The Liquidity Channel of Fiscal Policy

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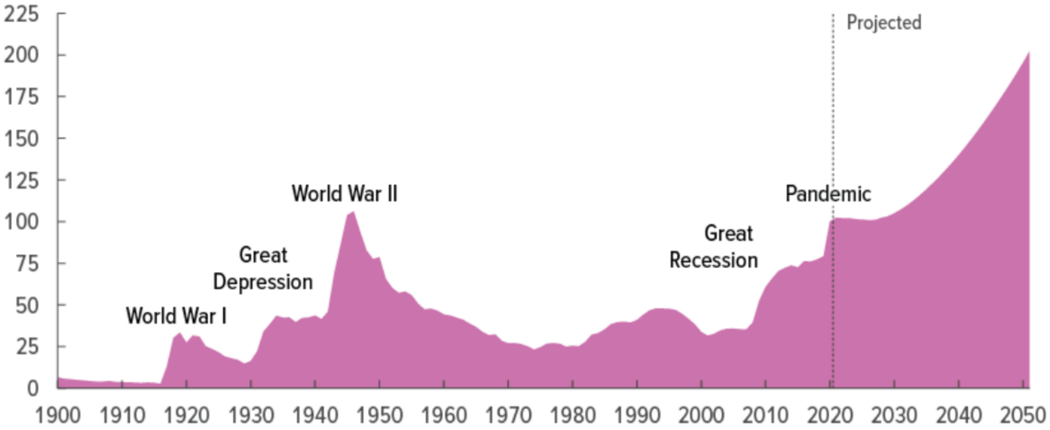
[1]**Disclaimer:** The views expressed here reflect only the views of the authors and do not reflect the views of the German Federal Ministry of Finance.

Motivation

US public debt currently above 100% of GDP and projected to increase further



Research question

What are the effects of public debt on the US economy?

Concretely, we are interested in the following (positive) questions:

- How do interest rates respond?
- How much crowding out of capital?
- What is the fiscal burden?
- What are the distributional effects?

From evidence to model to policy

First, we document that fiscal expansions increase rates but decrease spreads

- Local Projections: Return difference between capital and government bonds, "Liquidity Premium", falls after a fiscal shock increasing debt.

A HANK model features the same effect

- Estimating a 2-asset medium-scale HANK model, we show the same effect on the liquidity premium is present in the model and quantitatively of the same size.

Policy experiments and importance of the channel

- Consider the effects of higher debt-to-gdp ratio targets in our estimated model. We find the interest-rate effects of these policies to be important.

We contribute to three literatures

1) Importance of heterogeneity for business cycles and policy

- Ahn et al. (2018), Auclert et al. (2018), Bayer et al. (2019), Broer et al. (2019), Challe and Ragot (2015), Den Haan et al. (2017), Gornemann et al. (2012), Guerrieri and Lorenzoni (2017), Hagedorn et al. (2019), McKay et al. (2016), McKay and Reis (2016), Ravn and Sterk (2017), Sterk and Tenreyro (2018), Wong (2019), and Auclert et al. (2020) ...

2) Public debt and physical private capital

- Aiyagari and McGrattan (1998), Challe and Ragot (2011), Heathcote (2005), and Woodford (1990) and a number of papers focusing on the optimal level of public debt.

3) Public debt and interest rates

- Krishnamurthy and Vissing-Jorgensen (2012), Summers and Rachel (2019), Ardagna (2009), Laubach (2009), Azzimonti und Yared (2019), Aguiar et al. (2021), Mian et al. (2021), Reis (2021).

Public Debt and Asset Returns

Evidence from Local Projections

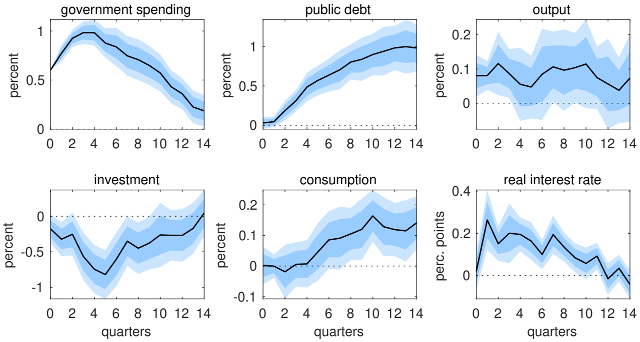
Identification

Debt increases through spending shocks

- We want to look at exogenous variations in debt.
- Here through spending shocks.
- Identifying assumption – available for all data sets:
  government spending is predetermined (Blanchard and Perotti, 2002) .
- Robust to alternatives for the US.
  - We can also use the military news series from Ramey (2011)
  - or tax shocks from Romer and Romer (2010).

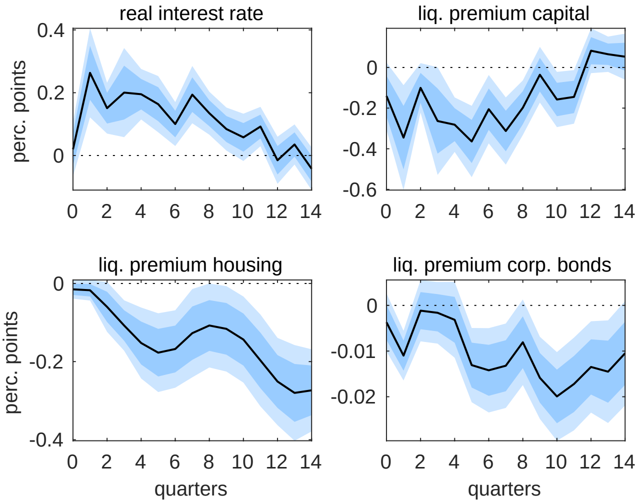
▸ Local Projection ▸ Data

Empirical Evidence: US quarterly, aggregates



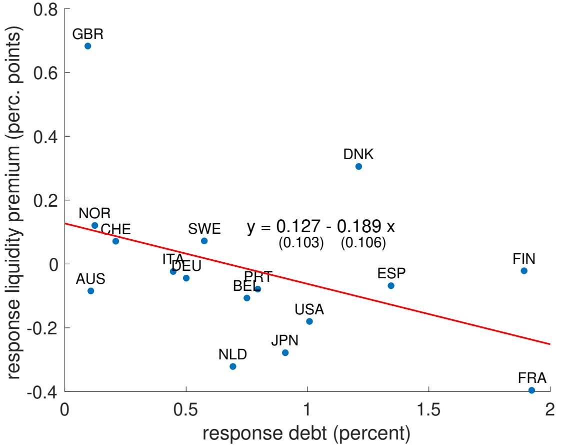
- Standard response to fiscal shock.
- Normalize top peak debt response to 1%.
- Reached roughly 3 years after shock.

Empirical Evidence: US quarterly, premia



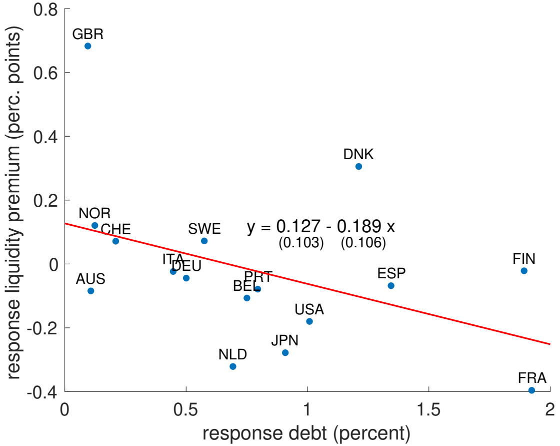
- Returns of public bonds increase.
- Relative returns of less liquid assets fall.
- Same finding employing international panel data
  ▸ details

Empirical Evidence: Differences in financing fiscal shocks



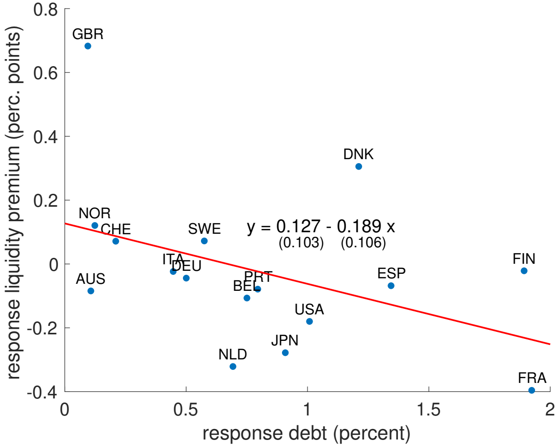
- Not all countries finance fiscal expansion by deficits.
- Individual country regressions.

Empirical Evidence: Differences in financing fiscal shocks



- Not all countries finance fiscal expansion by deficits.
- Individual country regressions.
- Plot relative housing return response against debt response (average years 4-6 after shock).

Empirical Evidence: Differences in financing fiscal shocks



- Not all countries finance fiscal expansion by deficits.
- Individual country regressions.
- Plot relative housing return response against debt response .
- **Finding:** 1% more debt response decreases the LP by 19bp.

Summary

Bond returns and returns on other assets do not move in lockstep

- The capital-bond spread falls after fiscal expansion.
- The more debt financed the expansion, the stronger the spread response.

Public Debt and Asset Returns

In a Two Asset HANK model

Heterogenous Agent New Keynesian (HANK) model with portfolio choice

Evidence for the importance of portfolio adjustment costs

- Households will require a compensation to hold their wealth in illiquid form.
- Known since Aiyagari and Gertler (1991): This has the potential to explain a large part of the equity premium.

The total supply of liquidity matters

- Government debt has a special role.
- Only source of external liquid wealth in these models.
- More government debt implies a lower premium.
- Compared to one-asset incomplete markets models: *less crowding out* of capital.

Model overview

Households		Production Sector	Government
Obtain Income	Trade Assets	Produce and Differentiate Consumption Goods	Monetary Authority, Fiscal Authority
Wages -> set by unions -> s.t. adj. costs -> Idiosyncratic Risk **Interest** -> from bonds **Dividends** -> from capital: MPK -> liquid rental market **Profits** -> as "entrepreneurs"	**Bonds** ($b > \underline{B}$) = claims on HH debt, + government debt, (nominal, liquid) and **Illiquid Assets**, k = capital (trading friction)	**Intermediate goods producers** Rent capital & labor Competitive Market for Intermediate Goods **Entrepreneurs** Monopolistic resellers s.t. price adjustment costs Capital goods producers	Policy Rules: • **Monetary authority** sets nominal interest rate -> Taylor rule • **Fiscal authority** supplies government debt, consumes goods, taxes labor income and profits -> Spending rule -> Tax rule

Estimate HANK-DSGE

Two Step Estimation Procedure:

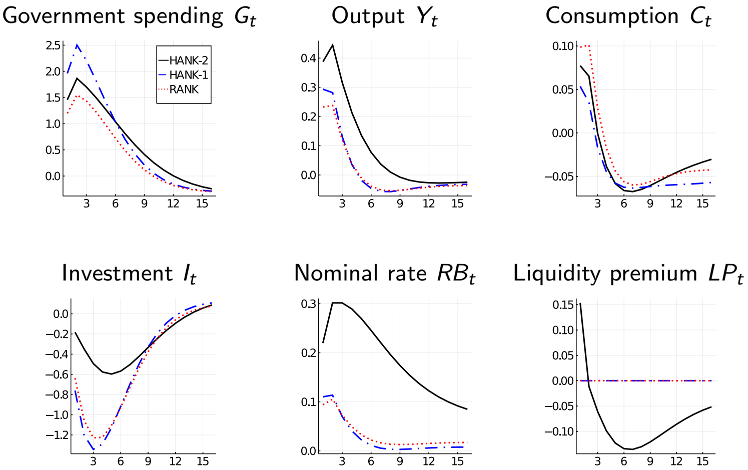
- First, estimate or fix all parameters that affect the steady state (matching wealth, portfolio, and income distributions in the micro data)
- Second, estimate the parameters that only matter for dynamics via Bayesian methods. Same shocks and observables as in Smets and Wouters (2007).

Solution Procedure: We build on the algorithm suggested by Reiter (2009) to solve for aggregate dynamics, which treats the policy functions as controls and the distribution function as a state, representing the dynamic system as a function valued difference equation using the refinement of Bayer and Luetticke (2018).

The Short Run

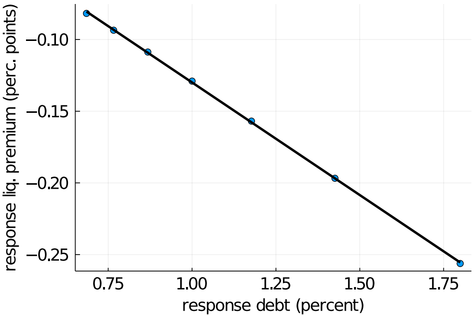
Government Spending Shocks

IRFs to Government Spending Shock



- Estimated HANK model
- IRFs normalized to 1% debt increase.
- matches the movements of the Liquidity Premium
- as well as aggregates.

Debt vs. Liquidity Premium: Model



- In line with empirical finding:
- A 1% stronger debt response leads to a 16bp stronger LP response.
- (Empirical: 19bp)

Notes: Dots represent the response of government debt (x-axis) and liquidity premium (y-axis) at 12 horizons to a spending shock for alternative solutions of the model, where we let taxes react differently strong to the growth rate of government debt.

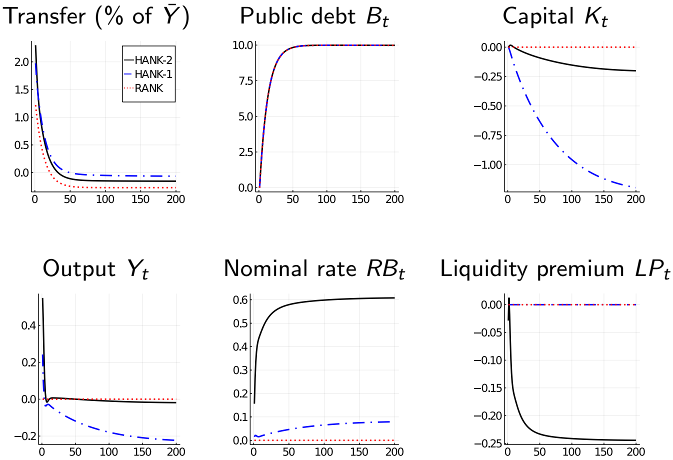
The Long Run

Public Debt and Interest Rates

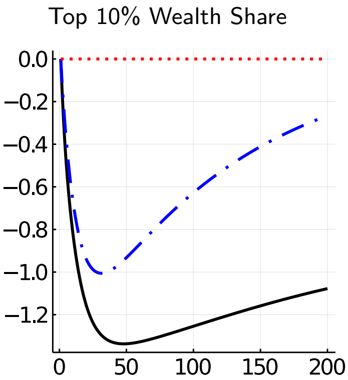
Increasing the government debt target

- Increase government debt target by 10%.
- Almost permanent increase ($\rho_{\bar{B}} = 0.9999$).
- 10 year transition period.
- Let (non-distortionary) taxes adjust, constant expenditures.

Response to an increase in the debt target



Distributional consequence of an increase in the debt target



Fiscal Implications of Public Debt

- Fiscal burden of public debt: $\mathcal{R}(B)B$, where $\mathcal{R} = R_t^b/\pi_t - \log(Y_{t+1}/Y_t)$
- Our log-linearized solution yields constant semi-elasticity of interest-growth differential:

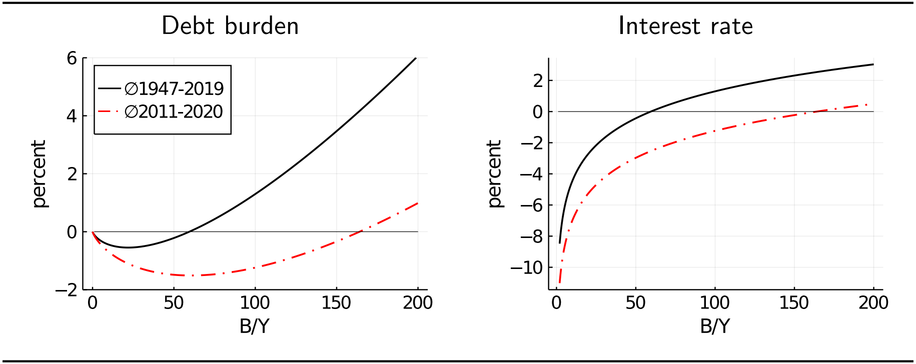
$$\mathcal{R}(B) \approx \mathcal{R}(\bar{B}) + \eta_B \ln\left(B/\bar{B}\right)$$

- Marginal fiscal burden of additional debt starting from steady state:

$$\frac{\partial(\mathcal{R}(B)B)}{\partial B} = \mathcal{R}(B) + \eta_B$$

- Our estimate: $\eta_B = 2.5\% \Rightarrow$ despite the fact that the marginal real rate on government bonds is zero, there is an important fiscal burden from higher public debt.

Fiscal Implications of Public Debt



Conclusion

Concluding Remarks

- Return differentials between public debt and physical capital respond to fiscal expansions
- Overshooting of bond yields:
  $+25$ basis points on impact vs. $+2.5$ basis points in the long run (after $+1\%$ debt)
- A HANK model with liquid and illiquid assets can explain this effect.

Concluding Remarks

How much debt is fiscally optimal?

- Debt is fiscally more expensive than R-g suggests.
- Low debt levels below can nonetheless be (fiscally) inefficient.
- Under the currently high demand for liquidity, this critical level has moved to around 60%.
- Much higher debt rates needed to "normalize" ($R > g$) interest rates.

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Local projection

- Letting x_{t+h} denote the variable of interest in period $t+h$, we estimate how it responds to fiscal shocks in period t:

$$x_{t+h} = \psi_h \log g_t + \beta_0 + \beta_1 t + \beta_2 t^2 + \Gamma(L) Z_{t-1} + u_{t+h} \,. \tag{1}$$

- ψ_h provides a direct estimate of the impulse response at horizon h to the government spending shock in period t
- Z_{t-1} is a vector of control variables that always includes four (annual one) lags of government spending, output, and debt, plus the real interest rate and lags of the respective dependent variable.

back

Data

US and international data

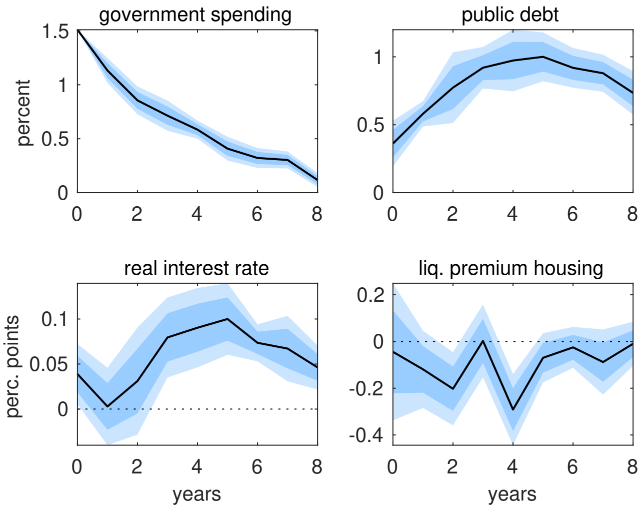
- Quarterly US Data 1947-2015.
- Annual data from 16 advanced economies 1947-2015.
  Aggregates and in particular housing returns (Jordà et al., 2019).

Liquidity Premium

- Return to capital (incl. housing and private capital) from Gomme et al. (2011)
- Housing return (Jordà et al., 2019)
- AAA corporate bond yield (Krishnamurthy and Vissing-Jorgensen, 2012)
- To compute the premium, we subtract a long-term government bond rate.

back

Empirical Evidence: International pooled, premia



- Returns of bonds increase.
- Relative returns of housing as an asset falls.
- Government debt response peaks around year 4.

back

Households

- Productivity h (idiosyncratic and risky)
- Labor/Leisure Choice
- Consume
- Cannot trade state-contingent claims
- Two Assets: Liquid nominal bond, illiquid capital

Households

- Households face productivity risk

$$\log h_{it} = \rho_h \log h_{it-1} + \epsilon^h_{it}, \quad \epsilon^h_{it} \sim N\left(0, \sigma_h\right)$$

Households

- Households face productivity risk
- Union differentiates labor, driving a wedge between MPL and wages paid to workers. It distributes related profits among workers

Households

- Households face productivity risk
- Union differentiates labor, driving a wedge between MPL and wages paid to workers.
- A random fraction λ of households participates in the market for illiquid capital

Households

- Households face productivity risk
- Union differentiates labor, driving a wedge between MPL and wages paid to workers.
- A random fraction λ of households participates in the market for illiquid capital
- A fraction of households becomes "entrepreneurs" and earns all other pure rents. Stochastic transition into and out of this state

Household Planning Problem

- GHH preferences with constant Frisch elasticity:
  $\Longrightarrow$ representative labor supply N_t.
- Budget equation:

$$
\begin{aligned}
c_{it} + b_{it+1} + q_t k_{it+1} = b_{it} \tfrac{R(b_{it}, R_t^b)}{\pi_t} + (q_t + r_t) k_{it} \\
+ (1 - \tau_t)[h_{it} w_t N_t + \mathbb{I}_{h_{it} \neq 0} \Pi_t^U + \mathbb{I}_{h_{it} = 0} \Pi_t^F], \\
k_{it+1} \geq 0, \quad b_{it+1} \geq \underline{B}\ .
\end{aligned}
$$

Household Planning Problem

- GHH preferences with constant Frisch elasticity:
  $\implies$ representative labor supply N_t.
- Budget equation:
- Bellman equation:

$$V_t^a(b,k,h) = \max_{k',b'_a} u[x(b,b'_a,k,k',h)] + \beta \mathbb{E}_t V_{t+1}(b'_a,k',h')$$
$$V_t^n(b,k,h) = \max_{b'_n} u[x(b,b'_n,k,k,h)] + \beta \mathbb{E}_t V_{t+1}(b'_n,k,h')$$
$$\mathbb{E}_t V_{t+1}(b',k',h') = \mathbb{E}_t \left[\lambda V_{t+1}^a(b',k',h')\right] + \mathbb{E}_t \left[(1-\lambda) V_{t+1}^n(b',k,h')\right]$$

Embedded in an otherwise almost standard NK model

- Factor prices equal marginal products

$$
\begin{aligned}
w_t^F &= \alpha mc_t Z_t \left(\frac{u_t K_t}{N_t}\right)^{1-\alpha}, \\
r_t + q_t \delta(u_t) &= u_t (1-\alpha) mc_t Z_t \left(\frac{N_t}{u_t K_t}\right)^{\alpha}
\end{aligned}
$$

Embedded in an otherwise almost standard NK model

- Factor prices equal marginal products
- Capital price equals cost of production of capital

$$1 = q_t \left[1 - \frac{\phi}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 - \phi \left(\frac{I_t}{I_{t-1}} - 1 \right) \frac{I_t}{I_{t-1}} \right] + \beta q_{t+1} \phi \left(\frac{I_{t+1}}{I_t} - 1 \right) \left(\frac{I_{t+1}}{I_t} \right)^2$$

Embedded in an otherwise standard NK model

- Phillips Curve under quadratic price adjustment costs

$$\log\left(\frac{\pi_t}{\bar{\pi}}\right) = \beta \mathbb{E}_t \log\left(\frac{\pi_{t+1}}{\bar{\pi}}\right) + \kappa_Y \left(mc_t - \frac{1}{\mu_t^Y}\right),$$

- Wage Phillips Curve under quadratic price adjustment costs

$$\log\left(\frac{\pi_t^W}{\bar{\pi}_W}\right) = \beta \mathbb{E}_t \log\left(\frac{\pi_{t+1}^W}{\bar{\pi}_W}\right) + \kappa_w \left(\frac{w_t}{w_t^F} - \frac{1}{\mu_t^W}\right),$$

Government

Monetary Policy

- Monetary policy follows Taylor rule

$$\frac{R^b_{t+1}}{\bar{R}^b} = \left(\frac{R^b_t}{\bar{R}^b}\right)^{\rho_R} \left(\frac{\pi_t}{\bar{\pi}}\right)^{(1-\rho_R)\theta_\pi} \left(\frac{Y_t}{Y_{t-1}}\right)^{(1-\rho_R)\theta_Y} \epsilon^R_t .$$

Government

Spending

- We assume that the government follows an expenditure rule

$$\frac{G_t}{\bar{G}} = \left(\frac{G_{t-1}}{\bar{G}}\right)^{\rho_G} \left(\frac{Y_t}{Y_{t-1}}\right)^{(1-\rho_G)\gamma_Y} \left(\frac{B_t}{\bar{B}_t}\right)^{(1-\rho_G)\gamma_B} D_t,$$

where $D_t = \epsilon_t^G \left(\epsilon_{t-1}^G\right)^{\gamma_\epsilon}$

Government

Budget Constraint

- Total taxes T_t are then

$$T_t = \tau \left(w_t n_{it} h_{it} + \mathbb{I}_{h_{it} \neq 0} \Pi_t^U + \mathbb{I}_{h_{it} = 0} \Pi_t^F \right),$$

  with constant tax rate τ

- The government budget constraint determines government bonds residually:

$$B_{t+1} = G_t - T_t + R_t^b / \pi_t B_t.$$

Equilibrium

Equilibrium is characterized by the same system of equations as in a standard NK Model except for

- Bonds-Market Equilibrium

$$\begin{aligned} B_{t+1} &= B^d(R_t^b, A_t, r_t, q_t, \Pi_t^F, \Pi_t^U, w_t, \lambda_t, \Theta_t, V_{t+1}) \\ &:= \mathbb{E}_t\left[\lambda_t b_{a,t}^* + (1-\lambda_t) b_{n,t}^*\right], \end{aligned}$$

  instead of simple Consumption-Euler Equation

- Capital-Market Equilibrium

$$\begin{aligned} K_{t+1} &= K^d(R_t^b, A_t, r_t, q_t, \Pi_t^F, \Pi_t^U, w_t, \lambda_t, \Theta_t, V_{t+1}) \\ &:= \mathbb{E}_t[\lambda_t k_t{}^* + (1-\lambda_t) k] \end{aligned}$$

  instead of an arbitrage condition between bonds and capital (using the stochastic discount factor)

Steady State

Table: Calibration Targets

Targets	Model	Data	Source	Parameter
Mean illiquid assets (K/Y)	2.87	2.87	NIPA	Discount factor
Mean liquidity (B/Y)	0.59	0.59	FRED	Port. adj. probability
Private liquidity (IOUs/Y)	0.14	0.14	FRED	Borrowing penalty
Top10 wealth share	0.68	0.68	WID	Fraction of entrepreneurs

More...

Parameter	Value	Description	Target
Households			
β	0.983	Discount factor	K/Y=2.88
ξ	4	Relative risk aversion	Kaplan et al. (2018)
γ	2	Inverse of Frisch elasticity	Chetty et al. (2011)
ν	6.4%	Prob. of capital holding adjustment	B/Y=0.59
ρ_h	0.98	Persistence labor income	Storesletten et al. (2004)
σ_h	0.12	STD labor income	Storesletten et al. (2004)
$\bar{R}$	1.0%	Interest wedge	IOUs/Y=0.14
τ	0.29	Tax rate	G/Y=0.2
Intermediate Goods			
α	0.68	Share of labor	Income share of labor of 62%
δ_0	1.75%	Depreciation rate	NIPA: Fixed assets
Final Goods			
μ^Y	11	Price markup	10% markup
μ^W	11	Wage markup	10% markup

Estimate HANK-DSGE

We consider the following shocks (as in Smets-Wouters)

- total factor and investment-specific productivity
- price and wage markup
- intermediation cost
  (a.k.a. "government bond spread", "risk premium")
- monetary policy
- government spending

Estimate on the same time series as in Smets-Wouters.

Observables

Quarterly US data from 1947Q1 – 2019Q4

In first-differences

- GDP, Consumption, Investment
- the real wage

In log-levels

- GDP deflator based inflation rates
- Hours worked per capita
- the (shadow) federal funds rate

All demeaned and without measurement error.

Observables

Quarterly US data from 1947Q1 – 2015Q4

In log-levels

- Liquidity premium based on Gomme et al. (2011)'s capital return
- Demeaned and with measurement error.

Prior and Posterior

Parameter		Prior		Posterior			
	Distribution	Mean	Std. Dev.	Mean	Std. Dev.	5 %	95 %
			Frictions				
δ_s	Gamma	5.00	2.00	0.499	0.086	0.363	0.645
ϕ	Gamma	4.00	2.00	0.117	0.017	0.090	0.146
κ	Gamma	0.10	0.01	0.111	0.010	0.096	0.128
κ_w	Gamma	0.10	0.01	0.099	0.011	0.082	0.117
			Monetary policy rule				
ρ_R	Beta	0.50	0.20	0.820	0.012	0.800	0.839
σ_R	Inv.-Gamma	0.10	2.00	0.230	0.011	0.213	0.250
θ_π	Normal	1.70	0.30	1.704	0.086	1.567	1.846
θ_Y	Normal	0.13	0.05	0.360	0.041	0.293	0.428
			Spending rule				
γ_B	Normal	0.00	1.00	-0.335	0.094	-0.493	-0.186
γ_Y	Normal	0.00	1.00	-9.925	0.637	-11.00	-8.902
ρ_G	Beta	0.50	0.20	0.727	0.024	0.686	0.766
γ_ϵ	Beta	0.50	0.20	0.385	0.043	0.312	0.454
σ_G	Inv.-Gamma	0.10	2.00	4.689	0.285	4.245	5.178

Prior and Posterior

Parameter		Prior		Posterior			
	Distribution	Mean	Std. Dev.	Mean	Std. Dev.	5 %	95 %
			Structural shocks				
ρ_A	Beta	0.50	0.20	0.976	0.008	0.961	0.989
σ_A	Inv.-Gamma	0.10	2.00	0.177	0.018	0.148	0.207
ρ_Z	Beta	0.50	0.20	0.972	0.006	0.963	0.981
σ_Z	Inv.-Gamma	0.10	2.00	0.803	0.035	0.749	0.862
ρ_Ψ	Beta	0.50	0.20	0.936	0.008	0.922	0.950
σ_Ψ	Inv.-Gamma	0.10	2.00	1.868	0.112	1.692	2.058
ρ_μ	Beta	0.50	0.20	0.854	0.018	0.824	0.882
σ_μ	Inv.-Gamma	0.10	2.00	1.938	0.138	1.723	2.174
$\rho_{\mu w}$	Beta	0.50	0.20	0.786	0.026	0.742	0.828
$\sigma_{\mu w}$	Inv.-Gamma	0.10	2.00	7.175	0.757	6.036	8.516
			Measurement error				
σ_{LP}^{me}	Inv.-Gamma	0.05	0.01	1.885	0.091	1.741	2.040

Robustness

Table: Post-2010 Scenarios for the Interest Rate Elasticity

Parameter	Capital (K/Y)	Private liquidity (IOUs/Y)	Top 10% wealth share	Interest Rate semi-elasticity (%)
Baseline	2.87	0.14	0.68	2.50
Data (1947-2019)	2.87	0.14	0.68	
Data (2010-2019)	2.95	0.18	0.72	
A) Post-2010 public-debt-to-GDP ratio of 110%				
Discount factor	3.11	0.08	0.63	2.36
Risk premium	2.79	0.12	0.66	1.68
Income risk	3.00	0.08	0.56	3.06
Price markup	2.92	0.14	0.76	2.79
Portfolio liquidity	2.77	0.15	0.66	3.13
Borrowing limit	2.85	0.01	0.62	5.70

Robustness

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Data (2010-2019)	2.95	0.18	0.72	
B) Post-2010 real interest rate of -1%				
Discount factor	3.05	0.14	0.67	2.60
Risk premium	2.88	0.12	0.67	2.47
Income risk	2.96	0.14	0.63	2.61
Price markup	2.93	0.19	0.77	2.68
Portfolio liquidity	2.83	0.19	0.70	2.55
Borrowing limit	2.88	0.07	0.67	3.95

Debt-financed Sovereign Wealth Fund

- Idea: Government exploits liquidity premium when issuing debt in order to buy marketable capital goods
- Our calibration: return difference of 1.5% p.a.
- However: marginal fiscal burden equal to our semi-elasticity of 2.5% (as st. st. interest rate is zero) $>>$ liquidity premium
- Wealth fund remains fiscal burden as long as

  semi-elasticity $>$ return difference

  $\rightarrow$ would require either lower spending or higher taxes in long run

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  $\rightarrow$ would require either lower spending or higher taxes in long run
- Would debt-financed build-up of government-owned capital (financed by taxes in long run) increase or decrease the economy's capital stock?

Debt-financed build-up of government-owned capital