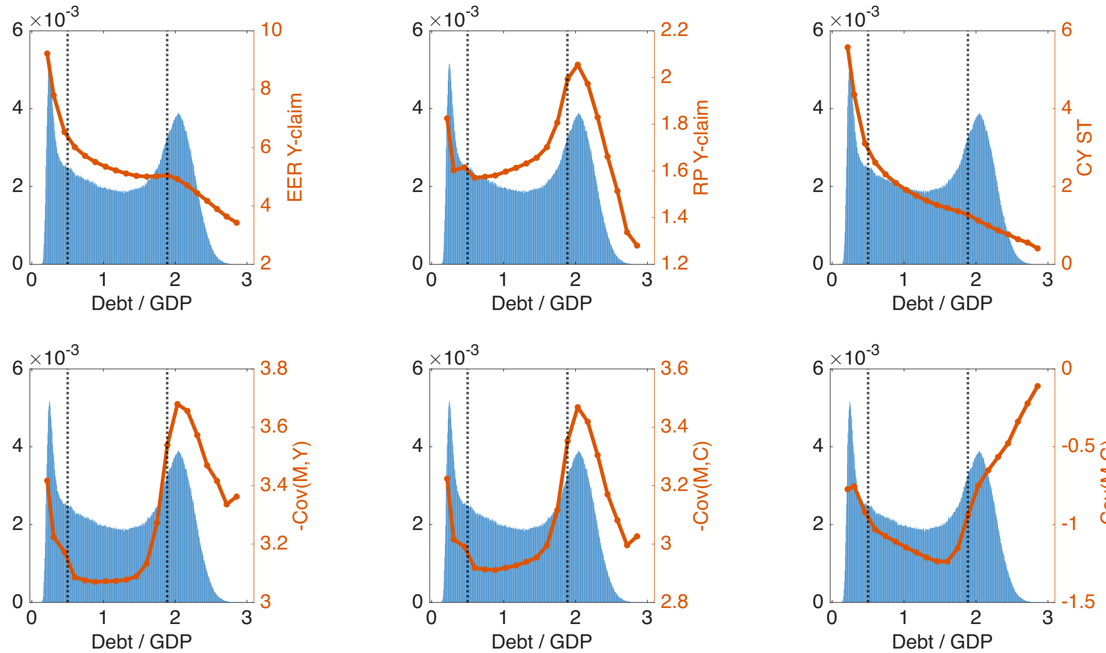
The central bank follows a Taylor rule for the interest rate on short-term government debt. The coefficient on inflation, ϕ^π is set to 1.6, targeting the volatility of inflation in the model to the volatility of core PCE inflation in the data. The coefficient on output, ϕ^y, is set to 0.125, which is a standard value in the literature. Qualitatively, results would be unchanged if we set this coefficient to zero. The inflation target $\bar{\Pi} = 1.005$ is set to target average inflation of 2% per year.

C Additional Results

C.1 Decomposing the Expected Excess Return on Output Claim

Figure C.1 shows a decomposition of the expected excess return on a GDP-claim in excess of the ST bond yield in the top left panel into several components.

Figure C.1: Tax Austerity: Risk Premium Decomposition



Note: This figure shows the histogram of debt/GDP from the simulated model under *tax austerity* overlaid with conditional means of the expected excess return on the GDP claim (top left), the risk premium on the GDP claim (top middle, measured as excess return over a hypothetical convenience-free short-term bond), the convenience yield on short-term government bonds (top right), conditional covariance of saver SDF and output (bottom left), conditional covariance of saver SDF and consumption (bottom middle), and conditional covariance of saver SDF and government purchases (bottom right).

C.2 Taxes and Debt

Since debt/GDP is in the interior region most of the time, the model with tax austerity generates long time paths with changes in debt/GDP, but no adjustments in tax rates or spending in response. This is a realistic feature of the model: Table C.1 demonstrates that in the post-war sample, we do not observe tax increases prompted by higher debt/GDP ratios. Rather, column (1) shows that increases in debt/GDP coincide with decreases in tax revenue to GDP ratio periods. Similarly, debt/GDP growth from $t-1$ to t is associated with decreases in the primary surplus in t in the data. These correlations in the data are likely driven by (1) long-run trends of rising debt/GDP and declining tax revenue since the early 1980s, and (2) the strong cyclicality of government spending and tax revenues: during recessions, spending rises and revenues decline, causing higher debt/GDP going forward. The model matches the data coefficient for the surplus qualitatively (columns (4) and (6)). As in the data, the cyclical responses of spending and tax revenue drive the correlations in the model. Since we have a much longer sample for the model-generated data, we observe visits to profligacy (the indicator variable "Prof" is one if the economy is in the profligacy region, and zero otherwise) and austerity regions (the indicator "Aust."). Columns (5) and (6) verify that profligacy leads to decreases in tax revenue and surpluses, while austerity has the opposite effects. Furthermore, in either austerity or profligacy region an increase of debt/GDP offsets the cyclical effect in tax revenue and surpluses. For tax revenue, growth in debt/gdp is associated with an increase in tax revenues in the tax austerity regime, as expected from the alternative fiscal regime in these regions of the state space. Therefore,

Table C.1: Debt/GDP and Surplus Dynamics: Data versus Tax Austerity Model

	Dependent variable:					
	Δ Tax Rev.	Δ Surplus	Δ Tax Rev.	Δ Surplus	Δ Tax. Rev.	Δ Surplus
	Data	*Data*	*Model*	*Model*	*Model*	*Model*
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Debt/GDP	−0.109**	−0.490**	0.000***	−0.017***	−0.020***	−0.038***
	(0.043)	(0.216)	(0.00)	(0.00)	(0.00)	(0.00)
Prof.					0.000***	−0.0002***
					(0.00)	(0.00)
Aus.					0.000***	0.001***
					(0.00)	(0.00)
Δ Debt/GDP × Prof.					-0.008***	-0.029***
					(0.00)	(0.00)
Δ Debt/GDP × Aus.					0.040***	0.043***
					(0.00)	(0.00)
Observations	313	313	3,999,600	3,999,600	3,999,600	3,999,600
R^2	0.137	0.300	0.135	0.146	0.405	0.191

Note: *p<0.1; **p<0.05; ***p<0.01

This table presents the results of regressing changes in tax revenue to GDP and primary surplus to GDP on changes in the debt to GDP ratio. Columns (1) and (2) present the results from observed quarterly data for 1953-2021 for tax revenues and primary surpluses, respectively. Columns (3) and (4) present analogous results using the simulated data. Columns (5) and (6) use the simulated data and include dummy variables to compute the slopes in the austerity and profligacy regions. Columns (2)–(6) are computed using 240 different simulated sample paths of 10,000 quarters each. We include a fixed effect for, and cluster standard errors by, simulation run.

our model demonstrates that lack of responsiveness in fiscal policy to changes in debt/GDP is still consistent with stationary debt dynamics in the long-run. This is because such fiscal adjustments can be triggered by debt/GDP reaching extreme levels, which we have not observed in the post-war history of U.S. fiscal policy.

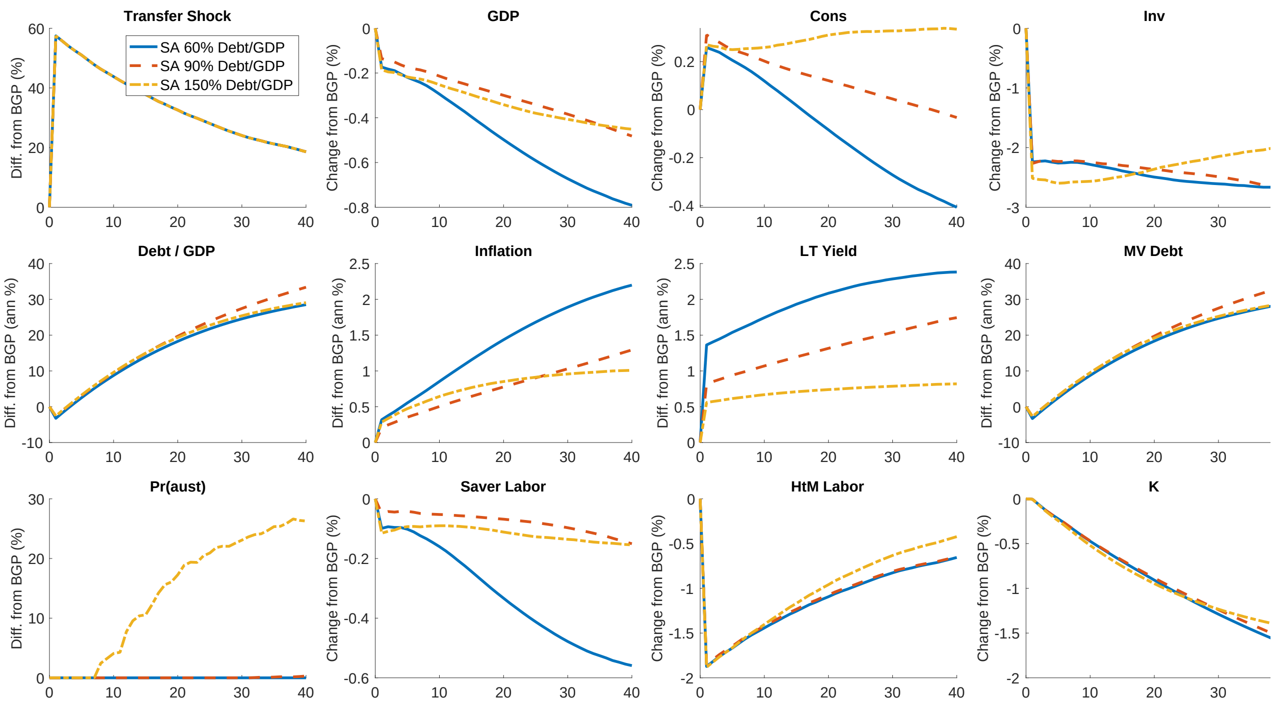
C.3 Crowding Out Effects of Debt under Spending Austerity

Figure C.2 shows the crowding out effect of higher transfer spending for different initial levels of debt/GDP.

C.4 Return β's of Fiscal Claims

Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2024a) demonstrate that we can understand the relative safety of government debt in terms of the covariance of the surplus claim with the stochastic discount factor. The surplus claim in turn is composed of the tax revenue and spending claims. Formally,

Figure C.2: Increased Transfer Spending: Macro Effects and Crowding Out



Note: This figure shows generalized impulse response graphs after the economy experiences a high transfer spending shock in the model with spending austerity ($F_t = 0$). The three lines correspond to different initial states of debt/GDP. The lines plot the average path of the economy from a sample of 10,000 paths of 40 quarters, with the starting point set to the respective ergodic mean of the state variables. The paths are relative to the unconditional transition of an economy with the same starting point (the balanced growth path, BGP).

denote the value of the tax revenue claim as p_t^T and the spending claim as p_t^G, where these values solve the recursions

$$p_t^T = \mathrm{E}_t[M_{t,t+1}(T_{t+1} + p_{t+1}^T)],$$
$$p_t^G = \mathrm{E}_t[M_{t,t+1}(G_{t+1} + \Theta_{t+1} + p_{t+1}^G)],$$

and the value of the surplus claim is $p_t^T - p_t^G$, where $M_{t,t+1}$ is the SDF of the saver. We can further define gross returns on these claims as $R_t^T = \frac{T_t + p_t^T}{p_{t-1}^T}$, $R_t^G = \frac{G_t + \Theta_t + p_t^G}{p_{t-1}^G}$ and

$$R_t^S = \frac{T_t + p_t^T - G_t - \Theta_t - p_t^G}{p_t^T - p_t^G} = \frac{p_t^T}{p_t^S} R_t^T - \frac{p_t^G}{p_t^S} R_t^G.$$

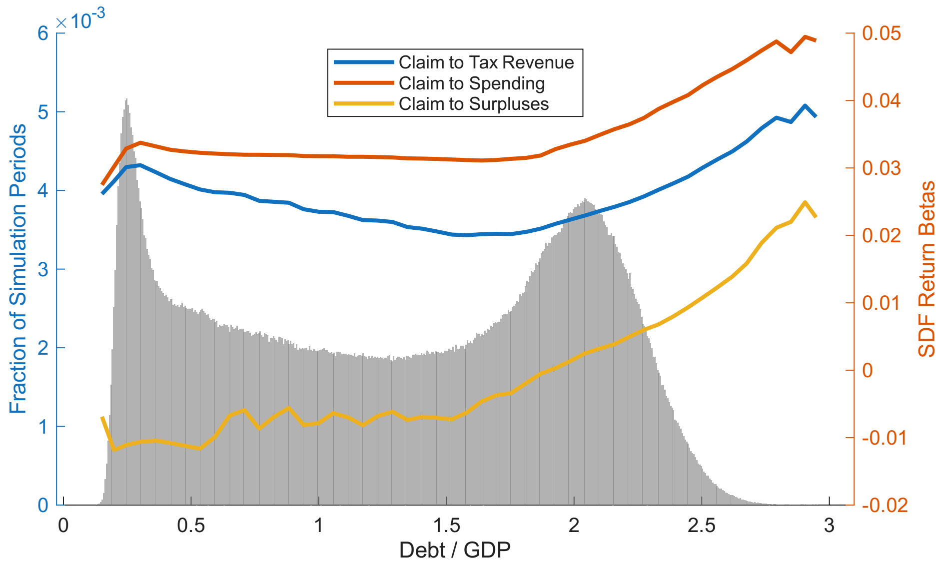
To represent the riskiness of an asset, we can compute the conditional return β

$$\beta_t^j = \frac{-\mathrm{Cov}_t(M_{t,t+1}, R_{t+1}^j)}{\mathrm{Var}_t(M_{t+1})},$$

for $j = T, G, S$, respectively.

Assets with positive betas command a risk premium. If government debt is a safe asset in this asset pricing sense, then the surplus claim has a return beta of close to zero. Indeed, when we separately compute the return betas of the tax, spending, and surplus claims and plot them in Figure C.3 for the baseline tax austerity economy, we see that both tax and spending claims are risky with a positive return beta. However, the return beta of the surplus claim, which is equivalent to the market value of government debt (up to convenience yields), is close to zero, since the surplus claim represents a "long-short portfolio" of the tax and spending claims.

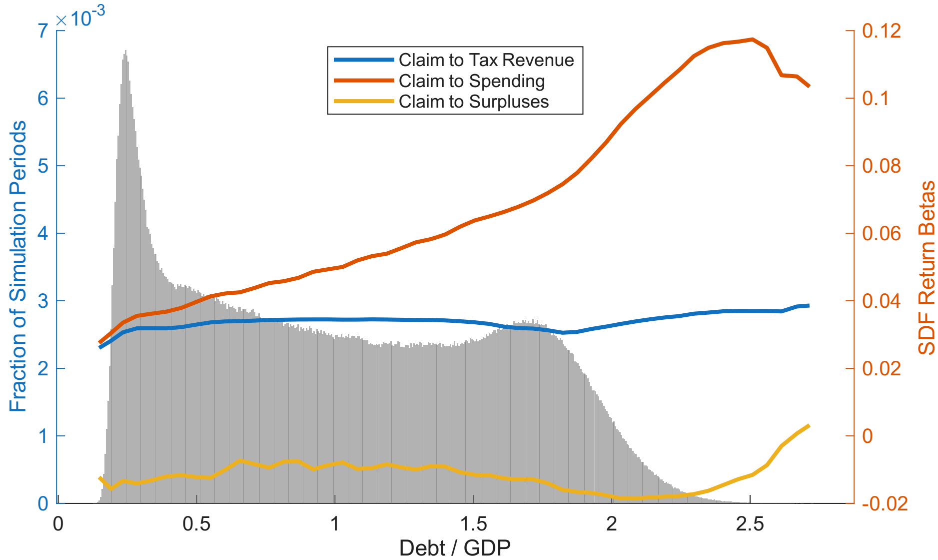
Figure C.3: Spending Austerity: Shocks and Adjustments



Note: This figure shows the histogram of debt/GDP from the simulated model under *tax austerity* overlaid with conditional return betas for tax, spending, and surplus claims.

The surplus claim provides insurance, with a slightly negative return beta, at low levels of debt and becomes riskier as the economy approaches austerity and the upper bound of sustainable debt. Since the spending claim is on average riskier than the tax claim, government debt can be a safe asset.

Figure C.4: Spending Austerity: Shocks and Adjustments

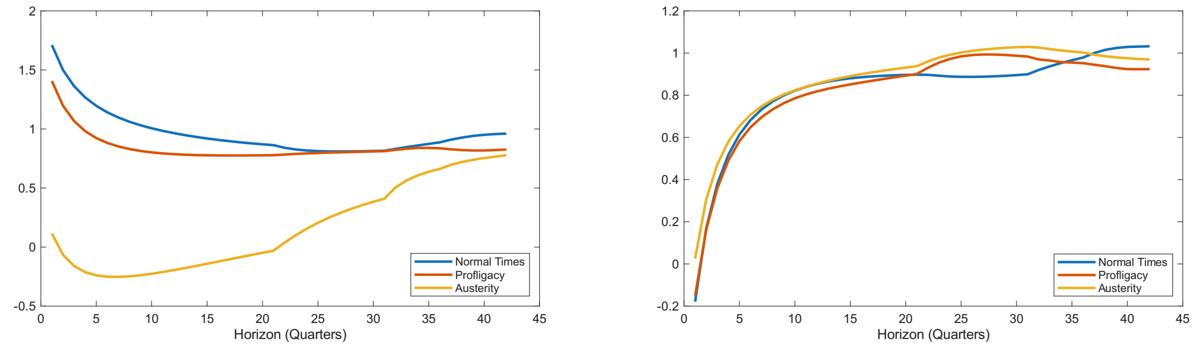


Note: This figure shows the histogram of debt/GDP from the simulated model under *spending austerity* overlaid with conditional return betas for tax, spending, and surplus claims.

Figure C.4 performs the same decomposition under spending austerity. The conditional return betas follow the same pattern. The beta on the surplus claim is negative for all but the highest levels of debt.

We also study the correlation of tax revenues and spending with output at short and long horizons (up to 40 quarters) in Figure C.5. This chart focuses on the tax austerity case. Consistent with empirical patterns documented in Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2024a), tax revenue is procyclical in the short-term and co-integrated with output in the long-run. The output beta of the tax claim in normal times starts above one at short horizons and converges to one at long horizons. The high short-term tax beta indicates that the government can insulate taxpayers from adverse shocks: tax collections can be low when output is low, at least temporarily. In sharp contrast, the output beta of tax revenue turns negative once debt/GDP crosses the austerity threshold. Even at short horizons, tax policy loses its ability to insure households against adverse economic shocks. The right panel shows that spending is counter-cyclical in line with fiscal policy concerned with output stabilization in the short run. Like tax revenue, spending is co-integrated with output in the long run. The perfect correlation of tax revenue and spending with output in the long run explains why the claims to these cash flows command a risk premium.

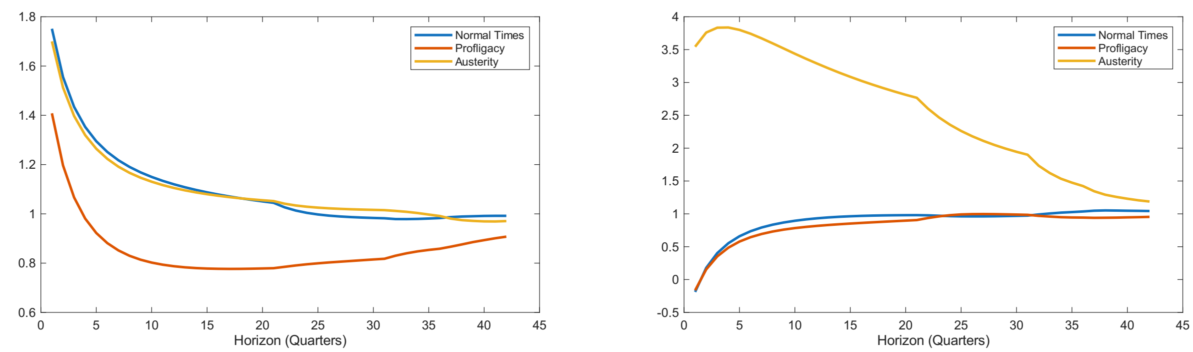
Figure C.5: Output Betas for Tax and Spending Cash Flows (Tax Austerity)



(a) Tax Revenue (b) Spending

Figure C.6 shows output betas for the spending austerity case. Tax betas are unchanged by assumption during austerity. However, spending betas in the right panel change sign during austerity. Rather than being countercyclical, spending must become strongly procyclical (going down in bad times) during austerity in order to preserve the safety of debt.

Figure C.6: Output Betas for Tax and Spending Cash Flows (Spending Austerity)



(a) Tax Revenue (b) Spending

D Computational Methods

D.1 Numerical Solution Method

We solve the model globally using time iteration. We extend the solution method proposed by Elenev, Landvoigt and Van Nieuwerburgh (2021). Since that model is a real model without monetary policy, the nominal side of the model is new. Methodologically, this paper innovates by solving for a fixed point in key parameter values, in addition to equilibrium prices and quantities. This extension is necessary, since New Keynesian models like ours specify policy rules that characterize the actions taken by the government to stabilize output deviations from trend. With respect to the solution method, this means that the model contains endogenous parameters: trend output along the balanced growth path (i.e, the scale of the economy in the stationarized model) is endogenous, yet the policy rules that are part of the equilibrium system of equations depend on this trend output parameter. In NK models with small shocks that are solved using local methods this problem has a simple solution: trend output is given by the deterministic balanced growth path of the model, which is easy to compute. However, in our model with large risk premia, trend output is only known once we compute the model's solution and simulate its ergodic distribution.

For simplicity, we will use the term "steady state" to refer to deterministic balanced growth path going forward. To see the additional computational challenge, consider the Taylor-style monetary policy rule in our model: the central bank adjusts the interest rate based on deviations of output from trend output. Households in our model have a strong precautionary savings motive. As a result, the average output in a simulation of the stochastic model is approximately 7% higher than the steady state value. If we defined conventional monetary policy and fiscal policy rules using the deviation of output from steady state, as is usually done when computing local approximations, these rules would be significantly "off target" The average simulated time path would cause a contractionary policy response because the economy would appear to be significantly above trend. Thus, this dependence of policy rules on average output creates another fixed point: average output in the ergodic distribution of the stochastic model $\mathrm{E}[\hat{Y}_t]$ depends on policy rules, and the policy rules must be centered around $\mathrm{E}[\hat{Y}_t]$. To solve this additional fixed point, we extend the solution algorithm to normalize the average scale of aggregate output to one: $\mathrm{E}[\hat{Y}_t] = 1$. Fiscal and monetary policy rules are all centered around this value.

We can choose the disutility of labor ω_0 to achieve this normalization, while jointly matching all other targets using the other calibrated parameters. We update ω_0 when computing the Debt/GDP distribution in alternative economies when studying the determinants of the austerity threshold. The algorithm proceeds as follows:

1. Solve a nonlinear system of equations defining the equilibrium conditions at steady state ($\sigma_g = \sigma_z = 0$) assuming the intermediary leverage constraint binds. The system is augmented by an unknown parameter $\omega_0^{(0)}$ and an additional equation $\bar{Y} = 1$.

2. Implicitly differentiate the system with respect to $\omega_0^{(0)}$ at the solution and solve for $\frac{\partial Y^*}{\partial \omega_0^{(0)}}$.

3. Given the guessed value $\omega_0^{(i)}$, solve the model using transition function iteration as in Elenev et al. (2021). We discretize the exogenous process into $N_e = 3$ states using the Rouwenhorst (1995) method and define rectangular grids for 3 endogenous state variables: log market value of government debt $\log \hat{W}^G$, aggregate capital K, and intermediary wealth share $\frac{W^I}{(MPK+(1-\delta)Q)K+W^G}$. The grid for $\log \hat{W}^G$ is dense in and near profligacy and austerity regions since many equilib-

rium quantities, particularly labor and inflation, are highly nonlinear around the transitions into those states. We iterate several hundred times to convergence.

4. Simulate the model. We start at the steady state values and simulate N runs of $T_{\text{ini}} + T$ periods each discarding the first T_{ini} to eliminate the effect of initial conditions. Government debt-to-GDP is highly persistent, so one long simulation may not adequately sample the true ergodic distribution. To obtain robust simulation results, we set $N = 400$, $T_{\text{ini}} = 3,000$ and $T = 10,000$.

5. Compute the error $e = E[\hat{Y}_t] - 1$. If $|e| < \bar{\epsilon}$, proceed to the next step. Otherwise, update $\omega_0^{(i+1)} = \omega_0^{(i)} - \frac{e}{\partial Y^*/\partial \omega_0}$ using the derivative computed in Step 2, and repeat steps 3 to 5.

6. Compute impulse response functions (IRFs) starting from the average exogenous state, a fixed level of government debt, and values of the other two endogenous state variables consistent with the fixed level of government debt in the simulation. We compute generalized nonlinear IRFs by simulating 5,000 paths of 40 quarters from this starting point, and calculating the mean path for each model variable.

D.2 Numerical Risk Aversion Calculation

Proposition 1 in Swanson (2018) derives the Arrow-Pratt measure of risk aversion in models with recursive preferences. Adapting these derivations to our model, we find that the Arrow-Pratt measure of risk aversion at point x_t in the state space can be written as

$$RRA(x_t) = -\frac{\mathrm{E}_t[(V(x_{t+1}))^{-\alpha} V_{WW}(x_{t+1}) - \alpha(V(x_{t+1}))^{-\alpha-1} V_W^2]}{\mathrm{E}_t[(V(x_{t+1}))^{-\alpha} V_W(x_{t+1})]} W(x_t) \tag{41}$$

where $\alpha = \frac{\gamma-\varphi}{1-\varphi}$, V is the value function, V_W is the derivative of the value function with respect to wealth (i.e. marginal value of wealth), and V_{WW} is the second derivative (curvature) of the value function. In our model,

$$\begin{aligned} V_W(x_t) &= (1-\beta)C(x_t)^{-\varphi} \\ V_{WW}(x_t) &= -(1-\beta)\gamma C(x_t)^{-\varphi-1}\frac{\partial C}{\partial W}(x_t) \end{aligned}$$

We approximate the marginal propensity to consume out of wealth $\frac{\partial C}{\partial W}(x_t)$ using its steady state value

$$\frac{\partial C}{\partial W}(\bar{x}) = \frac{1-\beta e^{-(1+\varphi)\bar{g}}}{1+(1-\tau_0^w)^2\bar{w}^2\frac{\varphi\bar{C}_t^{-\varphi-1}}{\omega_0\omega_1\bar{N}^{\omega_1-1}}}$$

and compute $RRA(x)$ from (41) at every point in a long simulation using numerical solutions for $C(x), W(x)$ and $V(x)$. We find that for $\gamma = 25$, relative risk aversion always lies between 2.5 and 3.8, with the average value being 3.1.