Putting the Finance Back in Public Finance

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based mostly on joint work with Mindy Xiaolan (UT Austin), Zhengyang Jiang (Kellogg), Stijn Van Nieuwerburgh (Columbia) and some new work with Hal Cole (UPenn) and YiLi Chien (St. Louis Fed).

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Roadmap

Textbook Finance and Fiscal Calculus

- Federal Government has made lots of promises to transfer recipients. If kept, on track for debt/GDP ratio of 185% by 2053 (CBO, 2022).
- How much more debt can the U.S. Treasury issue?
  - This question gained urgency after the Great Financial Crisis of 2008–10 and the Covid-19 pandemic in 2020–21
- Look at this question of fiscal capacity using **textbook finance** and Sargent's debt valuation equation
  - Confronting risk and the pricing of *risk* and Ruling out *free lunches* for Treasury
    - Extant Finance literature on fixed income: On the pricing of *individual* government bonds.
    - Our work: On the pricing of the portfolio *all government bonds*.
  - Preview of Findings: Valuation of U.S. Treasurys is Puzzling.
    - Should you care?

Roadmap

Outline

Accounting

- Start from static government budget constraint: $G_t - T_t + D_{t-1}R_t = D_t$.
- Backward-looking expression for the debt/output ratio:

$$\frac{D_t}{Y_t} = \sum_{j=0}^{t} \left(\frac{G_{t-j}}{Y_{t-j}} - \frac{T_{t-j}}{Y_{t-j}} \right) \frac{R_{t-j,t}}{X_{t-j,t}} + R_{0,t} D_{-1}$$

- Determinants of the debt/output ratio:
  1. Primary Deficits
  2. Nominal Cumulative Returns on Debt $R_{t-j,t}$
  3. Nominal Cumulative Growth rate of GDP $X_{t-j,t}$
- If $\frac{R_{t-j,t}}{X_{t-j,t}} << 1$, then government can always run deficits without causing D/Y to explode (Blanchard, 2019).

Put (too) simply, the signal sent by low rates is not only that debt may not have a substantial fiscal cost, but also that it may have limited welfare costs.

Outline

Free Lunch ?

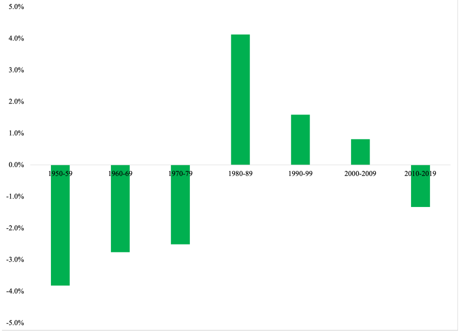
- Consider Deterministic Economy: Government's cost of capital is risk-free rate
- Steady-state Debt/Output ratio dynamics governed by:

$$\frac{D}{Y} = \frac{D}{Y}\left(\frac{1+r^f}{1+x}\right) + \frac{G-T}{Y}$$

  - Government can roll over Debt and run Steady-state Deficits:
  $$\frac{D}{Y} = \frac{G-T}{Y} \Big/ \frac{x-r^f}{1+x}.$$
  - No Limits to Fiscal Capacity? (Blanchard, 2019; Mehrotra and Sergeyev, 2021).
- Textbook Finance: cannot extrapolate to economies with priced risk:
  - $r_t^f << x_t$ in every state ruled out by no arbitrage: if not, borrow to go long in stocks and earn a positive excess return in all states.
  - Debt is only risk-free if you manufacture risk-free debt (zero beta).

Outline

$r < x$ only in pre-1980 Sample



	$r - x$	Returns	Real x	Inflation
1947-1949	-7.8%	-1.8%	0.6%	5.4%
1950-1959	-3.8%	2.7%	4.1%	2.4%
1947-1979	-3.5%	3.9%	3.6%	3.8%
1980-2020	1.5%	6.5%	2.4%	2.6%

- D/Y governed by past returns and growth rates:

$$\frac{D_t}{Y_t} = \sum_{j=0}^{t} \left(\frac{G_{t-j}}{Y_{t-j}} - \frac{T_{t-j}}{Y_{t-j}} \right) \frac{R_{t-j,t}}{X_{t-j,t}} + R_{0,t} D_{-1}$$

Summary of U.S. Treasury's Post-war Experience

- r not always $< x$ (Hall and Sargent, 2011)

  1. **Low Real Returns in 40s and 50s**: U.S. Bondholders earned low real returns after WW-II and in 1950s: high inflation and *financial repression*. (Hall and Sargent, 2022)
     - low real rates are not always equilibrium outcome.
  2. **High Real Growth in 50s and 60s**: U.S. Treasury helped by high growth in 1950s and 1960s.
  3. **High Real Returns in 80s**: U.S. Bondholders earned high real returns in 1980s. (but U.S. Debt/output ratio were in 30% range)

Outline

For when the credit of a country is in any degree questionable, it never fails to give an extravagant premium, in one shape or another, upon all the loans it has occasion to make. Nor does the evil end here; the same disadvantage must be sustained upon whatever is to be bought on terms of future payment...

It is a well known fact, that in countries in which the national debt is properly funded, and an object of established confidence, it answers most of the purposes of money.

(A. Hamilton, 1790, Report on Public Credit.)

Convenience Yields

- Convenience yields on U.S. government bonds (Longstaff, 2004; Krishnamurthy and Vissing-Jorgensen, 2012; Nagel, 2016; Binsbergen et al., 2022).
- U.S. Treasurys are typically expensive relative to do-it-yourself synthetic Treasurys:
  1. Agency bonds (Longstaff, 2004), TIPS (Fleckenstein et al., 2014) ,
  2. Corporate bonds (Bai and Collin-Dufresne, 2019),
  3. Foreign sovereign bonds (Du et al., 2018; Jiang et al., 2021a; Koijen and Yogo, 2019).

$$\mathbb{E}_t[M_{t+1}]e^{+\lambda_t^{USTR}} = P_t^{USTR}$$

M is SDF: pick your favorite asset pricing model (Market return (CAPM), IMRS of stand-in investor (Consumption-CAPM)).

Safe Asset Demand and Accounting

- Convenience yield $\lambda_t^{USTR} \Leftrightarrow$ Treasury bonds paying lower yields than implied from SDF: $\mathbb{E}_t[M_{t+1}] = P_t^{USTR} e^{-\lambda_t^{USTR}}$
- Yields on Treasurys below true Risk-free rates: $y_t^{USTR} = r_t^f - \lambda_t^{USTR}$, where $r_t^f = -\log(\mathbb{E}_t[M_{t+1}])$
  - Only Treasury borrows at Treasury Yield: $y_t^{USTR} = r_t^f - \lambda_t^{USTR} < x_t$
  - No arbitrage opportunities because investors borrow at r^f.

- Backward-looking expression for the debt/output ratio:

$$\frac{D_t}{Y_t} = \sum_{j=0}^{t} \left(\frac{G_{t-j}}{Y_{t-j}} - \frac{T_{t-j}}{Y_{t-j}} \right) \frac{R^f_{t-j,t} - \lambda^{USTR}_{t-j,t}}{X_{t-j,t}} + R_{0,tD_{-1}}$$

- As the government keeps issuing more bonds, the λ_t^{USTR} may decline (Krishnamurthy and Vissing-Jorgensen, 2015): $\lambda_t^{USTR\prime}\left(\frac{D_t}{Y_t}\right) < 0$

Safe Asset Demand and Limits to Fiscal Capacity

- Mian, Straub and Sufi (2021) analyze the role of λ_t earned by the Treasury in D/Y dynamics.
- Consider Deterministic Economy: Government's cost of capital is risk-free rate minus Convenience Yields
- When D/Y is low, in **goldilocks region**, $x + \lambda^{USTR}(\frac{D}{Y}) > r^f > x$,
  - Gov't can run small steady-state deficits while keeping the debt/output ratio sufficiently low (Mian et al., 2021) :

$$\frac{D}{Y} = \frac{G-T}{Y} / \frac{x + \lambda^{USTR}(\frac{D}{Y}) - r^f}{1+x}.$$

- When D/Y exceeds cutoff, $x + \lambda^{USTR}(\frac{D}{Y}) < r^f$, in **austerity region**,
  - Gov't runs steady-state surpluses:

$$\frac{D}{Y} = \frac{T-G}{Y} / \frac{r^f - x - \lambda^{USTR}(\frac{D}{Y})}{1+x}.$$

Roadmap

Introduction

- What is the fiscal capacity of the U.S.?
- **Deterministic model or model without priced aggregate** *growth* **risk**: maybe it's not limited, because *risk-free rate* < *growth rate* (Blanchard, 2018)
  - Since interest rates are below GDP growth rates, the U.S. can safely roll over its debt.
- Textbook Finance: **Asset pricing model with priced aggregate risk**: in economy subject to priced aggregate shocks, government's ability to make risk-free promises is limited: *growth* is risky, even if, on average, *risk-free rate* < *growth rate* :
- Insist on:
  - Pricing the entire government bond portfolio.
  - Pricing other assets (including equities).

Pricing the Entire Government Bond Portfolio

- Government debt is backed by current and future primary surpluses (see Hansen, Roberts and Sargent, 1991, for early reference)
  - Iterate forward on the government budget constraint:

$$G_t + Q_{t-1}^1 = \sum_{h=1}^{H} \left(Q_t^h - Q_{t-1}^{h+1} \right) P_t^h + T_t,$$

  - Impose no-arbitrage: $P_t^h = PV_t \left[P_{t+1}^{h-1} \right], \forall h \leq H$

$$D_t = \sum_{h=0}^{H} Q_{t-1}^{h+1} P_t^h = \sum_{j=0}^{T} PV_t (T_{t+j} - G_{t+j}) + PV_t \left[D_{t+T} \right]$$

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$$\underbrace{D_t}_{\text{the market value of government debt}} = \underbrace{\sum_{j=0}^{\infty} PV_t (T_{t+j} - G_{t+j})}_{\text{the expected risk-adjusted PDV of future primary surpluses}}$$

  - Debt Valuation Equation:
    - Holds ex-ante both in real and nominal terms.
    - Holds allowing for sovereign default risk (extension).
    - Does not depend on complete markets.

Pricing the Entire Government Bond Portfolio

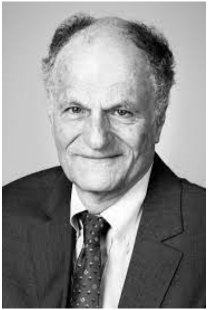
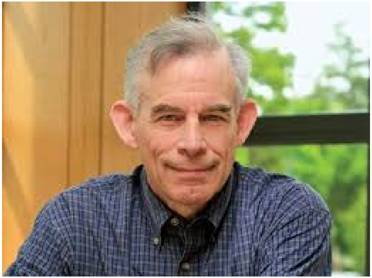
- Government debt is backed by current and future primary surpluses (see Hansen, Roberts and Sargent, 1991, for early reference)
  - Iterate forward on the government budget constraint:

$$G_t + Q_{t-1}^1 = \sum_{h=1}^{H} \left(Q_t^h - Q_{t-1}^{h+1} \right) P_t^h + T_t,$$

  - Impose no-arbitrage: $P_t^h = PV_t \left[P_{t+1}^{h-1} \right], \forall h \leq H$
  - Impose a TVC: $PV_t \left[D_{t+T} \right] \to 0$ as $T \to \infty$
    - Textbook Finance: TVC can and will hold even if $r^f < x$ when $r^f + RP > x$
    - Consider case with constant debt/output ratio

$$d \lim_{T \to \infty} PV_t \left[Y_{t+T} \right] = 0,$$

      which should be discounted at $r^f + RP - x$.
    - The unlevered equity premium RP is substantial (Hansen and Singleton, 1983; Mehra and Prescott, 1985). In Backus, Chernov and Martin (2011)'s version of disaster model, $RP \approx 3\%$

- **Intertemporal Budget Constraint, Debt Valuation Eqn.**: Hansen and Sargent (80); Hansen, Sargent, and Roberds (91); Sargent and Wallace (1984); Leeper (1991); Woodford (1994); Sims (1994); Blanchard (19), Cochrane (19, 20); Jiang (2019a,b), Brunnermeier, Merkel and Sannikov (2020); Reis (2020).
- **Fiscal policy risk**: Croce, Nguyen, Schmid (12), Croce, Kung, Nguyen, and Schmid (19), Chernov, Schmid, and Schneider (19), Liu, Schmid, and Yaron (20)

Bubbly Finance (Not in Berk and DeMarzo)

- The TVC is an optimality condition in models with long-lived investors. TVC: $PV_t\left[D_{t+T}\right] \rightarrow 0$ as $T \rightarrow \infty$
- In models *without long-lived investors*, this optimality condition is not imposed
    - Creating room for bubbles Samuelson (1958); Diamond (1965); Blanchard and Watson (1982); Hellwig and Lorenzoni (2009).
    - Bubbles, not only in bonds, but also in *all long-lived assets* (e.g. stocks)
        - Missing Wealth? Where is all this wealth?

Bonds Are Different: Convenience Yields

- Convenience yield $\lambda_t \Leftrightarrow$ Treasury bonds paying lower yields than implied from SDF:

$$\begin{aligned} \mathbb{E}_t[M_{t+1}] &= P_t^1 e^{-\lambda_t}, \\ \mathbb{E}_t[M_{t+1}P_{t+1}^1] &= P_t^2 e^{-\lambda_t}, \\ \mathbb{E}_t[M_{t+1}P_{t+1}^K] &= P_t^{K+1} e^{-\lambda_t}. \end{aligned}$$

- Debt now also backed by convenience services that Treasuries offers investors:

$$D_t = \sum_{j=0}^{\infty} PV_t \left(T_{t+j} - G_{t+j} + (1 - e^{-\lambda_{t+j}}) D_{t+j} \right)$$

Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2019)

Sovereign Bonds Are Special

- Existing Models: government bonds are special because they enable investors to self-insure against idiosyncratic risk (see Bassetto and Cui, 2018; Chien and Wen, 2019; Angeletos et al., 2020; Brunnermeier et al., 2022; Reis, 2021).
  - Is Seignorage revenue larger in less financially developed countries with more unspanned risk?
- But U.S. Treasurys are special:
  - Why fiscal capacity concentrated in some countries, like the U.S.?

Outline

Treasury Balance Sheet

- Government Budget Constraint and Debt Valuation Equation (no arbitrage, no bubbles):

$$D_t = \sum_{j=0}^{\infty} PV_t(T_{t+j} - G_{t+j}) = P_t^T - P_t^G.$$

- Treasury Balance Sheet: P^T and P^G are prices of tax and spending claims

A	*Treasury Balance Sheet* *L*
Tax Revenue Claim P_t^T	Spending Claim P_t^G Debt D_t
P_t^T	$P_t^G + D_t$

- Risk in tax revenue has to be absorbed by spending or by market value of debt.

Manufacturing Risk-free Debt: Trading off insuring bondholders vs. taxpayers

A	*Treasury Balance Sheet* *L*
Tax Revenue Claim P_t^T	Spending Claim P_t^G Debt D_t
P_t^T	$P_t^G + D_t$

- Government debt *beta* is given by:

$$\beta_t^D = \frac{D_t + P_t^G}{D_t}\beta_t^T - \frac{P_t^G}{D_t}\beta_t^G.$$

- need $\boxed{\beta_t^D = 0}$ $\rightarrow$ Restrictions on tax policy given a spending beta (β_t^G): $\beta_t^T = \frac{P_t^G}{D_t + P_t^G}\beta_t^G$
- With positive debt $D_t > 0$, we need $\beta_t^T << \beta_t^G$
  - Because of counter-cyclical government spending (insurance to transfer recipients), β_t^G is low.
  - Insuring bond holders requires a tax policy that implies even lower β_t^T. (see Jiang, Lustig, Van Nieuwerburgh and Xiaolan, 2020)

Simple Example

- Asset Pricing Parameters:
  - Risk-free rate $r^f = 1.5\%$,
  - Growth rate $x = 2\%$,
  - Output or Market Risk premium $RP = 3\%$ and

- Fiscal (Cash Flow) Parameters:
  - The tax/output ratio $T/Y = 0.25$ and spending/output ratio G/Y are constant.
  - $\mathbb{E}_0 Y_1$ is \$10 trillion in expectation in the first year.
  - Tax Revenue $\mathbb{E}_0 T_1$ is \$2.5 trillion,
  - Spending $\mathbb{E}_0 G_1$ is \$2.0 trillion,
  - $\mathbb{E}_0 S_1$ is \$0.5 trillion in the first year.
  - After year 1, Cash flows expected to grow at a rate of $x\%$ over time.

Treasury Balance Sheet with Risky Debt

Assets		Liabilities	
$PV(T)$	$\$100 = \$2.5 \times 40$	$PV(G)$	$\$90 = \$2.25 \times 40$
		D	$\$10 = \$.25 \times 40$
Total	\$ 100	Total	\$ 100

- T/Y and G/Y are constant.
- The government runs a primary surplus of \$0.25 trillion per year.
- The multiple for the T claim, the G claim and D is

$$\frac{1}{(r^f + RP - x)} = \frac{1}{(1.5\% + 3\% - 2\%)} = 40$$

  - valuation ratio for the market (total wealth): if GDP is \$10 trillion, then total wealth is \$400 trillion.
- The debt is as risky as the spending and tax claim.
- Taxpayers are not insuring bondholders.

Risk-free Debt: Not a Free Lunch.

Assets		Liabilities	
$PV(T)$	$\$100 = \$2.2 \times 45.5$	$PV(G)$	$\$90 = \$2.25 \times 40$
		D	$10
Total	$ 100	Total	$ 100

- $T/Y \nearrow$ in bad times (higher multiple on tax claim)
- The government runs a primary deficit of $0.05 trillion per year.
- The debt has zero beta because

$$\beta_t^T = \frac{P_t^G}{D_t + P_t^G} \times \beta_t^G = \frac{90}{100} \times \beta_G = 0.9$$

- The multiple for $T > 40$ (market multiple) because it's safer:

$$\frac{1}{r^f + RP - x} = \frac{1}{4.2\% - 2\%} = 45.5,$$

  where $\beta_t^T \times RP = .9 * 3\% = 2.7\%$ and $1.5\% + 2.7\% = 4.2\%$
- Taxpayers are insuring bondholders; zero beta debt with $r^f < x$ not a free lunch.

Convenience Yields and Trade-Off

A	*Treasury Balance Sheet*	*L*
Tax Revenue Claim P_t^T		Spending Claim P_t^G
Seigniorage Claim P_t^K		Debt D_t
$P_t^T + P_t^K = P_t^G + D_t$		$P_t^T + P_t^K = P_t^G + D_t$

- Risk-free debt ($\beta_t^D = 0$) implies:

$$\beta_t^T = \frac{P_t^G}{D_t + P_t^G - P_t^K}\beta_t^G - \frac{P_t^G}{D_t + P_t^G - P_t^K}\beta_t^K$$

- If $\beta_t^K = 0$, then β_t^T is higher than without convenience ($P_t^K > 0$). Trade-off is now less steep.
- If $\beta_t^K < 0$ (counter-cyclical convenience yield), then β_t^T is even larger, possibly allowing $\beta_t^D = 0$.
- Now, both bondholders and taxpayers can be insured

Outline

Valuation of Treasury Portfolio

1. Bond Valuation using CBO Projections to forecast future surpluses (deviations from rational expectations) Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2022)

2. Bond Valuation using regressions/VAR to forecast future surpluses: investors act like econometricians in developing expectations about future surpluses (rational expectations) Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2021b, 2019)

Valuation using Textbook Finance

- Government securitizes claim to surpluses

Assets	Liabilities
$PV_{2021}(\{T\})$	$PV_{2021}(\{G\})$
	$Debt$

Valuation using Textbook Finance

- Government securitizes claim to surpluses
- Debt is fully backed by PDV of surpluses; Fiscal backing:

$$PV_{2021}(\{T-G\}_{2022}^{2052}) + PV_{2021}(D_{2052}) = PV_{2021}(\{T-G\}_{2022}^{\infty})$$

Valuation using Textbook Finance

- Government securitizes claim to surpluses
- Debt is fully backed by PDV of surpluses; Fiscal backing:

$$PV_{2021}(\{T-G\}_{2022}^{2052}) + PV_{2021}(D_{2052}) = PV_{2021}(\{T-G\}_{2022}^{\infty})$$

- Suppose U.S. government collects tax revenue T/Y, spends G/Y and runs surplus S/Y that are constant as % of GDP.

$$PV_{2021}(\{T-G\}) = \frac{S}{Y}\sum_{j=1}^{\infty}\frac{Y_{2021+j}}{(1+r^{\$,y})^j} = pd^y \times \frac{S}{Y} \times Y_{2021}.$$

  - Only GDP is risky in this calculation
  - Measure of extra fiscal capacity per % of surplus (as fraction of GDP): Total Wealth/GDP Ratio

$$pd^y = \frac{1}{r^{\$,y} - x} = \frac{1}{r^f + term + rp^y - x}$$

  - $r^f - x$ is not sufficient statistic; depends on risk-free rate r^f and growth rate x, but also on term premium and GDP risk premium rp^y (unlevered equity premium).

U.S. Steady-State Fiscal Capacity

- Total wealth/GDP ratio is given by

$$pd^y = \frac{1}{(r^f + term) + rp^y - x} = \frac{1}{2.07\% + 2.60\% - 3.50\%} = \frac{1}{1.17\%}$$

- Total wealth is $85 \times GDP$
- What is steady-state surplus S/Y needed to get to $PV_{2021}(\{T - G\}) = 0.99 \times Y_{2021}$?

Assets/GDP		Liabilities/GDP	
$PV_{2021}(\{T\})/Y_{2021}$	$19.7 = 23.06\% \times 85.8$	$PV_{2021}(\{G\})/Y_{2021}$	$18.7 = 21.9\% \times 85.8$
		D/Y_{2021}	$0.99 = 1.16\% \times 85.8$

- Need a steady-state primary surplus of 1.16% of GDP to get to $D/Y = 0.99$
- CBO projects deficits of 3.19% until 2052.

Upper Bound on U.S. Steady-State Fiscal Capacity

- But tax revenue T/Y is pro-cyclical (risky) and spending G/Y is counter-cyclical (safer)
  - Higher risk premium on T claim $rp^T > rp^Y$; lower risk premium on G claim $rp^G < rp^Y$
  - Lower multiple on T claim $pd^T < pd^Y$; higher multiple on G claim $pd^G > pd^Y$

Assets/GDP		Liabilities/GDP	
$PV_{2021}(\{T\})/Y_{2021} \leq$	$19.7 = 23.0\% \times 85.8$	$PV_{2021}(\{G\})/Y_{2021} \geq$	$18.7 = 21.9\% \times 85$
		$D/Y_{2021} \leq$	$0.99 = 1.16\% \times 85$

- 0.99 is really an upper bound on fiscal capacity

$$PV_{2021}(\{T - G\}) \leq pd^y \times \frac{S}{Y} \times Y_{2021} = 0.99 \times Y_{2021}.$$

Boost Treasury's Fiscal Capacity

- Unless you think ..Treasury will start to run large surpluses during pandemics and financial crises
- Suppose tax revenue T/Y is counter-cyclical (safe) and spending G/Y is pro-cyclical (in PDV) (risky)

$$PV_{2021}(\{T-G\}) = pd^T \times \frac{T}{Y} \times Y_{2021} - pd^G \times \frac{G}{Y} \times Y_{2021}.$$

  - We can have steady-state deficits $\frac{T}{Y} << \frac{G}{Y}$ and positive fiscal capacity iff $pd^T > pd^Y > pd^G$

Assets/GDP		Liabilities/GDP	
$PV_{2021}(\{T\})/Y_{2021} \geq$	$\frac{T}{Y} \times 85.8$	$PV_{2021}(\{G\})/Y_{2021} \leq$	$\frac{G}{Y} \times 85.8$
		$FC \geq$	$\frac{S}{Y} \times 85.8$

- Taxpayers provide insurance and U.S. Treasury collects insurance premium
- Not what Treasury does (see Pandemic, GFC, etc.) or will do anytime soon!

Textbook Finance vs. Bubbly Finance

1. **Deterministic Economies Approach** ($rp^y = 0$): Debt is not fully backed by PDV of surpluses; $PV_{2021}(D_{2221}) \not\to 0$ because we're discounting at $r^f - x < 0$
   - We can keep rolling over the debt ;There's a lot more wealth than you think! $pd^y \to \infty$

	Assets		Liabilities
Until 2221	$PV_{2021}(\{T\}_{2022}^{2221})$		$PV_{2021}(\{G\}_{2022}^{2221})$
After 2221	$PV_{2021}(D_{2221})$	$\not\to \$0$	
			$D = PV_{2021}(\{T - G\}_{2022}^{2221} + D_{2221})$

Textbook Finance vs. Bubbly Finance

1. **Deterministic Economies Approach** ($rp^y = 0$): Debt is not fully backed by PDV of surpluses; $PV_{2021}(D_{2221}) \not\to 0$ because we're discounting at $r^f - x < 0$
2. **Our Textbook Finance Approach** ($rp^y > 0$): Debt is fully backed by PDV of surpluses; $PV_{2021}(D_{2221}) \to 0$ because we're discounting at $r^f + term + rp^y - x > 0$
   - We cannot keep rolling over the debt because r^f cannot always be smaller than g without creating arb. opps.

	Assets		Liabilities
Until 2221	$PV_{2021}(\{T\}_{2022}^{2221})$		$PV_{2021}(\{G\}_{2022}^{2221})$
After 2221	$PV_{2021}(D_{2222})$	\$0	
			$D = PV_{2021}(\{T - G\}_{2022}^{2221})$

   - Total wealth/GDP ratio $pd^y \not\to \infty$

Textbook Finance vs. Bubbly Finance

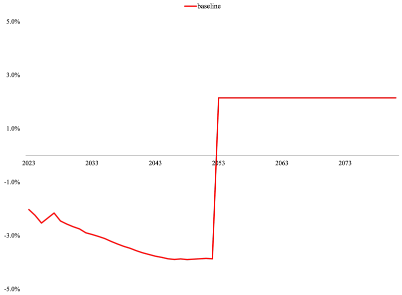
1. **Deterministic Economies Approach** ($rp^y = 0$): Debt is not fully backed by PDV of surpluses; $PV_{2021}(D_{2221}) \not\to 0$ because we're discounting at $r^f - x < 0$
2. **Our Textbook Finance Approach** ($rp^y > 0$): Debt is fully backed by PDV of surpluses; $PV_{2021}(D_{2221}) \to 0$ because we're discounting at $r^f + term + rp^y - x > 0$
3. **Bubbly Finance Approach**. ($rp^y \approx 0$): Debt is not fully backed by future surpluses and PDV of future debt $PV_{2021}(D_{2221}) \not\to 0$ because we're discounting at $DR < 0$
   - Bubble in some long-lived assets, typically in models without long-lived investors; Total wealth/GDP ratio $pd^y \to \infty$ (missing investors, missing wealth hypothesis)

	Assets		Liabilities
Until 2221	$PV_{2021}(\{T\}_{2022}^{2221})$		$PV_{2021}(\{G\}_{2022}^{2221})$
After 2221	$PV_{2021}(D_{2221})$	$\not\to \$0$	
			$D = PV_{2021}(\{T-G\}_{2022}^{2221} + D_{2221})$

Outline

1. Simple Steady-State Example
2. **Fiscal Capacity Measurement using CBO Projections**

U.S. Treasury Balance Sheet using CBO Projections



- feed in CBO surplus projections until 2052 and projected $(D/Y)_{2052}$ is 185%.
- **Assumption**: Treasury runs surpluses of 2.16% after 2052 such that $(D/Y)_{2052} = 85.8 \times 2.16\% = 185\%$

U.S. Treasury Balance Sheet using CBO Projections

- CBO projects surpluses until 2052 and debt outstanding at 2052.

	Assets		Liabilities	
Until 2052	$PV_{2021}(\{T\}_{2022}^{2052})$	\$124.95	$PV_{2021}(\{G\}_{2022}^{2052})$	\$146.11
After 2052	$PV_{2021}(D_{2052})$	\$33.54		
			Fiscal Capacity	\$ 12.38

- Baseline fiscal capacity estimate of \$ 12.38 trillion:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2052}) + PV_{2021}^{upper}(D_{2052}) = -\$21.16 + \$33.54 = \$12.38 \text{ tr.}$$

$$<< \$22.40 \text{ tr.}$$

- Fiscal capacity limited in spite of low rates
- Market is pricing in large fiscal correction (relative to CBO projections) or financial repression (e.g., Japan)

U.S. Treasury Balance Sheet with Convenience Yields

- US. Treasurys are special and earn convenience yields.
- **Assumption**: Treasury collects $0.60\% \times 99.6\% = 0.598\%$ of GDP in convenience-yield revenues per year

	Assets		Liabilities	
Until 2052	$PV_{2021}(\{T\}_{2022}^{2052})$	\$124.95	$PV_{2021}(\{G\}_{2022}^{2052})$	\$146.11
Until 2052	$PV_{2021}(\{CS\}_{2022}^{2052})$	\$4.04		
After 2052	$PV_{2021}(D_{2052})$	\$33.54		
			Fiscal Capacity	\$ 16.42

- Extended fiscal capacity estimate of \$ 16.42 trillion:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2052}) + PV_{2021}^{upper}(D_{2052}) + PV_{2021}^{upper}\left(\{CS\}_{2022}^{2052}\right) = \$12.38 + \$4.04$$

$$= \$16.42 \text{ tr.}$$

Creating a Bubble

- We can reverse-engineer $rp^y = 1.37\%$ to match the valuation of Treasurys at \$22.40 tr.

	Assets		Liabilities	
Until 2052	$PV_{2021}(\{T\}_{2022}^{2052})$	\$150.57	$PV_{2021}(\{G\}_{2022}^{2052})$	\$176.55
After 2052	$PV_{2021}(D_{2052})$	\$48.38		
			Fiscal Capacity	\$ 22.40

- Fiscal capacity estimate boosted to \$ 22.40 trillion by increasing PDV of future debt:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2052}) + PV_{2021}^{upper}(D_{2052}) = -\$25.98 + \$48.38 = \$22.40 \text{ tr.}$$

- We have generated a bubble: $pd^y \to \infty$

$$(r^f + term) + rp^y - g = 2.07\% + 1.37\% - 3.50\% < 0.$$

- All un-levered companies growing at rate of GDP have infinite valuations; Missing wealth hypothesis!

Reverse Engineering

- Different exercise: Debt must be priced correctly today given the CBO projections.
- Instead of using the CBO's projected debt/output ratio in 2052, back out the steady-state surplus needed after 2052:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2052}) + PV_{2021}^{upper}(D_{2052}) = -\$21.16 + \$43.45 = \$22.284 \text{ tr.}$$

- To obtain \$43.45 trillion for the present value of debt in 2052, we need annual primary surpluses of 2.79% from 2053 onwards:

$$PV_{2052}^{upper}(\{T-G\}_{2022}^{2052})/Y_{2052} = \frac{S}{Y} \times PV_{2052}(\{Y\}_{2053}^{\infty} = 2.79\% \times 85.8 = 239\%,$$

- Implies a debt/output ratio in 2052 of 239%, instead of the 185% projected by the CBO.

What do you Think?

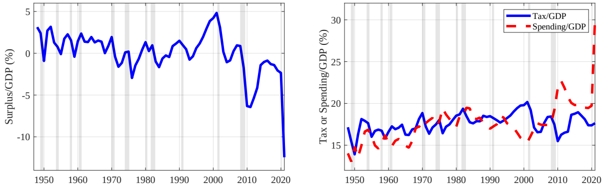
- Simple framework based in textbook finance for analyzing fiscal capacity using CBO projections
- U.S. Treasury's fiscal capacity is probably more limited than you think, ..unless you think
  - U.S. GDP risk premium is very low and there is a more wealth than commonly thought
  - U.S. Treasury has engineered permanent violations of the no-bubble constraints in securities markets

Outline

Cash Flow Risk in $\{T, G\}$

$$D_t = \sum_{j=0}^{\infty} PV_t(S_{t+j}) = \sum_{j=0}^{\infty} PV_t(T_{t+j} - G_{t+j})$$

- An investor who buys all government debt issuances and receives all redemptions has a claim to future primary surpluses $\{S_{t+j}\}$. Surpluses are the **cash flows on this investment strategy**.
- Surpluses are **highly pro-cyclical**:



- Cash flow has wrong-way business cycle risk ⇒ surplus claim carries business-cycle risk premium

Cash Flow Risk in $\{T, G\}$

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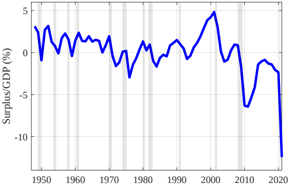
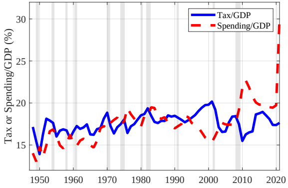
- Surpluses exposed to **long-run output risk**: are cointegrated with output.





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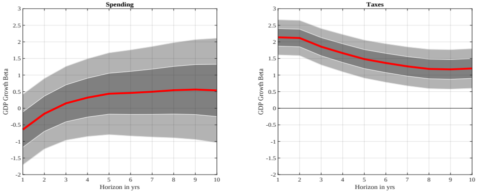
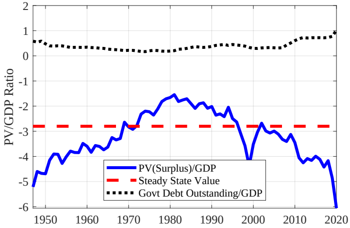


Government Bond Valuation Puzzle

- With VAR dynamics and the SDF in hand, we can value T and G claims

$$P_t^T = \sum_{j=0}^{\infty} PV_t(T_{t+j}); P_t^G = \sum_{j=0}^{\infty} PV_t(G_{t+j}).$$

- Value of the surplus claim is $P_t^T - P_t^G = T_t PD_t^T - G_t PD_t^G$
- Scale by GDP for easier comparison to debt/GDP
$\frac{T_t}{GDP_t} PD_t^T - \frac{G_t}{GDP} PD_t^G$



Government Bond Valuation Puzzle

- US Treasury debt is not fully backed by surpluses: portfolio of U.S. Treasurys is expensive relative to underlying collateral (surpluses)
- Treasury yields seem too low compared to returns of other assets
- Potential explanations:
  1. (Irrational) Beliefs: Investors Anticipate Large fiscal correction with small prob. (peso problem)
  2. Investors Anticipate Financial Repression
  3. Exorbitant Privilege

Outline

Fiscal Sustainability: Forward-looking Approach

- Current run-up in the U.S. debt/output ratio reflects:
  1. Lower future inflation-and-growth adjusted returns on government debt (Blanchard, 2019; Furman and Summers, 2020; Cochrane, 2019) :
     - $(r - g) < 0$ debate
  2. Higher future surpluses (Bohn, 1998; Cochrane, 2020)
  3. Higher future debt/output ratio

Excess Smoothness

- Apply standard asset pricing machinery (Campbell-Shiller decomposition) to a macro question (fiscal sustainability) without committing to fully specified model
- Campbell-Shiller decomposition of the U.S. debt/output ratio :
  1. **Discount rates**: No evidence that the debt/output ratio predicts real growth-adjusted returns.
  2. **Cash flows**: No evidence that the debt/output ratio predicts surpluses.
  3. **Residual**: higher future debt/output ratio

⇒ Excess smoothness: Bond prices today not responsive to news about future macro fundamentals

Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2021b)

Roadmap

Exorbitant Privilege

- Exorbitant privilege = advantage that the U.S. enjoys as the world's safe asset issuer.
- Gourinchas et al. (2019): *"Being the hegemon confers a specific ability to issue large amounts of nominally safe liabilities (dollar securities), which are happily absorbed by the rest of the world. Thus, the view is that, in case of a deficit, the United States does not have to take restrictive measures, so that the dollar is not an impartial means of international exchange. This is the essence of the exorbitant privilege."*
- Implications for fiscal sustainability in the U.S. and other countries?
- Our work looks back at history:
  - Investors allocate extra fiscal capacity to global safe asset supplier, even after accounting for extra convenience yields.
  - Investors withdraw extra fiscal capacity when relative fundamentals deteriorate

History of Exorbitant Privilege

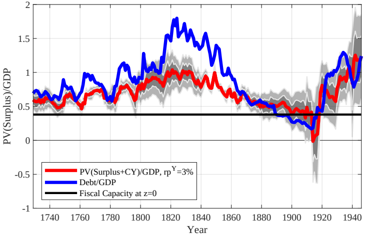
1. U.S. is hegemon post WW-II
   - Post-WW-II: U.S. Treasurys not fully backed by surpluses
   - Pre-WW-I: U.S. Treasurys fully backed

2. U.K. is hegemon pre-WW-I in 19th century
   - Pre-WW-I: U.K. Gilts not fully backed
   - Interbellum: financial repression
   - Post WW-II: U.K. Gilts fully backed

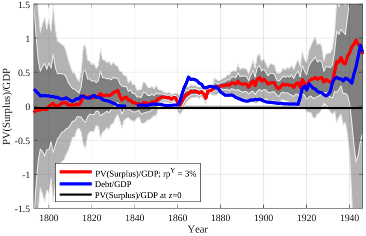
3. Dutch more dominant in 18-th century
   - Pre-Napoleonic War: Dutch Republic bonds not fully backed
   - Debt restructuring
   - Post-Napoleonic War: Dutch Republic bonds fully backed

Chen, Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2022)

U.K. and U.S. Fiscal Backing Pre-WW-II

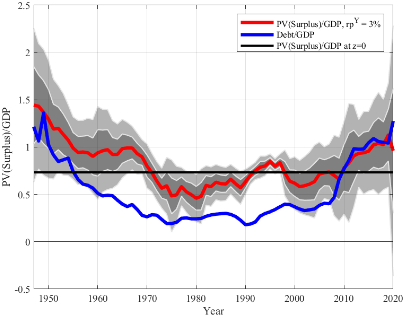


(a) U.K.

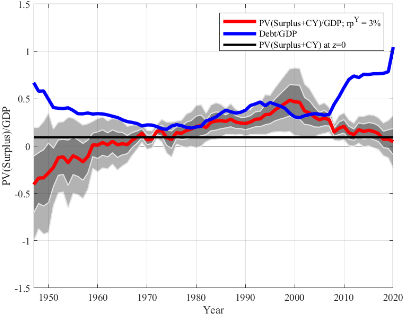


(b) U.S.

U.K. and U.S. Fiscal Backing: Post-WW-II



(a) U.K.



(b) U.S.

Roadmap

Japanese Govt Balance Sheet as % of GDP

December 1997			
Assets		**Liabilities**	
Currency and Deposits	5.75%	Currency	10.91%
Domestic Loans	6.55%	**Bank Reserves**	**0.65%**
Other Domestic Securities	5.77%	Bonds & T-Bills	58.97%
Domestic Equities	11.79%	Loans	25.54%
Foreign Securities	6.83%	**Deposits FILF**	**76.40%**
B.O.J. Loans	4.20%		
December 2021			
Assets		**Liabilities**	
Currency and Deposits	17.27%	Currency	23.43%
Domestic Loans	3.45%	**Bank Reserves**	**100.19%**
Other Domestic Securities	13.74%	Bonds & T-Bills	139.61%
Domestic Equities	31.92%	Loans	27.58%
Foreign Securities	54.65%	**Deposits FILF**	**4.69%**
B.O.J. Loans	27.16%		
Total	148%		295%

Consolidated Balance Sheet (% of GDP) for General Government, the Bank of Japan and Government-Owned Financial Institutions End of 1997 (2021).

Non-Marketable Debt

A	*Cons. Gov. Balance Sheet* *L*
Tax Revenue Claim P_t^T	Spending Claim P_t^G
Risky Assets A_t	Non-marketable Debt D_t^{nm}
P_t^T	$P_t^G + D_t$

- Financial Repression: Substitution of non-marketable debt for marketable debt
- Mispricing of Debt

Gov’t Long Duration

- Japanese QE and YCC is akin to **financial repression** deployed in Europe and US during wartime (WWI, WWII and interbellum): substituting (floating rate) non-marketable for (fixed rate) marketable debt
- Gov’t Funded mostly at short end borrowing at floating rates (295% of GDP), going long in high duration assets (148 % of GDP) (long on duration= measure of interest rate risk)
- Lower Real Rates $\rightarrow$ more fiscal space for Japanese government
  (Chien, Cole and Lustig, 2023)

Japanese Households: Trapped in Deposits; No Duration

Assets		Liabilities	
Currency and Deposits	**201.43%**	Loans	64.53%
Other Securities	4.73%		
Equities	39.03%		
Insurance & Pension	99.64%		

Japanese Household Balance Sheet (% of GDP) End of 2021.

$$\mathbb{E}_t[M_{t+1}]e^{+\lambda_t^1} = P_t^1$$

$$D_t = \sum_{j=0}^{\infty} PV_t \left(T_{t+j} - G_{t+j} + (1 - e^{-\lambda_{t+j}})D_{t+j} \right)$$

Reinterpreting λ as tax on savers trapped in deposits.

- Most households have no duration: save in deposits.

Welfare effects of Financial Repression

- Welfare effects of Financial Repression?
- Compare duration of household portfolio to duration of future consumption minus income (Greenwald, Leombroni, Lustig, Van Nieuwerburgh (2021)):
  (a) If $D^{\theta} > D^{c-y}$ then the household's consumption possibilities expand when the interest rate falls,
  (b) if $D^{\theta} < D^{c-y}$ the household's consumption possibilities contract.
- Lower Real Rates $\rightarrow$ Young Japanese households, especially those saving in deposits, are worse off.
- Lower Real Rates $\rightarrow$ Older Japanese households, especially those with savings in bonds, equities are better off

Conclusion

- Pricing of Treasury Portfolio is puzzling from the perspective of Textbook Finance
  - Exorbitant Privilege
  - Pricing in Future Financial Repression

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Betting on $r < g$: Free Lunch for Everyone?

- Cannot extrapolate to economies with Aggregate Growth Risk.
- Consider an Economy with i.i.d. growth risk x_t.

1. $r^f_t < x_t$ in every state of the world inconsistent with no arbitrage.
    - The P/D ratio on a claim to output is constant.
    - If $r^f_t < x_t$ in all states of the world, the return on a claim to output would always exceed the risk-free rate:

$$R^y_{t+1} = \frac{1 + pd}{pd}(1 + x_t) > 1 + r^f_t.$$

    - $r^f_t < x_t$ in all states of the world $\rightarrow$ arbitrage opportunities not only for the government, but for everyone else.
2. The $\mathbb{E}[R]$ on government debt only equals r^f_t if the government debt has zero beta.
    - Cannot impose zero beta in backward-looking approach.

Dynamic Efficiency and TVC in Disaster Model

- We adopt the Backus, Chernov and Martin (2011) calibration of the Rietz-Barro consumption disaster model.
  - The jump intensity ϖ of 0.01 (jump size θ of -0.3) consistent with evidence from international consumption data.
  - We choose the CRRA α of 6 to match the annual equity premium (in logs) of 6.47% between 1926.07 and 2022.04.
- The unlevered equity premium is given by:

$$RP = \mathbb{E}_t \left[r^{Y}_{t+1} - r^{f}_{t} \right] \quad = \quad 2.93\%,$$

- Hence, the condition for dynamic efficiency and TVC would be given by $r^f - x + 2.93\% > 0$.
- We would have to almost 300 bps to the risk-free rate.

Convenience Yields

A	*Treasury Balance Sheet*	*L*
Tax Revenue Claim P_t^T		Spending Claim P_t^G
Seigniorage Claim P_t^K		Debt D_t
$P_t^T = P_t^G + D_t$		$P_t^T = P_t^G + D_t$

- Government receives seigniorage revenues due to convenience yields: $K_{t+j} = (1 - e^{-\lambda_{t+j}})D_{t+j}$

$$D_t = \sum_{h=0}^{H} Q_{t-1}^{h+1} P_t^h = \mathbb{E}_t \left[\sum_{j=0}^{\infty} M_{t,t+j}(T_{t+j} + K_{t+j} - G_{t+j}) \right] = P_t^T + P_t^K - P_t^G,$$