Measuring U.S. Fiscal Capacity using Discounted Cash Flow Analysis

Zhengyang Jiang
Northwestern Kellogg, NBER

Hanno Lustig
Stanford GSB, NBER, and CEPR

Stijn Van Nieuwerburgh
Columbia Business School, NBER, and CEPR

Mindy Zhang Xiaolan
University of Texas at Austin

ASSA
January 7, 2023

Valuation using Textbook Finance

- Government securitizes claim to surpluses

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

- Debt is fully backed by PDV of surpluses; **Fiscal Capacity** as of 12/31/2021:

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

- 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: GDP growth is i.i.d. with mean g
  - Extra fiscal capacity per % of surplus: Total Wealth/GDP Ratio

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

Valuation using Textbook Finance

- Government securitizes claim to surpluses
- Debt is fully backed by PDV of surpluses; **Fiscal Capacity** as of 12/31/2021:

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

- 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: GDP growth is i.i.d. with mean g
  - Extra fiscal capacity per % of surplus: Total Wealth/GDP Ratio

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

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

Valuation using Textbook Finance

- Government securitizes claim to surpluses
- Debt is fully backed by PDV of surpluses; **Fiscal Capacity** as of 12/31/2021:

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

- 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: GDP growth is i.i.d. with mean g
  - Extra fiscal capacity per % of surplus: Total Wealth/GDP Ratio

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

  - $r^f - g$ is not sufficient statistic; depends on risk-free rate r^f and growth rate g, 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

$$pd^y = \frac{1}{(r^f + term) + rp^y - g} = \frac{1}{2.07\% + 2.60\% - 3.50\%} = \frac{1}{1.17\%} = 85.8$$

- Total wealth is $85.8 \times GDP$
- 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 $D/Y = 0.99$
- But, CBO projects primary surplus of -3.19% per year until 2052.

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

- Tax revenue T/Y is pro-cyclical and spending G/Y is counter-cyclical
  - Higher risk premium on T claim $rp^T \geq rp^Y$; lower multiple $pd^T \leq pd^Y$
  - Lower risk premium on G claim $rp^G \leq rp^Y$; higher multiple $pd^G \geq pd^Y$

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

- Hence, 0.99 is really an **upper bound** on fiscal capacity

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

Boosting Fiscal Capacity

- If tax revenue T/Y is *counter*-cyclical (safe) and spending G/Y is *pro*-cyclical (risky) in PDV: $pd^T > pd^Y > pd^G$
- Then we can have positive fiscal capacity and steady-state deficits $\frac{T}{Y} < \frac{G}{Y}$

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

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
- Treasury does not run primary surpluses during recessions, pandemics, and financial crises, nor will it 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 $r^f - g < 0$
   - 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	$PV_{2021}(\{T-G\}_{2022}^{2221} + D_{2221})$

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 $r^f + term + rp^y - g > 0$
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)

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 $r^f - g < 0$
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 $r^f + term + rp^y - g > 0$
   - We cannot keep rolling over the debt because r^f cannot always be smaller than g without creating arbitrage opps. Total wealth/GDP ratio $pd^y \not\to \infty$

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

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)

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 $r^f - g < 0$
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 $r^f + term + rp^y - g > 0$
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	$PV_{2021}(\{T-G\}_{2022}^{2221} + D_{2221})$

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 $r^f - g < 0$
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 $r^f + term + rp^y - g > 0$
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)

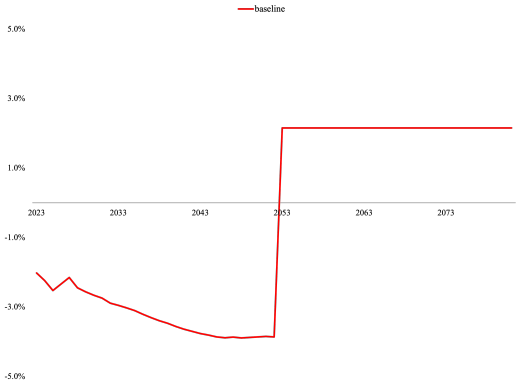
Need to believe U.S. Treasury has special ability to engineer bubbles. U.K. has not been able to do this in three centuries (Chen et al 2022):

U.K.	$1729-1914$	$1729-1946$	$1946-2020$
S/Y	2.5%	1.2%	1.8%

Outline

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

U.S. Treasury Balance Sheet using CBO Projections



- Feed in CBO surplus projections until 2052
- Combined with CBO interest rate and GDP growth rate projections: $(D/Y)_{2052}$ 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 despite
  - very low interest rates at end of 2021
  - strong assumption on large surpluses after 2052 (2.16%)
  - upper bound

U.S. Treasury Balance Sheet with Convenience Yields

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

	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

- Comprehensive fiscal capacity estimate of **\$16.42 trillion**:
- Still below observed debt of \$22.40 trillion in 2021

Reverse Engineering Observed Fiscal Capacity

- If we set $rp^y = 1.37\%$, we 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:

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

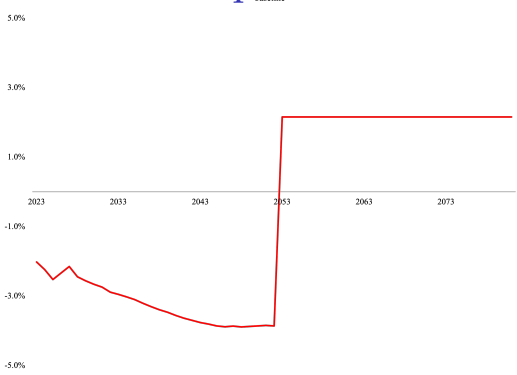
- We have generated a bubble: $pd^y \to \infty$

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

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

Outline

Backloaded Surpluses

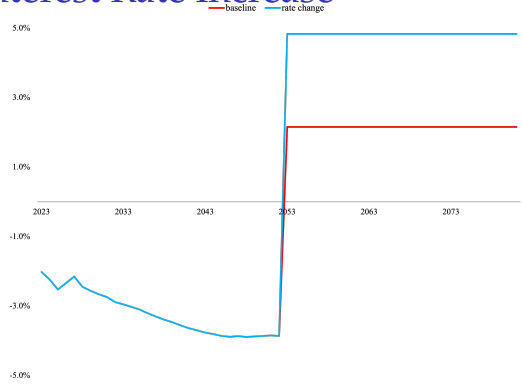


- Treasury runs primary deficits of 3.19% until 2052 ; projected $(D/Y)_{2052}$ 185%
- Treasury runs primary surpluses of 2.16% after 2052 such that $(D/Y)_{2052} = 85.8 \times 2.16\% = 185\%$
- Surpluses have high duration (171), but the Treasury's debt does not (5).

	Net Cash Inflows		Cash Outflows	
Until 2052	$PV_{2021}(\{T-G\}_{2022}^{2052})$	(\$21.16)		
After 2052	$PV_{2021}(D_{2052})$	\$33.54		
			FC	\$ 12.38

- Treasury has not matched cash inflows and outflows.

Interest Rate Increase



- Interest rate level shock of +1%
- Treasury neeed to run surpluses of 4.82% after 2052 such that $(D/Y)_{2052} = 46.18 \times 4.82\% = 223\%$
- An increase in surpluses by 2.67% of GDP every year after 2052!

	Net Cash Inflows		Cash Outflows	
Until 2052	$PV_{2021}(\{T-G\}_{2022}^{2052})$	(\$18.07)		
After 2052	$PV_{2021}(D_{2052})$	\$30.09		
			FC	\$ 12.03

- Low risk-free rates and rp^y increase FC, but also increase duration mismatch.

Conclusions

- Textbook finance framework for analyzing fiscal capacity using CBO projections
- U.S. Treasury's fiscal capacity is limited, unless you think
  - U.S. GDP risk premium is very low $\Rightarrow$ more wealth than commonly thought
  - U.S. Treasury has engineered permanent violations of the no-bubble constraints in securities markets
- Backloading of surpluses exposes Treasury to interest rate risk (more so if GDP risk premium is low)