DISCUSSION PAPER SERIES

DP17341

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FINANCIAL ECONOMICS

MACROECONOMICS AND GROWTH

CEPR

ISSN 0265-8003

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Discussion Paper DP17341
Published 30 May 2022
Submitted 25 May 2022

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JEL Classification: G12, E62

Keywords: fiscal capacity, Fiscal policy

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Acknowledgements
We gratefully acknowledge financial support from NSF award 2049260. We are grateful to Andy Atkeson for suggesting this exercise to us. Jeremia Huber provided excellent research assistance.

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March 25, 2022
First draft: March 15

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We use discounted cash flow analysis to measure a country's fiscal capacity. Crucially, the discount rate applied to projected cash flows includes a GDP risk premium. We apply our valuation method to the CBO's projections for the U.S. federal government's deficit between 2022 and 2051 and debt in 2051. In spite of low rates, our current measure of U.S. fiscal capacity is lower than the debt/GDP ratio. Because of the backloading of projected surpluses, the duration of the surplus claim far exceeds the duration of the outstanding Treasury portfolio. This duration mismatch exposes the government to the risk of rising rates, which would trigger the need for higher tax revenue or lower spending. Reducing this risk by front-loading the surpluses also requires major fiscal adjustment.

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1 Introduction

Recently, there has been an active debate about the fiscal capacity of the U.S. and other countries, but there is no consensus on the proper measurement of fiscal capacity. Some economists have argued that we can just use the ratio of the government's interest expense over GDP as a measure of fiscal capacity (Furman and Summers, 2020). Other economists have argued that we should compare the risk-free rate to the growth rate of the economy (Blanchard, 2019; Andolfatto, 2020). Most authors have concluded that low rates have substantially increased U.S. fiscal capacity, but they have not consider the effect on the duration mismatch faced by the Treasury.

We define fiscal capacity as the present discounted value (PDV) of future surpluses. The measurement of fiscal capacity is a forward-looking valuation question. We propose a simple, easy-to-implement discounted cash flow approach to this valuation question. As in any valuation exercise, this approach requires estimating the proper discount rates, as well as forecasting the underlying cash flows, government spending and tax revenues. We illustrate our method using the CBO's budget projections. Our objective is not to produce definitive estimates, but to develop a coherent forward-looking approach to measuring fiscal capacity.

The proper discount rate for projected surpluses and future debt depends on the riskiness of the underlying cash flows. Following Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2019), we develop an upper bound on fiscal capacity by using the expected return on the total wealth portfolio or the market portfolio, a claim to GDP, as a discount rate for future taxes, spending and future debt. Our approach in this paper is different from Jiang et al. (2019) because it does not rely on an econometric model to forecast future cash flows, and also differs from the backward-looking approach to measuring fiscal capacity developed in Hall (2014); Mian, Straub, and Sufi (2021). Instead, our method relies on the CBO's long-term budget projections. We believe these projections serve as a useful benchmark.

The PDV of the CBO-projected deficits between 2022 and 2051 is $21.6 trillion in 2021 dollars, roughly equal to the U.S. GDP at the end of 2021. In addition, the projected debt outstanding in 2051 is around 200% of GDP. Starting in 2051, the U.S. would need to generate a steady-state surplus of 3.1% to pay back the debt outstanding in 2051. Discounted back to 2021 at the appropriate discount rate, the 2051 debt is worth about $31.6 trillion.

When we combine the PDV of projected deficits until 2051 with the 2021 value of the projected debt outstanding in 2051 of $31.6 trillion, we end up with an upper bound on the U.S. fiscal capacity of around $10 trillion. The projected convenience yield seigniorage revenue earned by the Treasury between 2022 and 2051 adds another $ 3.66 trillion in fiscal capacity. Our final estimate for the upper bound on fiscal capacity is around $13.7 trillion in 2021, or 60% of 2021 GDP, well short of the actual $23.5 trillion value of all U.S. Treasurys outstanding. In spite of the current low rates, we find that the U.S. fiscal capacity is quite limited, and we conclude that the governments interest rate cost is not a sufficient statistic for fiscal capacity.

Three caveats are in order. First, these estimates put an upper bound on fiscal capacity. Second, our estimates of fiscal capacity assume major structural adjustment after 2051, an adjustment unlike any other in U.S. history. Third, we assume that seigniorage revenue is a constant fraction of GDP, meaning that safe asset demand is downward sloping. We discuss each of these assumptions in detail below.

Because of the backloading of projected surpluses in the baseline scenario, the duration of a claim to the projected surpluses exceeds 50 years.[1] This creates a duration mismatch between the Treasury's cash inflows and its cash outflows. When rates increase, U.S. fiscal capacity decreases dramatically, but the value of its outstanding debt does not, because the duration of its debt is much shorter (around 5 yrs in 2021) than the duration of its surpluses. As a result, a rate increase will require large fiscal adjustments: A 100 bps. increase in yields, holding constant nominal GDP growth and projected primary surpluses until 2051, will require a permanent increase in surpluses of more than 2.9% of GDP in 2052.

From an optimal maturity perspective, the Treasury should either front-load surpluses and/or increase the maturity of its outstanding debt to avoid costly variation in tax rates. In order to eliminate the duration mismatch completely, we find that the Treasury would have to front-load by increasing the primary surplus by 7% of GDP each year between 2022 and 2051 relative to the CBO's baseline projections.

As in any valuation exercise, our final estimate of fiscal capacity depends on the cash flow projections, including the seigniorage revenue earned on Treasurys, and the discount rate assumptions. Both are subject to considerable uncertainty. First, our measurement of fiscal capacity relies on CBO projections of future deficits and forecasts inflation. These budget projections are not forecasts. To be concrete, Congress can pass new legislation in order to increase tax revenue and decrease spending. The CBO does not try to forecast these fiscal policy adjustments. As shown by Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2021), these projections have turned out to systematically overstate realized surpluses by a large margin over the past two decades, not only during but even after the GFC. Should this overstatement continue, it would render our fiscal capacity estimates overly generous. Even taking CBO projections at face value, our estimates of fiscal capacity suggest that large fiscal corrections are anticipated by U.S. Treasury markets.

Second, our measurement of fiscal capacity relies on the discount rates. We use the discount rates on a claim to GDP, or equivalently, the expected return on the unlevered market portfolio, to derive an upper bound on fiscal capacity. The estimate is sensitive to the discount rate. As we

[1]Our estimate of fiscal capacity is sensitive to interest rates, and is boosted by the effect of the Fed's large scale asset purchases on the long end of the yield curve.

explain, choosing a lower discount rate results in higher estimates of fiscal capacity, but it also increases the sensitivity of fiscal capacity to interest rate rate changes, and worsens the duration mismatch. While the literature has argued that low interest rates increase fiscal capacity, the impact of low rates on duration mismatch has not been discussed (Blanchard, 2019; Furman and Summers, 2020; Andolfatto, 2020).

Importantly, our approach uses standard textbook finance to price long-lived assets. We show that the PDV of future debt is well-behaved when using the proper discount rate.[2] In our approach, the government can earn extra convenience yields on U.S. Treasurys. We note that other corporate U.S. issuers can earn similar convenience yields.

The market may anticipate a switch from a counter-cyclical fiscal policy regime to a pro-cyclical fiscal policy regime. This would lower the discount rate on the tax revenue claim, and increase the discount rate on the spending claim. Section 5 explores the impact of a switch from a counter-cyclical to a pro-cyclical fiscal policy regime on fiscal capacity. This change is the most potent way of boosting fiscal capacity, but arguably also the most painful and hence least realistic one.

We develop intuition for these quantitative estimates by examining the steady-state in which the surplus is constant, and the economy is growing at a constant rate. In the steady state, fiscal capacity equals the price/dividend ratio on the total wealth portfolio multiplied by the steady-state surplus. We estimate the price/dividend ratio for the total wealth portfolio of 65 at the end of 2021. To get an upper bound on the fiscal capacity of 102% of GDP in 2022, the size of the debt/GDP ratio at the end of 2021, the U.S. would need a steady-state primary surplus of 1.56% going forward. However, the CBO projects average primary deficits of 3.5% between 2022 and 2051. Hence our conclusion that the market seems to forecast a large fiscal correction before 2051, either because it believes the CBO projections are too pessimistic or because of major fiscal adjustments after 2051.

2 Discounted Cash Flow Analysis

2.1 CBO Projections

We start from the CBO's long-term budget projections for the U.S. federal government. These are projections based on current law. Table 1 lists the CBO's budget projections for 2022-2051 (Congressional Budget Office, 2021a,b). The first column reports government revenue as % of GDP. The second column reports government spending excluding interest as % of GDP. These

[2] In OLG models, there are no long-lived investors to enforce transversality conditions for long-lived assets. In these models, violations of transversality can be engineered. Typically, these violations would also appear in other long-lived assets, such as stocks. Institutional investors with a long horizon such as endowments, pension funds, sovereign wealth funds, are active investors in U.S. Treasury markets.

numbers are taken from the latest CBO long-term budget projections published in July of 2021. The third column reports the projected primary surplus as % of GDP, given by column (1) minus column (2). The U.S. federal government is projected to run large and growing primary deficits until the end of the projection window in 2051.[3]

Column (4) reports nominal GDP projections. For 2021 to 2031, we use projections from the July 2021 CBO report.[4] After that, we use the projected real GDP growth rate and the long-run projected rate of inflation.[5] We then compute the dollar numbers for projected nominal tax revenue and spending in columns (5) and (6).

2.2 Valuation and Discount Rates

These projections for $ spending and tax revenue are point estimates. The underlying cash flows are risky and cannot be discounted off the Treasury yield curve. As in any valuation, the proper discount rate is determined by the riskiness of the cash flows. To develop some intuition, consider the simplest case in which government spending and tax revenue are a constant fraction of output. Then these claims are as risky as a claim to GDP, the total wealth or market portfolio (Jensen, 1972; Roll, 1977; Stambaugh, 1982; Lustig, Van Nieuwerburgh, and Verdelhan, 2013). The return on the total wealth portfolio plays a central role in the canonical asset pricing models ranging from the Sharpe-Lintner CAPM to the version of the Breeden-Lucas-Rubenstein Consumption-CAPM with long run risks developed by Bansal and Yaron (2004).

In the data, the tax revenue claim is riskier than the GDP claim, and the spending claim is safer than the GDP claim. In the short run, the tax (spending) claim is exposed to more (less) business cycle risk. Tax revenue declines as a fraction of GDP in recessions, while government spending increases as a fraction of GDP (Jiang et al., 2019). In the long run, spending and taxes are both co-integrated with output, and hence exposed to long-run output risk.

Assumption 1. Government taxes, spending and the value of debt are co-integrated with output.

Cointegration is a necessary condition for fiscal sustainability. When fiscal policy is sustainable, then taxes, spending, debt and output are cointegrated with output. As a result, combining the short-run and long-run properties, the tax claim is riskier than the spending claim. [6]

[3] Jiang et al. (2021) document that CBO projections have been too optimistic over the past two decades, even well after the Great Financial Crisis, projecting mean reversion in deficits that failed to materialize.

[4] The CBO provides a supplement to the July 2021 fiscal projection report called "An Update to the Budget and Economic Outlook: 2021 to 2031."

[5] Projections from the figures in CBO's March 2021 report "The 2021 Long-Term Budget Outlook."

[6] As explained by Jiang et al. (2019), this rules out that the entire debt portfolio has zero or negative beta. Generating zero-beta debt can only be achieved if the beta of the tax claim is lower than the beta of the spending claim, i.e. by rendering the tax claim less risky than the spending claim. There is no empirical evidence to support this. In addition,

Table 1: CBO Projections of Government Cash Flows and Discounting.

Based on CBO projections released in July of 2021. Column (8) reports the discount rates used for spending and tax cash flows in that year. (4), (5), (6) and (11) in $ billions. Column (9) reports an upper bound on the PDV of projected primary surpluses in 2021 $ billions .

year	T/Y	G /Y	(T-G) /Y	Y	T	G	$y_j^{\$}$	$r_j^{\$,y}$	PV(T-G)	D/Y	D
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
2022	17.3%	20.7%	-3.4%	$ 24,638	$ 4,264	$ 5,090	1.10%	3.70%	$ (796.65)	102.0	$ 25,127
2023	17.5%	20.3%	-2.8%	$ 25,565	$ 4,464	$ 5,191	1.52%	4.12%	$ (670.47)	102.0	$ 26,075
2024	17.3%	19.8%	-2.5%	$ 26,405	$ 4,574	$ 5,226	1.71%	4.31%	$ (575.18)	101.4	$ 26,784
2025	17.2%	20.0%	-2.8%	$ 27,310	$ 4,689	$ 5,449	1.79%	4.39%	$ (640.22)	101.2	$ 27,633
2026	17.6%	20.0%	-2.4%	$ 28,291	$ 4,982	$ 5,668	1.84%	4.44%	$ (552.89)	100.9	$ 28,537
2027	17.9%	20.1%	-2.2%	$ 29,374	$ 5,267	$ 5,901	1.87%	4.47%	$ (487.64)	101.0	$ 29,660
2028	17.8%	20.6%	-2.8%	$ 30,471	$ 5,414	$ 6,278	1.90%	4.50%	$ (634.81)	102.2	$ 31,148
2029	17.7%	20.1%	-2.4%	$ 31,587	$ 5,578	$ 6,351	1.93%	4.53%	$ (541.94)	103.2	$ 32,588
2030	17.6%	20.6%	-3.0%	$ 32,746	$ 5,752	$ 6,738	1.97%	4.57%	$ (659.37)	105.0	$ 34,376
2031	17.5%	20.8%	-3.3%	$ 33,984	$ 5,955	$ 7,073	2.01%	4.61%	$ (712.74)	107.2	$ 36,430
2032	17.5%	21.0%	-3.5%	$ 35,207	$ 6,176	$ 7,391	2.04%	4.64%	$ (737.96)	109.8	$ 38,649
2033	17.6%	21.1%	-3.6%	$ 36,475	$ 6,403	$ 7,704	2.08%	4.68%	$ (751.14)	112.7	$ 41,095
2034	17.6%	21.3%	-3.7%	$ 37,788	$ 6,646	$ 8,034	2.11%	4.71%	$ (763.02)	115.9	$ 43,792
2035	17.6%	21.4%	-3.8%	$ 39,148	$ 6,901	$ 8,374	2.15%	4.75%	$ (769.59)	119.4	$ 46,735
2036	17.7%	21.5%	-3.9%	$ 40,557	$ 7,167	$ 8,731	2.18%	4.78%	$ (776.95)	123.1	$ 49,927
2037	17.7%	21.6%	-3.9%	$ 42,018	$ 7,448	$ 9,091	2.21%	4.81%	$ (775.41)	127.0	$ 53,346
2038	17.8%	21.8%	-4.0%	$ 43,530	$ 7,736	$ 9,485	2.23%	4.83%	$ (784.15)	131.1	$ 57,052
2039	17.8%	21.9%	-4.1%	$ 45,097	$ 8,036	$ 9,880	2.26%	4.86%	$ (785.60)	135.4	$ 61,049
2040	17.9%	22.0%	-4.2%	$ 46,721	$ 8,348	$ 10,291	2.28%	4.88%	$ (786.35)	139.9	$ 65,349
2041	17.9%	22.2%	-4.3%	$ 48,403	$ 8,674	$ 10,732	2.30%	4.90%	$ (790.75)	144.6	$ 69,995
2042	18.0%	22.3%	-4.3%	$ 50,097	$ 9,007	$ 11,168	2.32%	4.92%	$ (788.89)	149.5	$ 74,916
2043	18.0%	22.4%	-4.4%	$ 51,850	$ 9,356	$ 11,620	2.33%	4.93%	$ (784.85)	154.7	$ 80,190
2044	18.1%	22.5%	-4.4%	$ 53,665	$ 9,708	$ 12,082	2.35%	4.95%	$ (781.60)	159.9	$ 85,833
2045	18.1%	22.6%	-4.5%	$ 55,543	$ 10,078	$ 12,558	2.36%	4.96%	$ (775.61)	165.4	$ 91,868
2046	18.2%	22.7%	-4.5%	$ 57,487	$ 10,465	$ 13,051	2.38%	4.98%	$ (768.21)	171.0	$ 98,312
2047	18.3%	22.8%	-4.5%	$ 59,499	$ 10,869	$ 13,559	2.39%	4.99%	$ (758.67)	176.8	$ 105,192
2048	18.3%	22.9%	-4.6%	$ 61,582	$ 11,293	$ 14,107	2.40%	5.00%	$ (753.85)	182.8	$ 112,555
2049	18.4%	23.0%	-4.6%	$ 63,737	$ 11,719	$ 14,649	2.41%	5.01%	$ (745.71)	188.9	$ 120,426
2050	18.4%	23.1%	-4.6%	$ 65,968	$ 12,168	$ 15,214	2.42%	5.02%	$ (736.04)	195.3	$ 128,864
2051	18.5%	23.2%	-4.6%	$ 68,277	$ 12,641	$ 15,815	2.43%	5.03%	$ (728.36)	202.0	$ 137,927
Total PV									$(21,614)		$31,656

Assumption 2. The discount rate for projected tax cash flows is higher than the discount rate for projected spending cash flows: $\mathbb{E}[r^T] > \mathbb{E}[r^y] > \mathbb{E}[r^G]$.

As an alternative to a fully specified asset pricing model to infer the right discount rate, Jiang et al. (2019) propose to derive an upper bound on the U.S. fiscal capacity by discounting future spending and tax revenue at the same discount rate: the expected return on a claim to GDP, roughly equivalent to the total wealth portfolio.

When the transversality condition is satisfied, the no-arbitrage value of debt equals the PDV of tax revenue minus the PDV of spending:

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

By using the same discount rate for the tax and spending claims, we maximize the value of the tax claim, and we minimize the value of the spending claim, thus deriving an upper bound on the fiscal capacity. We return to the transversality condition below. Our measure of the upper bound on fiscal capacity is the properly discounted value of projected surpluses, as well the discounted value of future debt outstanding at the end of the projection period in 2051.

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2051}) + PV_{2021}^{upper}(D_{2051}).$$

We use the discount rate on a claim to GDP, or, equivalently, a claim to unlevered equity to discount the government spending and tax revenue cash flows. We begin by constructing a measure of the expected return on (levered) equity and then unlever this expected return. We infer the expected return on a claim to equity from valuations in asset markets. We compute an expected real excess return of equities of 5.1%. This forward-looking estimate of the real return on equities combines an earnings-based and a dividend yield-based estimate.[7] In 2022, the earnings-based estimate for the expected real return on U.S. stocks is given by the payout ratio times the earnings/price ratio plus the projected growth rate of earnings:

$$E[r^{equity}] = D/E \times E/P + g_{EPS} = 0.5 \times 2.8\% + 1.5\% = 2.9\%.$$

We use the inverse of Shiller's CAPE ratio to measure the E/P ratio. We use a dividend-payout ratio of 0.5. In 2022, the payout-based estimate for the real expected return on U.S. stocks is given by:

$$E[r^{equity}] = D/P + NBY + g_{PAGG} = 1.3\% + 0.2\% + 2.7\% = 4.2\%,$$

ss explained by Jiang et al. (2019), persistent deficits are non consistent with risk-free debt when the debt/output policy is mean reverting.

[7] We adopt the approach developed by AQR for its capital market assumptions (see *The Portfolio Solutions Group, AQR*, 2022, for details).

where D/P is the dividend yield on the S&P 500, NBY is the net buyback yield and g_{PAGG} is a forecast of aggregate U.S. earnings growth. We combine these two estimates with equal weights to obtain a blended real expected return of 3.6%. The real risk-free return is estimated to be -1.5%. As a result, we obtain an estimate of 5.1% in excess of the risk-free rate.[8] Importantly, this U.S. multiple is high and expected returns are low compared to other advanced countries.

The debt/equity ratio for the U.S. non-financial corporate sector in 2022 is roughly 1/2. As a result, we obtain an unlevered equity premium of 3.4%, from the levered equity premium of 5.1%. We also compute an expected excess return of long-term bonds over cash of 0.8%. This means that unlevered equities earn a risk premium rp^y of 2.6% over bonds. This is our measure of the GDP risk premium, or the unlevered equity risk premium.

To construct the discount rates for discounting tax revenue and spending claims, we start from the nominal zero-coupon bond yield curve at the end of 2021 for maturities from one to thirty years, constructed and updated by Refet S. Gurkaynak, Brian Sack, and Jonathan H. Wright (2006), and then add the unlevered equity risk premium or the market risk premium.

2.3 Steady-State Fiscal Capacity

We start by estimating a measure of steady-state fiscal capacity. In the steady-state, the government runs a constant primary surplus. Given that the tax claim is riskier than the spending claim, an upper bound on the steady-state fiscal capacity is given by the price/dividend ratio on a claim to GDP times the steady-state surplus. We use the 30-year zero coupon yield to proxy for the long end of the Treasury yield curve, and use the CBO's long-run forecast for real growth of 1.5% and inflation of 2%. The long discount rate minus the growth rate is given by:

$$r^{\$,y} - g = y^{30}_{2022} + rp^y - g = 2.43\% + 2.60\% - 3.50\% = 1.53\%,$$

In the steady-state, the valuation of future surpluses is given the price/dividend ratio on a claim to GDP times the steady-state surplus:

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

We can use Gordon's growth formula to compute the multiple on the claim to GDP:

$$pd^y = \frac{1}{r^{\$,y} - g} = \frac{1}{1.53\%} = 65.$$

[8] We could also construct the term structure of equity risk premia from futures to develop more precise estimates of the appropriate discount rates at different horizons (Binsbergen, Brandt, and Koijen, 2012).

The multiple on a claim to GDP is 65. As a result, the U.S. gets an additional 65% of GDP in fiscal capacity (maximum) per 1% of steady-state primary surplus $\frac{S}{Y}$. This multiple is high because valuations in equity markets are high as well. As a result, our calculation produces high estimates of fiscal capacity, holding fixed the projected deficits. We need a steady-state surplus of about 1.56% of 2021 GDP to get to an upper bound that includes the projected debt/GDP ratio for 2022: $65 \times 1.56\% = 102\%$ of projected GDP in 2021.

Column (3) in Table 1 reports the projected primary deficits. The CBO projects average deficit of 3.7% of U.S. GDP between 2022 and 2051. One would need a permanent U.S. fiscal correction of 5.26% of GDP (from -3.7 to 1.56%) to reconcile this back-of-the-envelope upper bound with the actual value of U.S. Treasurys.

2.4 CBO Cash Flow, Debt Projections and Discounted Cash Flow Analysis

Next, we carry out our main, more detailed analysis. For each CBO projected cash flow in columns (5) and (6), we use the discount rate $r_j^{\$,y}$, shown in column (8), that is equal to the nominal zero coupon yield for that maturity plus the unlevered equity risk premium over bonds $rp^y = 2.6\%$. The sum of the PDV of the tax revenue minus spending cash flows from 2022-2051 adds up to minus \$21.6 trillion dollars:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2051}) = \sum_{j=1}^{30} \frac{T_{2021+j} - G_{2021+j}}{(1+r_j^{\$,y})^j} = \$(21,614).$$

This is the sum of column (9) starting with \$bn. (796) , the deficit in 2022 ,. . ., including \$ bn. (728), the PDV of the 2051 deficit.

The CBO also publishes interest rate projections, which in turn can be combined with the projected deficits, to generate debt projections. These are reported in column (10) of Table 1. According to the CBO debt projections, the debt outstanding will equal 202% of U.S. GDP in 2051. This would amount to approximately \$138 trillion in nominal debt.

What do we need to assume about surpluses starting in 2052 to justify this number as the present-discounted value of future primary surpluses (after 2051)? Recall that the multiple on a claim to GDP in 2022 is 65. It seems reasonable to use this same multiple in 2051. To obtain a valuation of the debt outstanding in 2051 equal to 200% of GDP, the U.S. federal government would need to generate a steady-state surplus of 3.1% after 2051.[9] Figure 1 plots the time path of projected primary surpluses; the red line is the baseline case. After 2052, the primary surplus is

[9]The multiple in 2021 is high relative to its historical mean, and is likely to revert back to its long-run mean. The conservative approach would be to use the historical average multiple. This would result in a higher required annual average primary surplus after 2051 to justify the same debt/output ratio in 2051. This does not affect the present value of debt in 2051, only the required surpluses to repay this debt.

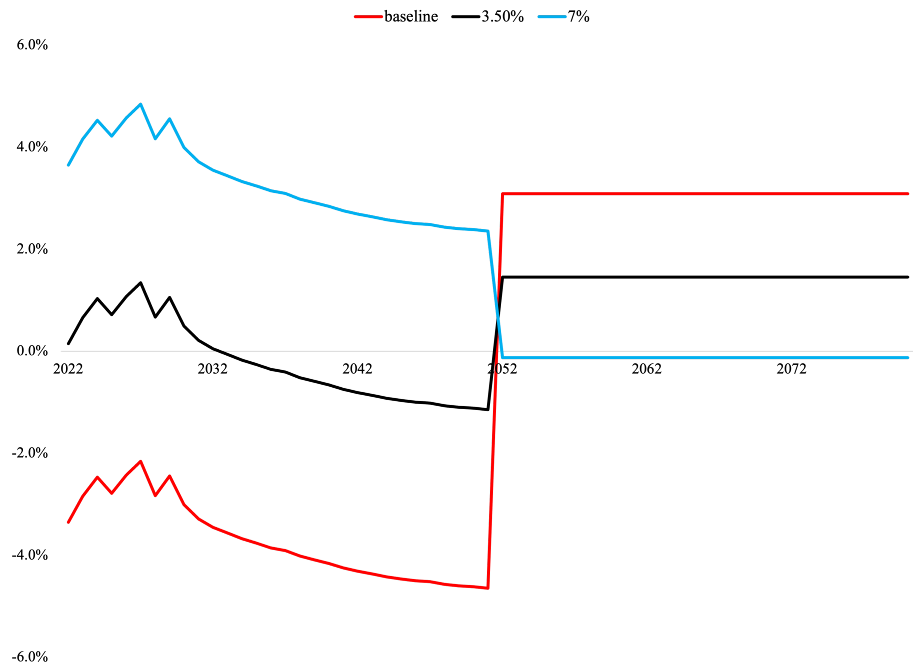

Figure 1: CBO Baseline Projections of Primary Surplus (baseline in red, baseline +3.5% in black and baseline +7% in blue) between 2022 and 2051. Starting in 2052, steady-state surplus is chosen to match debt/GDP ratio in 2052.

assumed to be equal to 3.1%, the surplus needed to enforce the intertemporal budget constraint.

We take this number at face value. This debt outstanding in 2051, projected to be $138 trillion, also needs to be discounted using the same discount rate used for the spending and tax revenue cash flows, even if the debt is risk-free: The valuation of debt is co-integrated with GDP. Discounted back to 2021, the PDV of D_{2051} is $31.7 trillion.

$$PV_{2021}^{upper}(D_{2051}) = \frac{D_{2051}}{(1 + r_{30}^{\$,y})^{2051-2021}} = \$31,656.$$

When we add up the properly discounted value of debt outstanding in 2051 and the surpluses between 2022 and 2051, we obtain a total value of $ 10.04 trillion, well short of the actual valuation of debt in 2021 of $23.5 trillion:

$$PV_{2021}^{upper}(\{T - G\}_{2022}^{2051}) + PV_{2021}^{upper}(D_{2051}) = \$(21,614) + \$31,656 = \$10,041$$

Our upper bound cannot be reconciled with the actual valuation of debt given these baseline CBO projections, even if we assume that the U.S. will generate primary surpluses after 2051 that are large enough to rationalize the projected value of outstanding debt. Our baseline upper bound on fiscal capacity falls short of the actual debt valuation by about $13.5 trillion.

2.5 Discounting Future Debt

The right discount rate for debt outstanding far in the future includes a GDP risk premium when output and debt are cointegrated (see Jiang, Lustig, Van Nieuwerburgh, and Xiaolan, 2020, for a detailed derivation).[10] Even when the debt is risk-free or has zero beta, if the debt/output ratio is stationary, the necessary condition for the TVC to be satisfied is $y^{long} + rp^{y} > g + \frac{1}{2}\sigma^2$, where σ is the volatility of output growth (Jiang et al., 2020). In our calculation, we use 2.43% for the long yield, 2.60% for the GDP risk premium and 3.50% for the long run-growth rate g. Importantly, this is the right discount rate, regardless of the short-term debt/output, tax and spending dynamics, even when the debt has zero beta.

If we had used the risk-free yield curve, without adding the GDP or market risk premium, when discounting, then the discounted value of future debt in 2051 would have been \$68 trillion in 2021 dollars. We would have obtained a fiscal capacity estimate of \$39 trillion at the end of 2021. The federal government's debt is projected to grow faster than output, and the discount rate (2.43%) is lower than the growth rate of output 3.50%. This is essentially the $y < g$ approach to fiscal sustainability pursued by Blanchard (2019) and others. As one pushes the final period T further out, the present value of debt outstanding at T does not converge to zero. However, from a standard finance perspective, the $y < g$ argument is flawed, unless the output risk premium is zero. Future debt outstanding cannot be discounted using the risk-free yield curve unless the future debt's valuation is known today, or if this valuation was insensitive to the growth of output.[11] This cannot be the case when debt and output are co-integrated, a necessary condition for fiscal sustainability (see Assumption 1), even if debt is risk-free or zero-beta. As a result, discounting future debt at the risk-free rate is not consistent with fiscal sustainability. When discounted at the right discount rates, including the market or GDP risk premium, the value of future debt is much smaller, and the fiscal capacity does not increase if we push T out further into the future. Debt cannot be rolled over indefinitely, even though the risk-free rate is lower than the growth rate.

Suppose we took the counterfactual view that the entire debt portfolio really has zero beta, because the tax claim is less risky than the spending claim. Then, we can discount the projected surpluses until 2051 off the risk-free yield curve, but we still need to discount the future debt at the proper discount rate, which includes the DDP risk premium:

$$PV_{2021}^{upper}(D_{2051}) = \frac{D_{2051}}{(1 + r_{30}^{\$,y})^{2051-2021}} = \$(33,830) + \$33,247 = \$(582)$$

[10] See also work by van Wijnbergen, Olijslagers, and de Vette (2020); Barro (2020) on the same topic.

[11] Recently, Brunnermeier, Merkel, and Sannikov (2022) have argued that the government can engineer violations of transversality conditions by providing safe assets that serve uniquely as insurance against idiosyncratic risk. Our calculations do not allow for this.

We end up with negative fiscal capacity, because the projected deficits now increase in present value.

2.6 Duration

The fiscal capacity calculation is sensitive to the yield curve, given the long duration of the surplus claim. To see this, assume a 100 basis points parallel upward shift in the yield curve, holding constant all other parameters, including nominal GDP growth, as shown in column (8) and (9) of Table 2.[12] We also add an additional 100 basis points to the CBO's projected net interest cost as a fraction of debt in each year between 2022 and 2051, as shown in column (4) of Table 2.

The projected debt outstanding in 2051 in this high rate scenario grows from 200 to 240% or a $164 trillion, as shown in column (11) and (12). Because of the rate increase, the steady-state multiple of a claim to GDP has decreased from 65 to 39. Starting in 2051, the U.S. now has to generate a steady-state primary surplus of $6.07\% = \frac{240\%}{39.55}$, an increase of 2.97% of GDP relative to the baseline scenario.[13] Hence, an increase in rates of 100 basis points, holding constant nominal GDP growth, implies a 2.97% of GDP increase in surpluses starting in 2051. The increase in surpluses starting in 2051 divided by the increase in rates is almost 3. This is the signature of the duration mismatch on the Treasury's balance sheet.

This dramatic increase in long-run future surplus is one adjustment mechanism in response to the rate increase. Alternatively, if investors believe the government is unable to generate surpluses of this size, the valuation of the Treasury portfolio has to decline, triggering a sell off and a widening of default spreads.

The duration of the surplus claim is very high in the baseline scenario because the surpluses are extremely backloaded. Accordingly, U.S. fiscal capacity is extremely sensitive to the yield curve. In the baseline scenario, the duration of the surplus claim is 52 years if we model future debt as a fixed bullet payment. However, if we model the part of the surplus claim that starts after 2051 more plausibly as backed by steady primary surpluses that accrue after 2051 (as opposed to as a large bullet payment), the duration surges to 260 years. Figure 2 plots the contribution of each payment at horizon k to the total duration $\frac{k \times PV(S_{2021+k})}{\sum_{j=0} PV(S_{2021+j})}$.

To eliminate duration risk, the Treasury would have to match the duration of its inflows to the duration of its outflows. The duration of the outstanding Treasurys is currently around 5 years as shown in Figure 3. In the baseline scenario, the U.S. Treasury faces an extreme type of duration

[12] Economists have found that large-scale asset purchases by the Federal Reserve have successfully lowered long term yields (Krishnamurthy and Vissing-Jorgensen, 2011; D'Amico, English, López-Salido, and Nelson, 2012; Joyce, Lasaosa, Stevens, and Tong, 2020), with estimates ranging from 50-100bps declines. This implies that in the absence of QE, nominal long-term bond yields would be higher by that amount.

[13] The estimate of the upper bound on fiscal capacity is essentially unchanged at $9.728 trillion, but this assumes a 2.97% additional primary surplus starting in 2052.

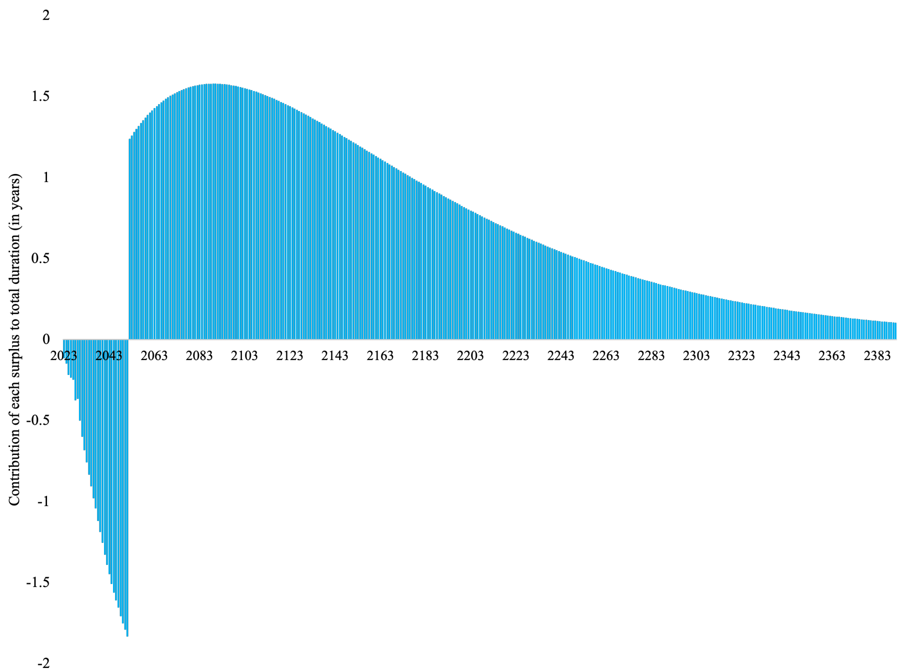

Figure 2: Duration Composition in Baseline Scenario. Contribution of each payment $\frac{k \times PV(S_{2021+k})}{\sum_{j=0} PV(S_{2021+j})}$ to total duration of $\frac{\sum_{k=0} k \times PV(S_{2021+k})}{\sum_{j=1} PV(S_{2021+j})}$ in CBO Baseline Projection. Units in years. The duration is the sum of the plotted contributions.

mismatch between its cash inflows (the surpluses) and cash outflows (the principal and coupon payments), a direct result of the backloading of surpluses. This creates rollover risk and/or costly variation in future taxes, and suggests that the Treasury should shift towards longer-maturity debt (Bhandari, Evans, Golosov, Sargent et al., 2017).

In order to be fully hedged against interest rate risk, the Treasury should match the projected surplus (cash inflows) in each period to the coupon and principal payments (cash outflows), much like what a pension fund would typically try to do. To a first order, this requires matching the duration of the Treasury portfolio to the duration of the projected surpluses. In an optimal taxation framework, Bhandari et al. (2017) show that the Ramsey planner wants to approximately match the duration of the projected surpluses, conditional on current tax rates, to the duration of the Treasury portfolio.

3 Adding Seigniorage from Convenience Yields

Our benchmark analysis abstracted from any convenience yields the Treasury earns on its sales of Treasurys. Jiang et al. (2019) estimate that the U.S. earns around 60 bps. per annum in convenience

Table 2: CBO Projections of Government Cash Flows and Discounting in Rate Increase Scenario.

Based on CBO projections . Column (8) reports the discount rates used for spending and tax cash flows in that year –100 bps increase relative to basesline. Column (4) reports projected the CBO's Net Interest Cost over Debt +100 bps. (5), (6), (7) and (12) in $ billions. Column (10) reports an upper bound on the PDV of projected primary surpluses in 2021 $ billions . Column (12) reports the Debt dynamics: $D_{t+1} = D_t \times R_{t+1} + (T_{t+1} - G_{t+1})$. R_{t+1} is taken from Column (4).

year	T/Y	G /Y	(T-G) /Y	NI/D	Y	T	G	$y_j^{\$}$	$r_j^{\$,y}$	PV(T-G)	D/Y	D
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2022	17.3%	20.7%	-3.4%	2.2%	$ 24,638	$ 4,264	$ 5,090	2.1%	4.7%	$ (789.0)	102.0	$ 25,127
2023	17.5%	20.3%	-2.8%	2.1%	$ 25,565	$ 4,464	$ 5,191	2.5%	5.1%	$ (657.8)	103.2	$ 26,391
2024	17.3%	19.8%	-2.5%	2.1%	$ 26,405	$ 4,574	$ 5,226	2.7%	5.3%	$ (559.0)	104.5	$ 27,600
2025	17.2%	20.0%	-2.8%	2.2%	$ 27,310	$ 4,689	$ 5,449	2.8%	5.4%	$ (616.3)	106.0	$ 28,954
2026	17.6%	20.0%	-2.4%	2.3%	$ 28,291	$ 4,982	$ 5,668	2.8%	5.4%	$ (527.2)	107.1	$ 30,308
2027	17.9%	20.1%	-2.2%	2.5%	$ 29,374	$ 5,267	$ 5,901	2.9%	5.5%	$ (460.5)	107.9	$ 31,705
2028	17.8%	20.6%	-2.8%	2.7%	$ 30,471	$ 5,414	$ 6,278	2.9%	5.5%	$ (593.9)	109.7	$ 33,435
2029	17.7%	20.1%	-2.4%	2.9%	$ 31,587	$ 5,578	$ 6,351	2.9%	5.5%	$ (502.2)	111.4	$ 35,179
2030	17.6%	20.6%	-3.0%	3.1%	$ 32,746	$ 5,752	$ 6,738	3.0%	5.6%	$ (605.2)	113.8	$ 37,263
2031	17.5%	20.8%	-3.3%	3.3%	$ 33,984	$ 5,955	$ 7,073	3.0%	5.6%	$ (648.1)	116.6	$ 39,615
2032	17.5%	21.0%	-3.5%	3.6%	$ 35,207	$ 6,176	$ 7,391	3.0%	5.6%	$ (664.7)	120.0	$ 42,243
2033	17.6%	21.1%	-3.6%	3.8%	$ 36,475	$ 6,403	$ 7,704	3.1%	5.7%	$ (670.1)	123.8	$ 45,148
2034	17.6%	21.3%	-3.7%	4.0%	$ 37,788	$ 6,646	$ 8,034	3.1%	5.7%	$ (674.3)	128.0	$ 48,354
2035	17.6%	21.4%	-3.8%	4.2%	$ 39,148	$ 6,901	$ 8,374	3.1%	5.7%	$ (673.7)	132.5	$ 51,867
2036	17.7%	21.5%	-3.9%	4.3%	$ 40,557	$ 7,167	$ 8,731	3.2%	5.8%	$ (673.8)	137.3	$ 55,682
2037	17.7%	21.6%	-3.9%	4.4%	$ 42,018	$ 7,448	$ 9,091	3.2%	5.8%	$ (666.1)	142.3	$ 59,781
2038	17.8%	21.8%	-4.0%	4.5%	$ 43,530	$ 7,736	$ 9,485	3.2%	5.8%	$ (667.3)	147.5	$ 64,210
2039	17.8%	21.9%	-4.1%	4.6%	$ 45,097	$ 8,036	$ 9,880	3.3%	5.9%	$ (662.2)	153.0	$ 68,980
2040	17.9%	22.0%	-4.2%	4.6%	$ 46,721	$ 8,348	$ 10,291	3.3%	5.9%	$ (656.6)	158.6	$ 74,116
2041	17.9%	22.2%	-4.3%	4.7%	$ 48,403	$ 8,674	$ 10,732	3.3%	5.9%	$ (654.1)	164.6	$ 79,659
2042	18.0%	22.3%	-4.3%	4.8%	$ 50,097	$ 9,007	$ 11,168	3.3%	5.9%	$ (646.4)	170.9	$ 85,623
2043	18.0%	22.4%	-4.4%	4.8%	$ 51,850	$ 9,356	$ 11,620	3.3%	5.9%	$ (637.0)	177.5	$ 92,037
2044	18.1%	22.5%	-4.4%	4.9%	$ 53,665	$ 9,708	$ 12,082	3.3%	5.9%	$ (628.4)	184.4	$ 98,938
2045	18.1%	22.6%	-4.5%	5.0%	$ 55,543	$ 10,078	$ 12,558	3.4%	6.0%	$ (617.7)	191.5	$ 106,356
2046	18.2%	22.7%	-4.5%	5.1%	$ 57,487	$ 10,465	$ 13,051	3.4%	6.0%	$ (606.1)	198.9	$ 114,326
2047	18.3%	22.8%	-4.5%	5.1%	$ 59,499	$ 10,869	$ 13,559	3.4%	6.0%	$ (592.9)	206.5	$ 122,885
2048	18.3%	22.9%	-4.6%	5.2%	$ 61,582	$ 11,293	$ 14,107	3.4%	6.0%	$ (583.6)	214.5	$ 132,094
2049	18.4%	23.0%	-4.6%	5.3%	$ 63,737	$ 11,719	$ 14,649	3.4%	6.0%	$ (571.9)	222.8	$ 141,996
2050	18.4%	23.1%	-4.6%	5.4%	$ 65,968	$ 12,168	$ 15,214	3.4%	6.0%	$ (559.2)	231.4	$ 152,639
2051	18.5%	23.2%	-4.6%	5.4%	$ 68,277	$ 12,641	$ 15,815	3.4%	6.0%	$ (548.13)	240.3	$ 164,090
Total PV										$(18,614)		$28,342

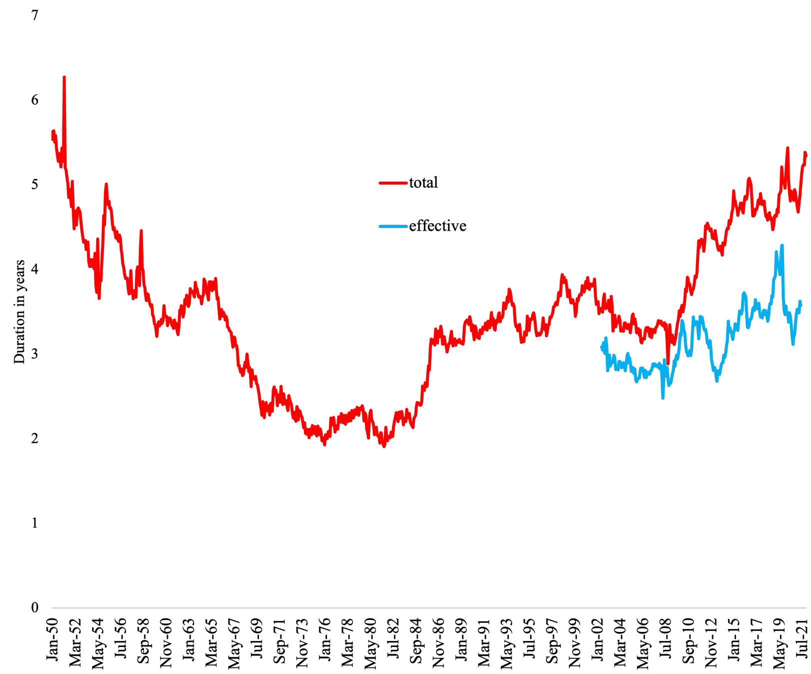

Figure 3: Duration of Treasurys help by the public. Data from CRSP Treasurys.

yields on the entire U.S. Treasury portfolio.[14]

The U.S. has a current debt/output ratio of 102% at the end of 2021. The average convenience yield is 60 bps per annum. Each year, the Treasury collects $0.60\% \times 102\% = 0.61\%$ of GDP in convenience-yield revenues. We assume that this revenue source is a constant fraction of GDP.

Assumption 3. The seigniorage revenue on Treasurys is a constant fraction of GDP.

This assumption of a constant seigniorage/GDP ratio implies that convenience yields decline as the debt/output ratio climbs to 200% of GDP in 2051. Krishnamurthy and Vissing-Jorgensen (2012) provide evidence on downward-sloping demand curves for safe assets.[15]

Table 3 reports the detailed calculations that account for convenience yields. Column (10) reports the seigniorage revenue in billions of dollars equal to 0.61% of GDP. Column (11) then discounts the seigniorage revenue back to 2022 dollars.[16] The sum of all this discounted seignior-

[14] Recently, Reis (2021) has convincingly argued that convenience yields on U.S. Treasurys could be much larger. While convenience yields generate an additional source of revenue, there may be an off-setting discount rate effect, since convenience yields raise the true discount rates (Jiang et al., 2019). In our analysis, we kept the discount rates constant when introducing convenience yields by assuming that the decline in the risk premium exactly offsets the increase in the true risk-free yield. Jiang et al. (2019) refer to this as a narrow convenience yield which does not accrue to asset classes other than Treasurys.

[15] In preference terms, if investors had utility defined over consumption and safe asset services, a constant expenditure share corresponds to an elasticity of substitution of one for the services provided by safe assets. The expenditure share accounted for by convenience yields is constant.

[16] We keep the discount rate unchanged, assuming that the true Treasury yield curve shifts up by 60 bps. per annum, but the risk premium declines by 60 bps.

Table 3: CBO Projections of Government Cash Flows and Discounting with Convenience Yields.

Based on CBO projections released in July of 2021. (3), (4), (5) and (10) in $ billions. Column (10) reports an estimate of the seigniorage revenue collected by the Treasury. We use a convenience yield of 60 bps. per annum. PDV of projected surpluses (8) and seigniorage (11) measured at the end of 2021.

year	T/Y	G /Y	Y	T	G	$y_j^{\$}$	$r_j^{\$,y}$	PV(T-G)	D/Y	CS	PV(CS)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
2022	17%	21%	$ 24,638	$ 4,264	$ 5,090	1.10%	3.70%	$ (797)	102	$ 151	$ 146
2023	17%	20%	$ 25,565	$ 4,464	$ 5,191	1.52%	4.12%	$ (670)	102	$ 157	$ 145
2024	17%	20%	$ 26,405	$ 4,574	$ 5,226	1.71%	4.31%	$ (575)	101	$ 162	$ 143
2025	17%	20%	$ 27,310	$ 4,689	$ 5,449	1.79%	4.39%	$ (640)	101	$ 168	$ 141
2026	18%	20%	$ 28,291	$ 4,982	$ 5,668	1.84%	4.44%	$ (553)	101	$ 174	$ 140
2027	18%	20%	$ 29,374	$ 5,267	$ 5,901	1.87%	4.47%	$ (488)	101	$ 180	$ 139
2028	18%	21%	$ 30,471	$ 5,414	$ 6,278	1.90%	4.50%	$ (635)	102	$ 187	$ 137
2029	18%	20%	$ 31,587	$ 5,578	$ 6,351	1.93%	4.53%	$ (542)	103	$ 194	$ 136
2030	18%	21%	$ 32,746	$ 5,752	$ 6,738	1.97%	4.57%	$ (659)	105	$ 201	$ 134
2031	18%	21%	$ 33,984	$ 5,955	$ 7,073	2.01%	4.61%	$ (713)	107	$ 209	$ 133
2032	18%	21%	$ 35,207	$ 6,176	$ 7,391	2.04%	4.64%	$ (738)	110	$ 216	$ 131
2033	18%	21%	$ 36,475	$ 6,403	$ 7,704	2.08%	4.68%	$ (751)	113	$ 224	$ 129
2034	18%	21%	$ 37,788	$ 6,646	$ 8,034	2.11%	4.71%	$ (763)	116	$ 232	$ 127
2035	18%	21%	$ 39,148	$ 6,901	$ 8,374	2.15%	4.75%	$ (770)	119	$ 240	$ 126
2036	18%	22%	$ 40,557	$ 7,167	$ 8,731	2.18%	4.78%	$ (777)	123	$ 249	$ 124
2037	18%	22%	$ 42,018	$ 7,448	$ 9,091	2.21%	4.81%	$ (775)	127	$ 258	$ 122
2038	18%	22%	$ 43,530	$ 7,736	$ 9,485	2.23%	4.83%	$ (784)	131	$ 267	$ 120
2039	18%	22%	$ 45,097	$ 8,036	$ 9,880	2.26%	4.86%	$ (786)	135	$ 277	$ 118
2040	18%	22%	$ 46,721	$ 8,348	$ 10,291	2.28%	4.88%	$ (786)	140	$ 287	$ 116
2041	18%	22%	$ 48,403	$ 8,674	$ 10,732	2.30%	4.90%	$ (791)	145	$ 297	$ 114
2042	18%	22%	$ 50,097	$ 9,007	$ 11,168	2.32%	4.92%	$ (789)	150	$ 308	$ 112
2043	18%	22%	$ 51,850	$ 9,356	$ 11,620	2.33%	4.93%	$ (785)	155	$ 318	$ 110
2044	18%	23%	$ 53,665	$ 9,708	$ 12,082	2.35%	4.95%	$ (782)	160	$ 329	$ 108
2045	18%	23%	$ 55,543	$ 10,078	$ 12,558	2.36%	4.96%	$ (776)	165	$ 341	$ 107
2046	18%	23%	$ 57,487	$ 10,465	$ 13,051	2.38%	4.98%	$ (768)	171	$ 353	$ 105
2047	18%	23%	$ 59,499	$ 10,869	$ 13,559	2.39%	4.99%	$ (759)	177	$ 365	$ 103
2048	18%	23%	$ 61,582	$ 11,293	$ 14,107	2.40%	5.00%	$ (754)	183	$ 378	$ 101
2049	18%	23%	$ 63,737	$ 11,719	$ 14,649	2.41%	5.01%	$ (746)	189	$ 391	$ 100
2050	18%	23%	$ 65,968	$ 12,168	$ 15,214	2.42%	5.02%	$ (736)	195	$ 405	$ 98
2051	19%	23%	$ 68,277	$ 12,641	$ 15,815	2.43%	5.03%	$ (728)	202	$ 419	$ 96
Total								$ (21,614.62)	$ 31,656.14		$ 3,661.78

age revenue between 2022 and 2051 is $ 3.66 trillion in 2021 dollars. The upper bound is revised upwards to $13.7 trillion:

$$PV_{2021}^{upper}\left(\{T-G\}_{2022}^{2051}\right)+PV_{2021}^{upper}\left(D_{2051}\right)+PV_{2021}^{upper}\left(\{CS\}_{2022}^{2051}\right)=\$10,043+\$3,660=\$13,703.$$

This number is still almost $10 trillion short of the actual valuation of government debt.

Steady-state If you assume that the U.S. collects a constant share of seigniorage revenue in the steady-state, then we need a steady-state surplus of about $2.49\% = 3.1\% - 0.61\%$ of 2051 GDP, not 3.1%, to get to an upper bound that includes the projected debt/GDP ratio for 2051.

4 Front-loaded Fiscal Adjustment

This section implements a counterfactual exercise: How much do CBO primary surplus projections have to rise in order to obtain a fiscal capacity estimate consistent with the 102% debt/output ratio at the end of 2021?

Assumption 4. We assume the surplus changes relative to the CBO baseline do not change the projected growth rate of GDP nor the yield curve.

Figure 4 plots the total fiscal capacity on the y-axis against the increase in the projected surpluses as fraction of GDP between 2022 and 2052.

An increase in the primary surplus by 3.5 percentage points of GDP decreases the PDV of deficits between 2022 and 2051 to $0.7 trillion. This also decreases the value of debt outstanding. In 2051, the projected debt is only 94% of GDP. Discounted back to 2021, that is $ 14.86 trillion. We compute these projected debt dynamics using the new projected primary surpluses and the CBO's interest rate projections: $D_{t+1} = D_t \times R_{t+1} + (T_{t+1} - G_{t+1})$.[17] All of this raises the upper bound on fiscal capacity to $ 14.12 trillion:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2051})+PV_{2021}^{upper}(D_{2051})=\$(740)+\$14,860=\$14,120$$

In this counter-factual exercise, the U.S. Treasury front-loads the fiscal adjustment, compared to the benchmark case in which the U.S. waits until 2051. In this front-loaded case, the U.S. only needs a 1.4% steady-state primary surplus starting in 2051. Figure 1 plots this front-loaded path of surpluses (in black). In this scenario, the duration declines to 100 yrs (from 260).

[17] The CBO reports net interest /GDP projections. We back out an estimate of the effective interest rate on Debt R_t and apply this to the projected debt outstanding.

Table 4: CBO Projections of Government Cash Flows and Discounting in Front-loaded Scenario.

Based on CBO projections +7% of GDP in Primary Surplus. Column (8) reports the discount rates used for spending and tax cash flows in that year. Column (4) reports projected Net Interest Cost over Debt. (5), (6), (7) and (12) in $ billions. Column (10) reports an upper bound on the PDV of projected primary surpluses in 2021 $ billions . Column (12) reports the Debt dynamics: $D_{t+1} = D_t \times R_{t+1} + (T_{t+1} - G_{t+1})$. R_{t+1} is taken from Column (4).

year	T/Y	G /Y	(T-G) /Y	NI/D	Y	T	G	$y_j^{\$}$	$r_j^{\$,y}$	PV(T-G)	D/Y	D
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2021	23.0%	24.9%	-1.9%	1.4%	$ 22,974	$ 5,277	$ 5,716					
2022	24.3%	20.7%	3.6%	1.2%	$ 24,638	$ 5,988	$ 5,090	1.1%	3.7%	$ 866.5	102.0	$ 25,127.4
2023	24.5%	20.3%	4.2%	1.1%	$ 25,565	$ 6,253	$ 5,191	1.5%	4.1%	$ 980.4	95.2	$ 24,349.7
2024	24.3%	19.8%	4.5%	1.1%	$ 26,405	$ 6,422	$ 5,226	1.7%	4.3%	$ 1,053.6	88.7	$ 23,424.1
2025	24.2%	20.0%	4.2%	1.2%	$ 27,310	$ 6,601	$ 5,449	1.8%	4.4%	$ 969.5	82.5	$ 22,542.2
2026	24.6%	20.0%	4.6%	1.3%	$ 28,291	$ 6,962	$ 5,668	1.8%	4.4%	$ 1,041.1	76.1	$ 21,543.1
2027	24.9%	20.1%	4.8%	1.5%	$ 29,374	$ 7,323	$ 5,901	1.9%	4.5%	$ 1,094.1	69.6	$ 20,447.8
2028	24.8%	20.6%	4.2%	1.7%	$ 30,471	$ 7,547	$ 6,278	1.9%	4.5%	$ 932.6	64.1	$ 19,532.4
2029	24.7%	20.1%	4.6%	1.9%	$ 31,587	$ 7,789	$ 6,351	1.9%	4.5%	$ 1,009.0	58.5	$ 18,466.6
2030	24.6%	20.6%	4.0%	2.1%	$ 32,746	$ 8,044	$ 6,738	2.0%	4.6%	$ 874.0	53.6	$ 17,551.6
2031	24.5%	20.8%	3.7%	2.3%	$ 33,984	$ 8,334	$ 7,073	2.0%	4.6%	$ 803.7	49.1	$ 16,696.6
2032	24.5%	21.0%	3.5%	2.6%	$ 35,207	$ 8,640	$ 7,391	2.0%	4.6%	$ 758.0	45.1	$ 15,876.1
2033	24.6%	21.1%	3.4%	2.8%	$ 36,475	$ 8,957	$ 7,704	2.1%	4.7%	$ 723.7	41.3	$ 15,067.4
2034	24.6%	21.3%	3.3%	3.0%	$ 37,788	$ 9,291	$ 8,034	2.1%	4.7%	$ 690.4	37.8	$ 14,266.8
2035	24.6%	21.4%	3.2%	3.2%	$ 39,148	$ 9,641	$ 8,374	2.1%	4.7%	$ 662.0	34.4	$ 13,458.8
2036	24.7%	21.5%	3.1%	3.3%	$ 40,557	$ 10,006	$ 8,731	2.2%	4.8%	$ 632.8	31.2	$ 12,633.8
2037	24.7%	21.6%	3.1%	3.4%	$ 42,018	$ 10,389	$ 9,091	2.2%	4.8%	$ 612.4	28.0	$ 11,766.7
2038	24.8%	21.8%	3.0%	3.5%	$ 43,530	$ 10,783	$ 9,485	2.2%	4.8%	$ 582.0	25.0	$ 10,878.4
2039	24.8%	21.9%	2.9%	3.6%	$ 45,097	$ 11,193	$ 9,880	2.3%	4.9%	$ 558.9	22.1	$ 9,953.0
2040	24.9%	22.0%	2.8%	3.6%	$ 46,721	$ 11,618	$ 10,291	2.3%	4.9%	$ 536.8	19.2	$ 8,987.3
2041	24.9%	22.2%	2.7%	3.7%	$ 48,403	$ 12,062	$ 10,732	2.3%	4.9%	$ 511.4	16.5	$ 7,989.4
2042	25.0%	22.3%	2.7%	3.8%	$ 50,097	$ 12,514	$ 11,168	2.3%	4.9%	$ 491.2	13.9	$ 6,945.4
2043	25.0%	22.4%	2.6%	3.8%	$ 51,850	$ 12,985	$ 11,620	2.3%	4.9%	$ 473.5	11.3	$ 5,846.8
2044	25.1%	22.5%	2.6%	3.9%	$ 53,665	$ 13,465	$ 12,082	2.3%	4.9%	$ 455.4	8.7	$ 4,693.0
2045	25.1%	22.6%	2.5%	4.0%	$ 55,543	$ 13,966	$ 12,558	2.4%	5.0%	$ 440.4	6.3	$ 3,472.3
2046	25.2%	22.7%	2.5%	4.1%	$ 57,487	$ 14,489	$ 13,051	2.4%	5.0%	$ 427.0	3.8	$ 2,175.6
2047	25.3%	22.8%	2.5%	4.1%	$ 59,499	$ 15,034	$ 13,559	2.4%	5.0%	$ 416.3	1.3	$ 789.9
2048	25.3%	22.9%	2.4%	4.2%	$ 61,582	$ 15,604	$ 14,107	2.4%	5.0%	$ 401.1	-1.1	$ (673.9)
2049	25.4%	23.0%	2.4%	4.3%	$ 63,737	$ 16,180	$ 14,649	2.4%	5.0%	$ 389.6	-3.5	$ (2,233.7)
2050	25.4%	23.1%	2.4%	4.4%	$ 65,968	$ 16,786	$ 15,214	2.4%	5.0%	$ 379.9	-5.9	$ (3,902.9)
2051	25.5%	23.2%	2.4%	4.4%	$ 68,277	$ 17,421	$ 15,815	2.4%	5.0%	$ 368.6	-8.3	$ (5,681.4)
Total PV										$20,135		$(1,303)

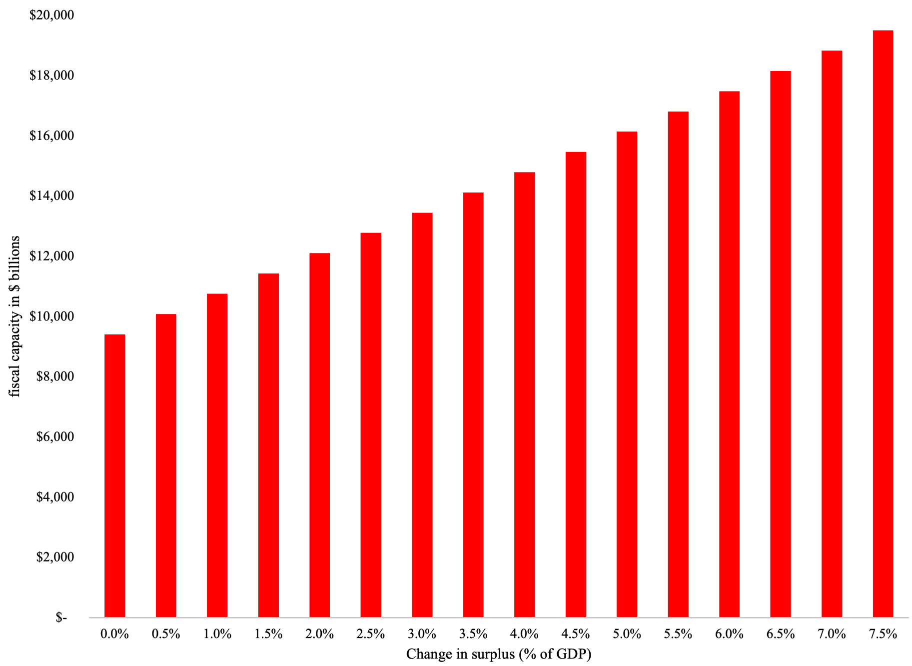

Figure 4: Fiscal Capacity in $ billions on vertical axis. Horizontal axis: Change in primary surplus as % of U.S. GDP in each year between 2022 and 2051 relative to the Baseline CBO Projection.

To get to an upper bound on fiscal capacity of $ 18.8 trillion, we need an extra primary surplus of 7.0% of GDP in all years between 2022 and 2051. Table 4 provides all of the details of the calculation. This scenario pushes the debt/GDP ratio into negative territory by 2051:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2051}) + PV_{2021}^{upper}(D_{2051}) = \$20,130 + \$(1300) = \$18,830$$

Figure 1 also plots this path of completely front-loaded surpluses (in blue). Figure 5 plots the contribution of each surplus to the overall duration of the surplus claim in this front-loaded scenario. In this scenario, the duration declines to 6.44 years. The Treasury needs to front-load surpluses by increasing primary surpluses by 7% of GDP relative to the CBO baseline scenario to roughly match the duration of its cash outflows (coupon and principal payments) to the duration of its inflows (surpluses). In this fully front-loaded scenario, an increase in the yield curve of 100 bps (and a similar 100 bps. increase in the next interest cost of the government in each year between 2022 and 2051) raises the debt in 2051 from -8.3 to 4.1 % of GDP, requiring a small steady-state surplus of 0.10 % of GDP starting in 2052 , compared to a small steady-state deficit of -0.12% of GDP.

To get to $23.5 trillion, the current valuation of Treasurys, even more front-loading is needed, even if we include the seigniorage revenue from safe asset demand. However, these scenarios lead to substantial government saving (negative debt) in 2051, and we do not consider these scenarios.

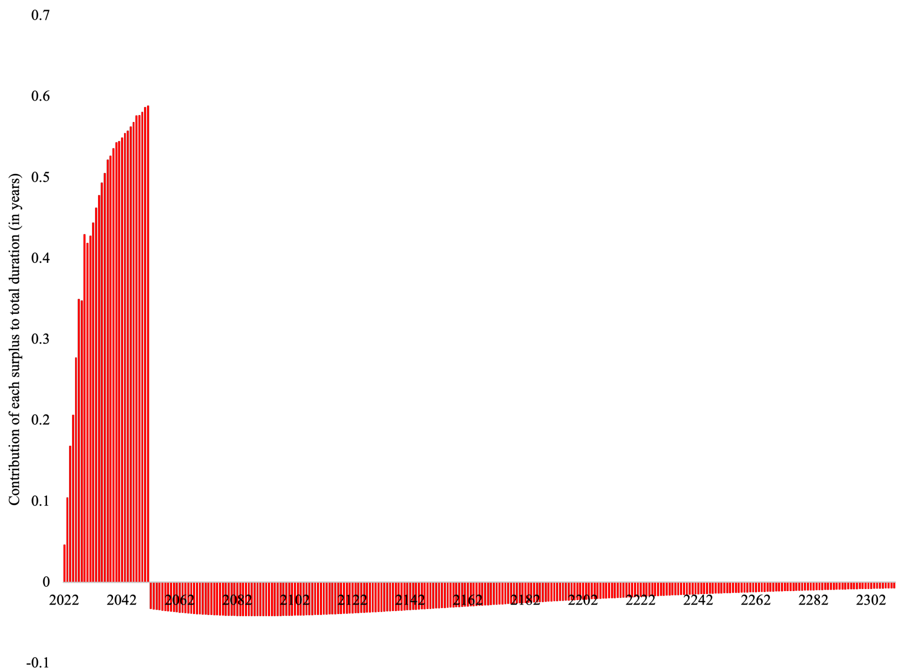

Figure 5: Duration Composition in Front-loaded Scenario. Contribution of each payment $\frac{k \times PV(S_{2021+k})}{\sum_{j=0} PV(S_{2021+j})}$ to total duration of $\frac{\sum_{k=0} k \times PV(S_{2021+k})}{\sum_{j=0} PV(S_{2021+j})}$. Primary surplus: CBO Baseline Projection +7% of GDP. Total Duration (6.44 yrs) is sum.

5 Pro-cyclical Fiscal Policy Regime

Can the U.S. run steady-state deficits and maintain fiscal capacity, as many have claimed? Not according to standard finance, unless the U.S. federal government changes the fiscal regime from counter-cyclical to pro-cyclical. The U.S. Treasury would have to render the tax claim less risky than the spending claim. Only in that case would our upper bound calculation fail, because Assumption 2 fails. In this case, the U.S. taxpayers would be providing insurance to bondholders (Jiang et al., 2020). This insurance premium would allow the U.S. to run steady-state deficits.

Hence, the only way to reconcile the CBO projections with the value of U.S. Treasurys, is to use a much lower discount rate for the tax cash flows than for the spending cash flows. Importantly, this is necessary if we want the entire debt to be zero beta or risk-free. However, this condition is not satisfied in post-war U.S. data, because of the pro-cyclical nature of tax revenue and the counter-cyclical nature of spending (Jiang et al., 2019).

If the U.S. government were to radically change its future fiscal policy and raise more tax revenue in recessions, this would make the tax claim less risky than the spending claim. We entertain this possibility because this regime change can sustain steady-state deficits.

In the steady-state, the valuation of future surpluses is given the price/dividend ratio on a claim to GDP times the steady-state surplus:

$$PV^{upper}_{2051}(\{T-G\}^{\infty}_{2051}) = \sum_{j=1}^{\infty}\frac{T_{2021+j}}{(1+r^{\$,t}_j)^j} - \sum_{j=1}^{\infty}\frac{G_{2021+j}}{(1+r^{\$,g}_j)^j} = (pd^t \times \frac{T}{Y} - pd^g \times \frac{G}{Y}) \times Y_{2021}.$$

If the tax claim is less risky, and the price/dividend ratio on the tax claim exceeds that on the spending claim, $pd^g < pd^t$, then a steady-state deficit is consistent with positive fiscal capacity.

Suppose that the tax claim's appropriate discount rate is 100 bps. lower than that the discount rate for the output claim. Table 5 reports the calculations. Now, the sum of (the upper bound on) the PDV of the tax revenue minus spending cash flows from 2022-2051 adds up to -\$5.3 trillion dollars:

$$PV^{upper}_{2021}(\{T-G\}^{2051}_{2022}) = \sum_{j=0}^{30}\frac{T_{2021+j}}{(1+r^{\$,y}_j - 0.01)^j} - \sum_{j=0}^{30}\frac{G_{2021+j}}{(1+r^{\$,y}_j)^j} = \$(5,306).$$

The lower discount rate for the tax revenue claim expands our estimate of fiscal capacity. In this case, the total PDV of deficits, computed as the difference between the sum of columns (9) and columns (10), has shrunk from \$22 to \$ 5.31 trillion. If we combine this with the \$31.66 trillion in PDV of future debt, we end up with a total value of \$26.35 trillion for the value of debt at the end of 2021.

$$PV^{upper}_{2021}(\{T-G\}^{2051}_{2022}) + PV^{upper}_{2021}(D_{2051}) = \$26,350$$

This measure of fiscal capacity exceeds the current debt outstanding at the end of 2021. This exercise goes to show that the nature of risk in tax revenues (and government spending) is crucial for the determination of fiscal capacity. A radical fiscal regime shift of the kind entertained in this section seems unlikely because of the pain it would inflict on taxpayers.

Table 5: CBO Projections of Government Cash Flows and Discounting. Pro-Cyclical Fiscal Policy.

Based on CBO projections released in July of 2021. (4), (5), (6) and (12) in $ billions. Column (9) and (10) reports an estimate of PDV of tax revenue and spending in 2021 $ billions.

year	T/Y	G /Y	(T-G) /Y	Y	T	G	$y_j^{\$}$	$r_j^{\$,y}$	PV(T)	PV(G)	D/Y	D
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2022	17.3%	20.7%	-3.4%	$ 24,638	$ 4,264	$ 5,090	1.10%	3.70%	$ 4,152	$ 4,908	102.0	$ 25,127
2023	17.5%	20.3%	-2.8%	$ 25,565	$ 4,464	$ 5,191	1.52%	4.12%	$ 4,198	$ 4,788	102.0	$ 26,075
2024	17.3%	19.8%	-2.5%	$ 26,405	$ 4,574	$ 5,226	1.71%	4.31%	$ 4,148	$ 4,605	101.4	$ 26,784
2025	17.2%	20.0%	-2.8%	$ 27,310	$ 4,689	$ 5,449	1.79%	4.39%	$ 4,103	$ 4,588	101.2	$ 27,633
2026	17.6%	20.0%	-2.4%	$ 28,291	$ 4,982	$ 5,668	1.84%	4.44%	$ 4,207	$ 4,562	100.9	$ 28,537
2027	17.9%	20.1%	-2.2%	$ 29,374	$ 5,267	$ 5,901	1.87%	4.47%	$ 4,293	$ 4,539	101.0	$ 29,660
2028	17.8%	20.6%	-2.8%	$ 30,471	$ 5,414	$ 6,278	1.90%	4.50%	$ 4,256	$ 4,614	102.2	$ 31,148
2029	17.7%	20.1%	-2.4%	$ 31,587	$ 5,578	$ 6,351	1.93%	4.53%	$ 4,225	$ 4,455	103.2	$ 32,588
2030	17.6%	20.6%	-3.0%	$ 32,746	$ 5,752	$ 6,738	1.97%	4.57%	$ 4,195	$ 4,507	105.0	$ 34,376
2031	17.5%	20.8%	-3.3%	$ 33,984	$ 5,955	$ 7,073	2.01%	4.61%	$ 4,179	$ 4,509	107.2	$ 36,430
2032	17.5%	21.0%	-3.5%	$ 35,207	$ 6,176	$ 7,391	2.04%	4.64%	$ 4,166	$ 4,487	109.8	$ 38,649
2033	17.6%	21.1%	-3.6%	$ 36,475	$ 6,403	$ 7,704	2.08%	4.68%	$ 4,151	$ 4,450	112.7	$ 41,095
2034	17.6%	21.3%	-3.7%	$ 37,788	$ 6,646	$ 8,034	2.11%	4.71%	$ 4,137	$ 4,415	115.9	$ 43,792
2035	17.6%	21.4%	-3.8%	$ 39,148	$ 6,901	$ 8,374	2.15%	4.75%	$ 4,123	$ 4,375	119.4	$ 46,735
2036	17.7%	21.5%	-3.9%	$ 40,557	$ 7,167	$ 8,731	2.18%	4.78%	$ 4,109	$ 4,335	123.1	$ 49,927
2037	17.7%	21.6%	-3.9%	$ 42,018	$ 7,448	$ 9,091	2.21%	4.81%	$ 4,097	$ 4,290	127.0	$ 53,346
2038	17.8%	21.8%	-4.0%	$ 43,530	$ 7,736	$ 9,485	2.23%	4.83%	$ 4,082	$ 4,252	131.1	$ 57,052
2039	17.8%	21.9%	-4.1%	$ 45,097	$ 8,036	$ 9,880	2.26%	4.86%	$ 4,067	$ 4,208	135.4	$ 61,049
2040	17.9%	22.0%	-4.2%	$ 46,721	$ 8,348	$ 10,291	2.28%	4.88%	$ 4,052	$ 4,164	139.9	$ 65,349
2041	17.9%	22.2%	-4.3%	$ 48,403	$ 8,674	$ 10,732	2.30%	4.90%	$ 4,038	$ 4,124	144.6	$ 69,995
2042	18.0%	22.3%	-4.3%	$ 50,097	$ 9,007	$ 11,168	2.32%	4.92%	$ 4,020	$ 4,077	149.5	$ 74,916
2043	18.0%	22.4%	-4.4%	$ 51,850	$ 9,356	$ 11,620	2.33%	4.93%	$ 4,004	$ 4,029	154.7	$ 80,190
2044	18.1%	22.5%	-4.4%	$ 53,665	$ 9,708	$ 12,082	2.35%	4.95%	$ 3,984	$ 3,978	159.9	$ 85,833
2045	18.1%	22.6%	-4.5%	$ 55,543	$ 10,078	$ 12,558	2.36%	4.96%	$ 3,966	$ 3,928	165.4	$ 91,868
2046	18.2%	22.7%	-4.5%	$ 57,487	$ 10,465	$ 13,051	2.38%	4.98%	$ 3,949	$ 3,877	171.0	$ 98,312
2047	18.3%	22.8%	-4.5%	$ 59,499	$ 10,869	$ 13,559	2.39%	4.99%	$ 3,933	$ 3,825	176.8	$ 105,192
2048	18.3%	22.9%	-4.6%	$ 61,582	$ 11,293	$ 14,107	2.40%	5.00%	$ 3,918	$ 3,779	182.8	$ 112,555
2049	18.4%	23.0%	-4.6%	$ 63,737	$ 11,719	$ 14,649	2.41%	5.01%	$ 3,898	$ 3,728	188.9	$ 120,426
2050	18.4%	23.1%	-4.6%	$ 65,968	$ 12,168	$ 15,214	2.42%	5.02%	$ 3,881	$ 3,677	195.3	$ 128,864
2051	18.5%	23.2%	-4.6%	$ 68,277	$ 12,641	$ 15,815	2.43%	5.03%	$ 3,866	$ 3,630	202.0	$ 137,927
Total									$122,396	$127,702.70		

6 Conclusion

We use the CBO's projected primary surpluses to assess the U.S. fiscal capacity. Using plausible discount rate assumptions, we compute an upper bound on fiscal capacity implied by the CBO's projections of around 60% of 2022 GDP, in spite of the low current rates. This baseline estimate assumes a major structural adjustment after 2051. The back-loading of surpluses creates a large duration mismatch between the government's assets, its future surpluses, and its liabilities. Increases in interest rates then lead to sharp increases in fiscal adjustments. Because of the back-loading of future surpluses, the Treasury faces a duration mismatch between its cash inflows and outflows.

Many authors have emphasized that low rates create additional fiscal capacity for the U.S., but they have ignored the impact of low rates on the risk of future fiscal adjustment due to the duration mismatch. To eliminate the mismatch by front-loading surpluses, the U.S. would have run primary surpluses of 3.3% of GDP until 2051 instead of deficits of 3.7% of GDP.

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