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

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**Abstract**

We use discounted cash flow analysis to measure the fiscal capacity of the U.S. federal government. We apply our valuation method to the CBO's projections for the U.S. federal government's primary deficits between 2022 and 2052 and projected debt outstanding in 2052. The proper discount rate for projected cash flows and future debt includes a GDP or market risk premium. In spite of low interest rates, we find that U.S. fiscal capacity is currently more limited than you might think. Because of the back-loading of projected primary 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 primary surpluses requires a 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). Others 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.

When the economy's output is subject to growth shocks, the government's fiscal capacity is limited even if the average risk-free rate is lower than the average growth rate of its output. If the government could always roll over the debt at a risk-free rate lower than the growth rate of the economy, then an investor going long in unlevered equity funded by risk-free debt would have a risk-free profit opportunity.[1] In reality, going long in unlevered equities and short in the risk-free is quite risky. To be compensated for this risk, investors demand a large premium (see Mehra and Prescott, 1985).

Our paper reassess the fiscal capacity of the U.S. by ruling out free lunches for the government, as we typically do for other investors. To do so, we put the government and investors on the same footing, and we apply textbook finance to the Treasury's balance sheet. We define fiscal capacity as the present discounted value (PDV) of future primary surpluses. In standard models with long-horizon investors, the government's debt is fully backed by future surpluses.

The measurement of fiscal capacity is then a forward-looking valuation question. We propose a simple, easy-to-implement discounted cash flow approach to this valuation question. As in any asset pricing exercise, this approach requires estimating the proper discount rates, as well as forecasting the underlying cash flows, tax revenues and non-interest government spending. We illustrate our method using the CBO's long-term budget projections. We believe these projections serve as a useful benchmark.[2] Our objective is not to produce definitive estimates, but to develop a coherent forward-looking approach to measuring fiscal capacity that is firmly founded in modern finance.

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 a claim to GDP, also known as the total wealth portfolio or the market portfolio, to discount future taxes, spending,

[1] Moreover, the Treasury does not roll over the entire portfolio of debt every few months by issuing T-bills at the risk-free rate. The return on all outstanding Treasurys has exceeded the nominal growth rate of GDP throughout the 1980s and 1990s (Hall and Sargent, 2011).

[2] Instead, JLVX (2019) rely on an econometric model to forecast future fiscal cash flows, ultimately arriving at similar conclusions as the approach pursued here.

and future debt. This discount rate is the sum of a maturity-specific risk-free interest rate and the GDP risk premium. We argue that a plausible value for the GDP risk premium should be at least 2.5% per year. When we use the proper discount rate, the PDV of future debt is well-behaved even when the risk-free rate is lower than the growth rate (see Lucas, 2021, for an exposition on the proper discount rate for pension liabilities).

In the discounted cash flow approach, the PDV of debt outstanding in the distant future converges to zero, or the transversality condition (TVC) holds, because the discount rate applied to future debt includes a GDP risk premium.[3] Hence our definition of fiscal capacity as the PDV of future primary surpluses.[4]

The PDV of the CBO-projected deficits between 2022 and 2052 is $21.16 trillion in 2021 dollars, roughly equal to the U.S. GDP at the end of 2021. In addition, the projected debt outstanding in 2052 is 185% of GDP. Starting in 2053, the U.S. would need to generate a steady-state surplus of 2.16% to pay back the debt outstanding in 2052. Discounted back to 2021 at the appropriate discount rate, the 2052 debt is worth about $33.5 trillion. When we combine the PDV of projected deficits until 2052 with the 2021 value of the projected debt outstanding in 2052 of $33.5 trillion, we end up with an upper bound on the U.S. fiscal capacity of around $12.38 trillion. This is our baseline estimate of an upper bound on fiscal capacity. It falls $10 trillion short of the actual $22.28 trillion value of all U.S. Treasuries outstanding at the end of 2021.

An extended measure of fiscal capacity includes the seigniorage revenue earned by the Treasury. U.S. Treasurys earn a convenience yield because they play a special role in the global financial system. Adding the present value of these seigniorage revenues adds another $ 4.04 trillion in fiscal capacity. Our final estimate for the upper bound on fiscal capacity is $16.38 trillion in 2021, or 73% of 2021 GDP, substantially below the observed value of debt/GDP at the end of 2021. In spite of the current low interest rates (and hence low debt service), we find that U.S. fiscal capacity is quite limited.

Actual fiscal capacity may be even more limited for three reasons. First, our estimates only put an upper bound on fiscal capacity. Second, our estimates of fiscal capacity assume that a major fiscal adjustment will take place after 2052, turning from large primary deficits to large primary surpluses, an adjustment unlike any other in U.S. history. Third, the GDP risk premium used in our discount rate is at the lower end of the empirically plausible range. Each of these

[3] In the discounted cash flow approach, the TVC can only fail if the GDP risk premium is smaller than the gap between the risk-free rate and the growth rate. This is not the case for the U.S.

[4] In some macro-economic models without long-lived investors, the TVC, an optimality condition for long-lived investors, may be violated (see, e.g., Santos and Woodford, 1997). In these models, there are no long-lived investors to enforce TVC for long-lived assets (see Dumas, Ehling, and Yang, 2021, for a recent example). Most of these models do not have priced aggregate risk either. We can think of these violations as rational bubbles. Typically, these bubbles 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 in U.S. Treasury markets.

assumptions, discussed in detail below, increase our estimate of fiscal capacity, and shrink the gap with the observed debt/GDP ratio. This makes our calculations conservative.

Typically, pension funds will seek to match the duration of the cash inflows from its portfolio to the duration of the cash outflows to its retirees to avoid interest rate risk. The U.S. Treasury has not matched the duration of its projected cash inflows, its primary surpluses, and outflows, its coupon payments. Because of the backloading of projected primary surpluses, the duration of a claim to the projected primary surpluses is very long. This creates a duration mismatch between the Treasury's cash inflows and its cash outflows. When rates increase, U.S. fiscal capacity, the present value of future surpluses, decreases dramatically, but the value of its liabilities, the portfolio of outstanding Treasury debt, decreases by much less because the duration of its outstanding debt is much shorter (around 5 yrs in 2021) than the duration of its surpluses (283 years in the baseline model).

As a result, an interest rate increase will require large fiscal adjustments. A 1% point increase in yields of all maturities, holding constant nominal GDP growth and projected primary surpluses until 2052, requires an increase in surpluses of 2.67% of GDP each year after 2052 relative to the baseline model.

The large realized changes in interest rates between December 31, 2021 and May 31, 2022, when interest rates moved up anywhere from 130 to 175 basis points along the term structure are a concrete example of this duration argument. These changes require a massive increase in future primary surpluses to maintain the same fiscal capacity: from 2.16% per year to 6.24% per year after 2052.

From an optimal maturity management 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 primary surpluses by increasing the primary surplus by 6% of GDP each year between 2022 and 2052 relative to the CBO's baseline projections.

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. The price/dividend ratio determines the fiscal capacity per dollar of surplus, expressed as % of GDP. This ratio depends on the risk-free rate, the term premium, the GDP risk premium and the expected growth rate of GDP. An increase in the expected growth rate and/or a decrease in the risk-free rate increase fiscal capacity, but a decrease in the term premium and the GDP risk premium have similar effects.

We estimate the price/dividend ratio for the total wealth portfolio to be around 85.8 at the end of 2021, which implies an estimate for total wealth, including human wealth, of about 85 times GDP. To get an upper bound on the fiscal capacity of 99.6% of GDP, the size of the debt/GDP ratio at the end of 2021, the U.S. would need a steady-state primary surplus of 1.16% going forward. However, the CBO projects average primary surpluses of -3.2% between 2022 and 2052. Hence our conclusion that the market seems to forecast a large fiscal correction, either because it believes the CBO projections until 2052 are too pessimistic or because of major fiscal adjustments after 2052.

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 primary surpluses as well as GDP and interest rate forecasts. The primary surplus projections are not traditional 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 such future 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. Should this overstatement continue, it would render our fiscal capacity estimates overly generous, i.e., conservative. Even taking CBO projections at face value, our estimates of fiscal capacity suggest that large fiscal corrections relative to the CBO baseline are anticipated by U.S. Treasury markets.[5] Alternatively, the market may be pricing in some form of real rate distortions in the future.[6]

Second, our measurement of fiscal capacity relies on 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. Choosing a lower discount rate results in higher estimates of fiscal capacity. To match the current valuation of Treasurys, we need a discount rate that is lower than the projected growth rate of the economy, implying an implausibly low GDP risk premium, and implausibly high valuations of other assets.[7]

Lower discount rates also increase the sensitivity of fiscal capacity to interest 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 received much attention.

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 pro-

[5]In a classic paper, Bohn (1998) argues that increases in the debt/output ratio predict larger future surpluses, but, in a longer sample, Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2021) find no evidence of this mechanism.

[6]See Acalin and Ball (2022) for new evidence on the role of real rate distortions in the post-war US fiscal experience.

[7]Put differently, we need to engineer a violation of the TVC to match the valuation of Treasurys using the CBO projections.

to counter-cyclical primary surpluses 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 since it requires belt tightening at the worst possible (high marginal-utility) times.

Our forward-looking 'valuation' approach in the tradition of Hansen, Roberds, and Sargent (1991) is well-suited for use with the CBO projections. Others pursue a complementary backward-looking 'accounting' approach to the question of fiscal sustainability which characterizes debt/output dynamics as a function of past returns and surpluses (see, e.g. Hall and Sargent, 2011; Mehrotra and Sergeyev, 2021). More recently, Mian, Straub, and Sufi (2021) analyze debt/output ratio dynamics in low interest rate environments when the government earn seigniorage from the convenience yields on government bonds, but face a downward sloping demand curve for liquidity and safety.

In spite of the secular decline in real rates, private investment has stagnated. This phenomenon has been referred to as secular stagnation (Summers, 2015). Other economists have explored whether the U.S. economy is dynamically inefficient, perhaps as result of increased market power (Ball and Mankiw, 2021; Aguiar, Amador, and Arellano, 2021). Farhi and Gourio (2018) have countered that risk premia may have increased as real rates have decreased, thus accounting for low private investment. When using deterministic models without risk premia, economists may have mistakenly over-estimated the NPV of private investment opportunities. Private investment opportunities are more limited when you take into account risk premia. We make a related point about the government's fiscal capacity. In spite of the secular decline in real rates, the U.S. government's fiscal capacity is probably more limited than you think, once you account for risk premia.

Government Ponzi schemes that look promising in deterministic economies typically do not survive exposure to aggregate risk and long-lived investors (Jiang, Lustig, Van Nieuwerburgh, and Xiaolan, 2020; Barro, 2020). These schemes also do not survive a close look at the historical evidence which suggests that the fiscal capacity of governments has always been limited.[8] Our paper contributes to the measurement of these limits.

The paper is organized as follows. Section 2 describes the discounted cash flow analysis approach to measuring fiscal capacity and computes fiscal capacity in the benchmark scenario. Section 3 adds convenience yields. Section 4 analyzes a front-loaded fiscal adjustment. Section 5 analyzes the hypothetical case of counter-cyclical tax revenue. The last section concludes.

[8] For example, the U.K., for which we have the longest continuous time series, ran primary surpluses of 2.38% (1.22 %) of GDP between 1729 and 1914 (1946). After 1947, the UK ran primary surpluses of 1.77% of GDP (Chen, Jiang, Lustig, Van Nieuwerburgh, and Xiaolan, 2022).

## 2 Discounted Cash Flow Analysis

In a world without convenience yields on government debt, the market value of the portfolio of outstanding government debt equals the present discounted value of future primary surpluses.[9] This result, proven in JLVX (2019), follows from imposing (i) the government budget constraint in each period, (ii) no-arbitrage conditions on individual bond prices, and (iii) a transversality condition.[10] In other words, under mild conditions, the value of debt equals the expected present-discounted value of future primary surpluses:

$$D_t = \mathbb{E}_t \sum_{j=1}^{\infty} M_{t+j} S_{t+j} = PV_t(\{S\}_{t+1}^{\infty}). \tag{1}$$

For our baseline analysis, we abstract from convenience yields and calculate fiscal capacity as the present-discounted value of future surpluses, the right-hand side of this equation. This calculation requires an estimate of the surpluses $\{S_{t+j}\}$ and an estimate of the discount rate $\{M_{t+j}\}$. We tackle each of these in turn. We perform this calculation as of December 31, 2021. The actual market value of government debt at the end of 2021, $D_{2021}$, is 99.64% of GDP .

### 2.1 Cash Flows

The cash flows we need are primary surpluses from 2022 onwards, i.e., federal tax revenues minus federal non-interest spending. We break up this cash flow stream into the cash flow until 2052 and the cash flow after 2052. By value additivity, we can split up the PDV of surpluses as the sum of surpluses until the end of the CBO projection horizon in 2052 and the residual tail value:

$$PV_{2021}(\{S\}_{2022}^{\infty}) = PV_{2021}(\{S\}_{2022}^{2052}) + PV_{2021}(\{S\}_{2053}^{\infty}). \tag{2}$$

#### 2.1.1 Primary Surpluses Until 2052

We use the Congressional Budget Office's long-term budget projections for the U.S. federal government (Supplemental Table 1, Summary Data for the Extended Baseline). It contains the CBO projections for federal non-interest spending, revenues, debt held by the public, and GDP for each fiscal year from 2022 until 2051. These projections are as of May 2022. From the interest cost and

[9]This equation is alternatively referred to as the government intertemporal budget constraint or the debt valuation equation. This equation has a long history, going back to seminal work by Hansen et al. (1991).

[10]The transversality condition requires that the expected present-discounted value of debt in the far future, $\mathbb{E}_t[M_{t+T} D_{t+T}]$, goes to zero as the horizon $T$ goes to infinity. The TVC is an optimality condition in an economy with long-lived investors. JLVX (2020) show that the TVC is satisfied as long as the GDP risk premium exceeds the gap between the growth rate and the risk-free rate.

debt projections, we can back out an implicit interest rate on the portfolio of outstanding government debt for those same years.

Table 1 lists the CBO's budget projections for the years 2022-2052 (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. 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 2052. Column (4) reports nominal GDP projections. For 2022 to 2032, we use projections from the May 2022 CBO report.[11] After that, we use the projected real GDP growth rate and the long-run projected rate of inflation.[12] We then compute the implied dollar numbers for projected nominal tax revenue and spending in columns (5) and (6).

While the CBO forecasts GDP, inflation, and interest rates in unrestricted fashion, the CBO makes projections of future revenues and non-interest spending based only on current law. The CBO assumes that temporary spending and tax changes will expire as provided in the law. JLVX (2021) document that CBO projections have been too optimistic over the past two decades. This was not true prior to the late 1990s. While some of the overly optimistic projections are no doubt due to the Great Financial Crisis and Covid-19 crisis, the CBO projected a reduction in deficits well after the GFC and before the Covid-19 crisis that failed to materialize. If this pattern continues, the CBO projections are likely to be an upper bound on future surpluses over the next 31 years. Since we aim to establish a conservative measure of fiscal capacity, i.e., a measure that is as large as possible, we think of this as a feature, not a bug.

### 2.1.2 Primary Surpluses After 2052

We assume that surpluses are a constant fraction of GDP in each year after 2053. Furthermore, we impose that equation (1) holds at the end of 2052:

$$D_{2052} = \mathbb{E}_{2052} \sum_{j=1}^{\infty} M_{2052+j} S_{2052+j} = PV_{2052}(\{S\}_{2053}^{\infty}) \tag{3}$$

Given that we have the CBO's projection for the debt/GDP ratio at the end of 2052, we can back out what constant surplus/GDP ratio is needed in the years after 2052 to satisfy (3). This implied surplus/GDP ratio will be positive since the projected debt/GDP ratio in 2052 is 185% of GDP, as shown in the last row of column (10) of Table 1. However, the size of the surplus/GDP ratio after 2052 will depend on the discount rate. Hence, we need to discuss the discount rate next.

[11]The CBO provides a supplement to the May 2022 fiscal projection report called "An Update to the Budget and Economic Outlook: 2022 to 2032."

[12]Projections from the figures in CBO's May 2022 report "The 2022 Long-Term Budget Outlook."

## Table 1: Fiscal Capacity: Baseline Estimates

Based on CBO projections released in May of 2022. Column (8) reports the discount rates used for spending and tax cash flows in that year. (4), (5), (6), and (11) are 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) | (11) |
| 2022 | 19.6% | 21.9% | -2.3% | $24,694 | $4,836 | $5,405 | 0.42% | 3.02% | ($552.26) | 97.9 | $24,173 |
| 2023 | 18.6% | 20.7% | -2.0% | $26,240 | $4,889 | $5,419 | 0.76% | 3.36% | ($495.70) | 96.0 | $25,193 |
| 2024 | 18.0% | 20.3% | -2.2% | $27,291 | $4,924 | $5,535 | 0.99% | 3.59% | ($549.75) | 96.1 | $26,217 |
| 2025 | 17.6% | 20.1% | -2.5% | $28,271 | $4,982 | $5,696 | 1.15% | 3.75% | ($616.35) | 97.5 | $27,561 |
| 2026 | 18.0% | 20.4% | -2.3% | $29,266 | $5,280 | $5,962 | 1.27% | 3.87% | ($564.72) | 98.8 | $28,925 |
| 2027 | 18.3% | 20.4% | -2.2% | $30,332 | $5,548 | $6,201 | 1.36% | 3.96% | ($517.27) | 100.0 | $30,326 |
| 2028 | 18.2% | 20.6% | -2.4% | $31,487 | $5,716 | $6,486 | 1.43% | 4.03% | ($583.70) | 102.0 | $32,105 |
| 2029 | 18.1% | 20.7% | -2.6% | $32,716 | $5,934 | $6,773 | 1.49% | 4.09% | ($608.55) | 103.2 | $33,760 |
| 2030 | 18.1% | 20.8% | -2.7% | $33,996 | $6,161 | $7,066 | 1.55% | 4.15% | ($627.67) | 105.3 | $35,808 |
| 2031 | 18.1% | 20.9% | -2.7% | $35,318 | $6,402 | $7,371 | 1.59% | 4.19% | ($642.81) | 107.5 | $37,949 |
| 2032 | 18.2% | 21.1% | -2.9% | $36,680 | $6,662 | $7,722 | 1.63% | 4.23% | ($671.66) | 109.6 | $40,213 |
| 2033 | 18.2% | 21.2% | -3.0% | $38,081 | $6,938 | $8,062 | 1.67% | 4.27% | ($680.82) | 112.0 | $42,636 |
| 2034 | 18.3% | 21.3% | -3.0% | $39,519 | $7,217 | $8,413 | 1.71% | 4.31% | ($691.49) | 114.4 | $45,219 |
| 2035 | 18.3% | 21.4% | -3.1% | $40,996 | $7,506 | $8,779 | 1.74% | 4.34% | ($702.29) | 117.0 | $47,975 |
| 2036 | 18.4% | 21.6% | -3.2% | $42,514 | $7,801 | $9,166 | 1.77% | 4.37% | ($718.35) | 119.8 | $50,926 |
| 2037 | 18.4% | 21.7% | -3.3% | $44,074 | $8,110 | $9,567 | 1.80% | 4.40% | ($731.56) | 122.7 | $54,088 |
| 2038 | 18.4% | 21.8% | -3.4% | $45,680 | $8,423 | $9,975 | 1.83% | 4.43% | ($742.66) | 125.8 | $57,472 |
| 2039 | 18.5% | 22.0% | -3.5% | $47,335 | $8,749 | $10,391 | 1.85% | 4.45% | ($749.19) | 129.1 | $61,087 |
| 2040 | 18.5% | 22.1% | -3.6% | $49,035 | $9,082 | $10,827 | 1.88% | 4.48% | ($759.32) | 132.5 | $64,963 |
| 2041 | 18.6% | 22.2% | -3.6% | $50,782 | $9,426 | $11,272 | 1.90% | 4.50% | ($765.37) | 136.1 | $69,115 |
| 2042 | 18.6% | 22.3% | -3.7% | $52,581 | $9,782 | $11,727 | 1.92% | 4.52% | ($768.38) | 139.9 | $73,568 |
| 2043 | 18.7% | 22.4% | -3.8% | $54,443 | $10,158 | $12,208 | 1.94% | 4.54% | ($771.44) | 143.9 | $78,343 |
| 2044 | 18.7% | 22.5% | -3.8% | $56,372 | $10,539 | $12,685 | 1.96% | 4.56% | ($769.40) | 148.0 | $83,447 |
| 2045 | 18.7% | 22.6% | -3.9% | $58,371 | $10,939 | $13,193 | 1.98% | 4.58% | ($769.60) | 152.3 | $88,909 |
| 2046 | 18.8% | 22.7% | -3.9% | $60,444 | $11,359 | $13,709 | 2.00% | 4.60% | ($763.93) | 156.7 | $94,734 |
| 2047 | 18.8% | 22.7% | -3.9% | $62,594 | $11,798 | $14,219 | 2.01% | 4.61% | ($749.74) | 161.2 | $100,911 |
| 2048 | 18.9% | 22.8% | -3.9% | $64,824 | $12,260 | $14,782 | 2.03% | 4.63% | ($743.84) | 165.8 | $107,481 |
| 2049 | 19.0% | 22.8% | -3.9% | $67,132 | $12,726 | $15,328 | 2.04% | 4.64% | ($730.74) | 170.5 | $114,436 |
| 2050 | 19.0% | 22.9% | -3.9% | $69,514 | $13,217 | $15,900 | 2.05% | 4.65% | ($717.59) | 175.2 | $121,798 |
| 2051 | 19.1% | 22.9% | -3.8% | $71,970 | $13,733 | $16,500 | 2.07% | 4.67% | ($704.70) | 180.1 | $129,588 |
| 2052 | 19.1% | 23.0% | -3.9% | $74,505 | $14,254 | $17,130 | 2.07% | 4.67% | ($699.91) | 185.0 | $137,852 |
| Total PV | | | | | | | | | $(21,160) | | $33,540 |

Assuming (3), our 2021 fiscal capacity estimate in (2) can be rewritten as the sum of the PDV of surpluses until the end of the projection horizon and the PDV of outstanding (projected) debt:

$$PV_{2021}(\{S\}_{2022}^{\infty}) = PV_{2021}(\{S\}_{2022}^{2052}) + PV_{2021}(D_{2052}). \tag{4}$$

## 2.2 Discount Rates

### 2.2.1 Riskiness of Tax Revenues and Non-interest Spending

The CBO projections for non-interest spending and tax revenue are point estimates; there is substantial uncertainty around the point estimates. This uncertainty is naturally related to the uncertainty in the underlying macroeconomy. Because the underlying cash flows are risky, they cannot be discounted off the Treasury yield curve. As in any valuation exercise, the proper discount rate needs to reflect the systematic riskiness of the cash flows. They key question then is what the underlying source of aggregate risk to primary surpluses is.

To develop some intuition, consider the simplest case in which government spending and tax revenue are a constant fraction of GDP. Then, by definition, these claims are exactly as risky as a claim to GDP. The latter is often referred to as 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). The total wealth return is often proxied in the literature by the unlevered return on the stock market. The idea is that a portfolio that invests in all publicly-listed companies broadly reflects the evolution of the overall economy.[13] We will adopt this approach, recognizing that the stock market is a levered claim to corporate cash flows. This will lead us to un-lever the equity return to arrive at the total wealth return, the return on a claim to all future GDP. We discuss the implementation below.

Modeling tax revenue and non-interest spending as a constant fraction of GDP is sensible in the long run. At business cycle frequencies, the ratio of tax revenue to GDP is pro-cyclical while the ratio of non-interest spending to GDP is counter-cyclical (JLVX (2019)). These cyclical patterns imply that a claim to all future tax revenues is riskier than a claim to all future GDP, while a claim to all future non-interest spending is safer than the GDP claim. Intuitively, the spending claim is a hedge that has high payoffs in bad states of the world (recessions, high $M$ states). Investors prefer tese assets, bidding up their price, and bidding down their expected return. The tax revenue claim

[13] We effectively assume that the aggregate dividends from all publicly listed firms have the same riskiness as all corporate cash flows. Publicly traded firms represent a sizeable share of aggregate corporate cash flows. If anything, shares in the private firms have higher expected returns, because of the il-liquidity. As a result, our approach provides a lower bound on the market risk premium.

has the opposite properties, where tax revenues rise as a share of GDP exactly when investors care least about the extra income (good times, low $M$ states). Hence the tax claim is riskier than a claim to GDP, just like the dividend claim on stocks is riskier than the GDP claim. It carries an expected return and risk premium that exceeds that on the GDP claim. In summary, in the short run, the tax (spending) claim is exposed to more (less) business cycle risk.

In the long run, spending and taxes are both co-integrated with output, and hence (equally) exposed to long-run output risk.[14]

**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. Combining the short-run and long-run risk properties, we find that the tax claim is riskier than the GDP claim, which is riskier than the spending claim.[15]

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

### 2.2.2 Upper Bound on Fiscal Capacity

One approach is to estimate the expected return on the tax claim and the spending claim by committing to a fully-specified asset pricing model as well as dynamics for fiscal cash flows. This is the first approach pursued by JLVX (2019). The second approach in JLVX (2019), which is simpler and which we follow here, is to compute an *upper bound* on fiscal capacity. This upper bound comes about when discounting future non-interest spending and tax revenue at the same discount rate, namely the expected return on a claim to GDP: $\mathbb{E}[r^T] = \mathbb{E}[r^G] = \mathbb{E}[r^y]$. By using the same discount rate for the tax and spending claims, we maximize the value of the tax claim because we use a discount rate that is too low, and we minimize the value of the non-interest spending claim because we use a discount rate that is too high. Overstating the value of the tax claim and understating the value of the non-interest spending claim results in a value of the primary surplus claim that is unambiguously too large, thus deriving an upper bound on the fiscal capacity.

[14] A strip is a claim to one dividend payment in the future. When taxes (spending) are cointegrated with GDP, then long-run returns on tax strips and output strips converge (see Proposition 3 in JLVX (2019)). See Backus, Boyarchenko, and Chernov (2018) for a general proof. In the long run, the tax (spending) claim and the output claim are equally risky.

[15] As explained by JLVX (2019), this rules out that the entire debt portfolio has zero or negative beta. Generating zero-beta debt can only be achieved only 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. The empirical evidence points in the opposite direction. In addition, as explained by JLVX (2019), highly persistent deficits are not consistent with risk-free debt when the debt/output policy is mean reverting. See also work by van Wijnbergen, Olijslagers, and de Vette (2020); Barro (2020) on the same topic.

### 2.2.3 Implementation: Measuring the GDP Risk Premium.

As argued above, we proxy a claim to GDP as the unlevered version of a claim to the dividends of all publicly-listed stocks. Hence, to construct $\mathbb{E}[r^y]$, we begin by constructing a measure of the expected return on equity and unlever this expected return in a second step.

We infer the expected return on a claim to equity from valuations in the stock market. There are many ways one could measure the expected return on stocks: from a vector-autoregressive model (as in JLVX (2019)), from survey expectations (Fernandez, Banuls, and Acin, 2021), or from option markets (Andersen, Fusari, and Todorov, 2015; Binsbergen, Brandt, and Koijen, 2012), to name a few.

For simplicity, we use an off-the-shelf estimate from the private sector. It is an average of two approaches to measure the expected real return on U.S. equities going forward, as of the end of 2021: an earnings-based and a payout yield-based estimate.[16] 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:

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

where we use the inverse of Shiller's CAPE ratio to measure the E/P ratio, a dividend-payout ratio of 0.5, and an expected growth rate in earnings per share of 1.5% points, all measured at the end of 2021. The payout yield-based estimate for the real expected return on U.S. stocks is given by:

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

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, also measured at the end of 2021. 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. This number is very close to the 5.5% average (and median) estimate of the U.S. equity risk premium from an academic survey (Fernandez et al., 2021).

The equity risk premium is the risk premium on a levered claim. We are interested in an unlevered claim. The debt/equity ratio for the U.S. non-financial corporate sector is roughly 1/2 at the end of 2021, so that the equity/asset ratio is 2/3. As a result, we obtain an unlevered equity premium of 3.4% from a levered equity premium of 5.1% (2/3 of 5.1% is 3.4%).

We also compute an expected excess return of long-term bonds of 0.8%. This means that un-

[16] The approach is developed by AQR for its capital market assumptions (see *The Portfolio Solutions Group, AQR*, 2022, for details).

levered equities earn a risk premium $rp^y$ of 2.6% over long-term bonds. This is our measure of the GDP risk premium. The 2.6% GDP risk premium we use here is close to the 2.9% GDP risk premium that comes out of the calibrated disaster model in JLVX (2020).

We argue that 2.6% is a low estimate of the annual GDP risk premium because (i) the average excess return on stocks has been 8% over the 1947–2021 period and may have been at a cyclical low at the end of 2021, and (ii) using a higher cost of debt for corporations than the risk-free rate would also increase the unlevered equity risk premium. Using a lower discount rate will increase our measure of fiscal capacity. This will result in a conservative estimate of fiscal space, given that we will show that even this generous estimate of fiscal capacity falls short of the outstanding amount of debt at the end of 2021.[17]

To construct the discount rates for discounting tax revenue and spending claims at each horizon $h$, 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),[18] and then add the output risk premium of 2.6%:

$$\mathbb{E}_t[r^{\$,y}(h)] = y_t^{\$,f}(h) + rp^y.$$

This discount rate is reported in column (8) of Table 1, with the zero-coupon nominal bond yield component of that discount rate listed in column (7).

### 2.3 Steady-State Fiscal Capacity

Even when the average risk-free rate is lower than the growth rate $r^f < g$, fiscal capacity is limited. The standard argument used in a deterministic setting does not extend to an economy with priced aggregate growth risk for two reasons. First, the risk-free rate $r_t^f$ cannot always be lower than the realized growth rate $g_t$. To see why, consider the case in which the aggregate growth rate is independently and identically distributed over time and the price/dividend ratio of a claim to GDP is constant. If $r_t^f$ is always lower than $g_t$, then the return on going long in un-levered equity and borrowing at the risk-free rate is always positive. Hence, we have created an arbitrage opportunity, not only for the government, but for all investors.[19] Second, in a world with output

[17] A claim to GDP is potentially different from a claim to the cash flows of all current businesses, because the businesses in the current cohort are short-lived. Lustig et al. (2013) directly price the total wealth claim and obtain an annual risk premium of 2.38% per year.

[18] We assume that the yield on a 31-year zero-coupon bond equals the yield on a 30-year bond.

[19] If $r_t^f < g_t$ in all states of the world, the return on a claim to output would always exceed the risk-free rate: $R_{t+1}^y = \frac{1+pd}{pd}(1+g_t) > 1 + r_t^f$, giving rise to unbounded profit opportunities when borrowing at the risk-free and going long in unlevered equity. $r_t^f < g_t$ in all states of the world creates arbitrage opportunities not only for the government, but for everyone else. One exception is the case of convenience yields $\lambda_t$ which drive Treasury yield below the true risk-free rate: $y_t = r_t^f - \lambda_t$. We discus these in section 3. Convenience yields decline when the debt/output ratio

growth risk, the Treasury portfolio is risk-free and earns the risk-free rate only if the tax claim is less risky than the spending claim (JLVX (2019)). That restriction has bite and it appears to be violated in U.S. data (see JLVX (2020)). Our measure of fiscal capacity rules out free lunches for the government and investors.

As a warm-up exercise, we compute a measure of steady-state fiscal capacity. In the steady-state, the government runs a constant primary surplus relative to GDP. Given that the tax claim is riskier than the spending claim, an upper bound on the steady-state fiscal capacity is given by the valuation ratio on a claim to GDP times the steady-state surplus. 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:

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

Table 2: U.S. Treasury Balance Sheet in Steady-State Example

Treasury Balance Sheet in Market Values. Steady-State Example. Expressed as a multiple of U.S. GDP at the end of 2021. Example based on actual spending/GDP ratio in 2022.

| Assets | | Liabilities | |
|---|---|---|---|
| $PV_{2021}(\{T\})/Y_{2021}$ | $19.78 = 23.06\% \times 85.8$ | $PV_{2021}(\{G\})/Y_{2021}$ | $18.79 = 21.9\% \times 85.8$ |
| | | $D/Y_{2021}$ | $0.99 = 1.16\% \times 85.8$ |
| Total | 19.78 | Total | 19.78 |

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 nominal long discount rate minus the nominal growth rate is given by:

$$r^{\$,y} - g = y_{2022}^{\$,f}(30) + rp^y - g = 2.07\% + 2.60\% - (1.50\% + 2\%) = 1.17\%.$$

We can use Gordon's growth formula to compute the valuation ratio for the claim to GDP:

$$pd^y = \frac{1}{r^{\$,y} - g} = \frac{1}{1.17\%} = 85.8$$

The multiple on a claim to GDP is 85.8.[20] An unlevered company that grows forever at the same rate as the U.S. economy would have a price/dividend ratio of 85. If the company is only expected to live for 50 years, the multiple is still 36. At this high multiple, total U.S. wealth, including human

increases.

[20]Using a different approach with a no-arbitrage term structure model, Lustig, Van Nieuwerburgh, and Verdelhan (2013) obtain an average U.S. wealth/consumption ratio of 83.

wealth, is about 85 times the size of GDP.[21]

Table 2 shows the U.S. Treasury's balance sheet in market values, expressed as a percentage of GDP. Total assets and total liabilities are exposed to the same cash flow risk. The Treasury cannot financially engineer risk away. The risk in the tax process on the left hand side of the ledger has to show up on the right hand side in spending risk or in the riskiness of the debt. If the $S/Y$ ratio was constant, then the surplus inherits the risk properties of a GDP claim. In this simple case, the discount rate for a GDP claim is obviously the right discount rate for the surplus claim. And the valuation of debt would be 0.99 times GDP, as shown in Table 2. However, as we have explained, $S/Y$ is actually pro-cyclical in the data, implying that the surplus claim is riskier than the output claim. As a result, our calculation produces an upper bound on fiscal capacity.

In the right panel of Table 2, we start from the 2022 spending ratio of 21.9%. We need a steady-state primary surplus of 1.16% of GDP to get to an upper bound on fiscal capacity that includes the observed debt/GDP ratio of 99.7% as of the end of 2021: $85.8 \times 1.16\% = 99.7\%$ of 2021 GDP. On the left hand side, we back out the implied steady-state tax ratio $T/Y$ of 23.06% that is needed. The implied value of the tax claim is almost 20 times GDP.

The U.S. gets an additional 85.8% of GDP in fiscal capacity (maximum) per 1% of steady-state primary surplus $\frac{S}{Y}$. As noted above, our GDP risk premium estimate is low, resulting in a high price-dividend ratio on the GDP claim. As a result, our calculation produces high estimates of fiscal capacity, holding fixed the projected deficits.

Column (3) in Table 1 reports the actual projected primary deficits. The CBO projects average deficit of 3.19% of U.S. GDP between 2022 and 2052. One would need a large, permanent fiscal correction of 4.35% of GDP (from -3.19% to 1.16%) to reconcile this back-of-the-envelope upper bound with the actual value of U.S. Treasury debt/GDP.

## 2.4 Baseline Estimate of Fiscal Capacity

Next, we carry out our main analysis, which is to compute fiscal capacity as spelled out in equation (4). We discount each CBO projected cash flow, column (5) minus (6) of Table 1, with the discount rate $r^{\$,y}(h)$, shown in column (8), to arrive at the present discounted value listed in column (9). The sum of the PDV of primary surpluses from 2022-2052 adds up to minus \$21.16 trillion dollars:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2052}) = \sum_{h=1}^{31} \frac{T_{2021+h} - G_{2021+h}}{(1+r^{\$,y}(h))^h} = -\$21.16 \text{ tr.}$$

This is the sum of column (9) starting with -\$552 bn, the PDV of deficit in 2022, until and including -\$699.9 bn, the PDV of the 2052 deficit.

[21] In 2021, that's about \$5.825 million per American. Most of this the PDV of future labor income.

The CBO also publishes debt projections until 2052.[22] These are reported in column (10) of Table 1. According to the CBO debt projections, the debt outstanding will equal 185% of U.S. GDP at the end of 2052. This would amount to approximately $138 trillion in nominal debt, as shown in column (11).

What do we need to assume about surpluses starting in 2053 to justify this number as the present-discounted value of future primary surpluses, as in equation (3)? Recall that the multiple on a claim to GDP at the end of 2021 is 85.8. It seems reasonable and conservative to use this same multiple at the end of 2052. The valuation multiple of 85.8 at the end of 2021 is high relative to its historical mean because of low long-term nominal rates and a low risk premium, and is likely to revert back to its long-run mean. Using the historical average multiple would result in a higher required annual average primary surplus after 2052 to justify the same debt/output ratio at the end of 2052. This does not affect the present value of debt in 2052, only the required surpluses to repay this debt. To obtain a valuation of the debt outstanding at the end of 2052 equal to 185% of GDP, the U.S. federal government would need to generate a steady-state surplus of 2.16% after 2052.

Figure 1 plots the time path of projected primary surpluses; the red line is the baseline case. Until 2052, it plots the projected primary surpluses from the CBO. After 2052, the primary surplus is assumed to be equal to 2.16%, the surplus needed to enforce the intertemporal budget constraint at the end of 2052.

The debt outstanding at the end of 2052, projected to be $138 trillion, also needs to be discounted back to 2021 using the same discount rate used for the primary surplus cash flow in 2052. The second term in equation (4) is given by:

$$PV_{2021}^{upper}(D_{2052}) = \frac{D_{2052}}{(1 + r_{31}^{\$,y})^{2052-2021}} = \$33.54 \text{ tr.}$$

Discounted back to the end of 2021, the PDV of $D_{2052}$ is $33.5 trillion.

When we add up the properly discounted value of debt outstanding in 2052 and the surpluses between 2022 and 2052, we obtain our baseline fiscal capacity estimate of $ 12.38 trillion:

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

The key observation is that this fiscal capacity estimate falls about $10 trillion short of the actual valuation of debt in 2021 of $22.3 trillion. In sum, our fiscal capacity bound cannot be reconciled with the actual valuation of debt at the end of 2021, given the baseline CBO projections of future primary surpluses and realistic discount rates.

[22]Supplemental Table 1: Summary Data for the Extended Baseline.

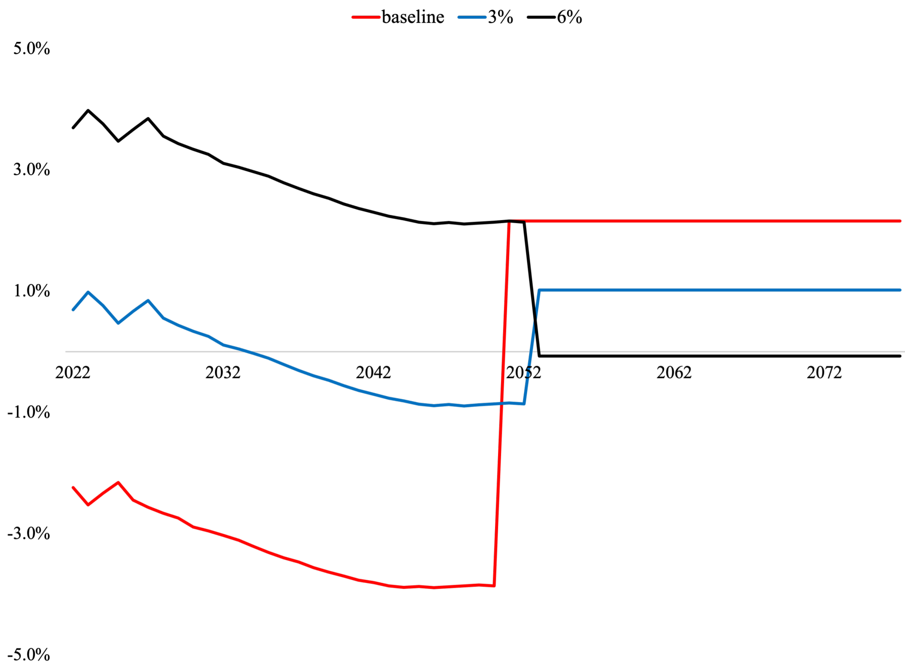


Figure 1: CBO Projections of Primary Surplus

Red line: Baseline CBO projections of primary surplus for 2022-2052, followed by primary surpluses after 2052 needed to pay back the debt in 2052. Blue line: Increase in primary surpluses between 2022-52 by 3.0% of GDP each year, followed by primary surpluses after 2052 needed to pay back the debt in 2052. Black line: Increase in primary surpluses between 2022-52 by 6.0% of GDP each year, followed by primary surpluses after 2052 needed to pay back the debt in 2052.

This is surprising result in light of four observations that bear repeating. First, this is an upper bound on fiscal capacity by virtue of discounting the fiscal cash flows at the GDP discount rate (rather than at the higher tax and lower spending discount rates). Second, the CBO's primary surplus projections have tended to be too high compared to realized values over the past two decades. Third, our point estimate for the GDP risk premium is, if anything, low. Fourth, we have assumed that the U.S. will generate primary surpluses after 2052 that are large enough to rationalize the projected value of outstanding debt in 2052. This would constitute a sea change from what we have observed in the past many decades. Relaxing any of these four assumptions would result in an even lower value of fiscal capacity and an ever larger wedge between the estimated fiscal capacity and the observed debt/GDP ratio at the end of 2021. Those are the four reasons that our estimate of fiscal capacity is conservative: if anything too high rather than too low.

### 2.5 Discounting Future Debt

The right discount rate for debt outstanding far in the future includes the GDP risk premium when output and debt are cointegrated. The reason is that GDP is the far future is uncertain, and hence risky. If the debt/output ratio is stationary, the necessary condition for the transversality condition (TVC) to be satisfied, $\lim_{H\to\infty} \mathbb{E}_t[M_{t+H}D_{t+H}] = 0$, is $y^{\$,f}(H) + rp^y > g + \frac{1}{2}\sigma^2$, for some long horizon $H$ and where $\sigma$ is the volatility of output growth (see JLVX (2020), for details). In our calculation, we use 2.07% for the nominal long yield, 2.60% for the GDP risk premium and 3.50% for the long-run nominal growth rate $g$. These values imply that the TVC is satisfied (4.67% $>$ 3.5%). Importantly, this long-run discount rate that includes a GDP risk premium is the right discount rate regardless of the short-term debt/output, tax, and spending dynamics, and even when the debt is risk-free, i.e., has a zero beta.

If we had used the risk-free yield curve, without adding the GDP risk premium, when discounting, then the discounted value of future debt in 2052 would have been \$73.15 tr in 2021 dollars. The present value of the deficits until 2052 would have been -\$33.15 tr. We would have obtained a fiscal capacity estimate of \$40 trillion at the end of 2021, comfortably above the observed debt/GDP ratio at the end of 2021. The federal government's debt is projected to grow faster than output, and the discount rate (2.07%) is lower than the growth rate of output (3.50%). This is essentially the $r < g$ approach to fiscal sustainability. As we push the final period $T$ further out, the PDV of debt outstanding at $T$ does not converge to zero.

From a standard finance perspective, the $r < g$ argument is flawed, unless the GDP 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 unless its valuation was insensitive to the growth rate of output. 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 (locally) 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 rate, which includes the GDP risk premium, the value of future debt is much smaller, and the fiscal capacity estimate does not increase if we push $T$ out further into the future.[23]

Suppose we took the counterfactual view that the entire debt portfolio really had a zero beta, because the tax claim was less risky than the spending claim. Then, we could discount the projected surpluses until 2052 off the risk-free yield curve. However, we would still need to discount the future debt at the proper discount rate which includes the GDP risk premium. The estimated fiscal capacity would then become:

$$PV_{2021}^{upper}(D_{2052}) = \frac{D_{2052}}{(1 + r_{31}^{\$,y})^{2052-2021}} = -\$33.74 + \$33.54 = -\$0.20 \text{ tr.}$$

We would end up near-zero fiscal capacity, because the projected deficits increase in present value when discounted at a lower rate. This calculation shows that even discounting future primary surpluses over the next thirty years at the risk-free rate results in a low estimate of fiscal capacity as long as debt in the far future is discounted using a conceptually coherent discount rate.

This discussion raises a related question: How low would the GDP risk premium have to be to result in a fiscal capacity estimate that matches the observed debt/GDP ratio at the end of 2021.[24] The answer is 1.37% per year. However, at this risk premium, the TVC fails because the discount rate is lower than the GDP growth rate and the economy is dynamically inefficient:

$$r^{\$,y} - g = y_{2022}^{\$,f}(30) + rp^y - g = 2.07\% + 1.37\% - (1.50\% + 2\%) < 0.$$

The steady-state multiple on claim to GDP tends to $\infty$. This has troubling valuation implications. An unlevered firm that is expected to grow at the rate of U.S. output growth would have an infinite valuation. We conclude that a value of 1.37% or lower for the GDP risk premium is implausible. In any case, in the baseline scenario, we cannot match the valuation of debt without engineering a violation of the TVC.

[23] Lucas (2021) illustrates the flaw in the typical $r < g$ argument in the context of pension liabilities. Recently, Brunnermeier, Merkel, and Sannikov (2022) have argued that the government can engineer violations of TVC by providing safe assets that serve uniquely as insurance against idiosyncratic risk. But this approach raises questions about what distinguishes the U.S. governments from other governments who cannot seem to do this in countries where households are exposed to more idiosyncratic risk.

[24] Cochrane (2020) articulates the view that fiscal capacity is simply what the market says it is. In other words, we back out the discount rate that sets the fiscal capacity equal to the market value of debt. However, the risk premium on the market or the GDP risk premium is not a free parameter. We find that this reverse-engineered GDP risk premium violates the TVC, implying unbounded valuations for companies.

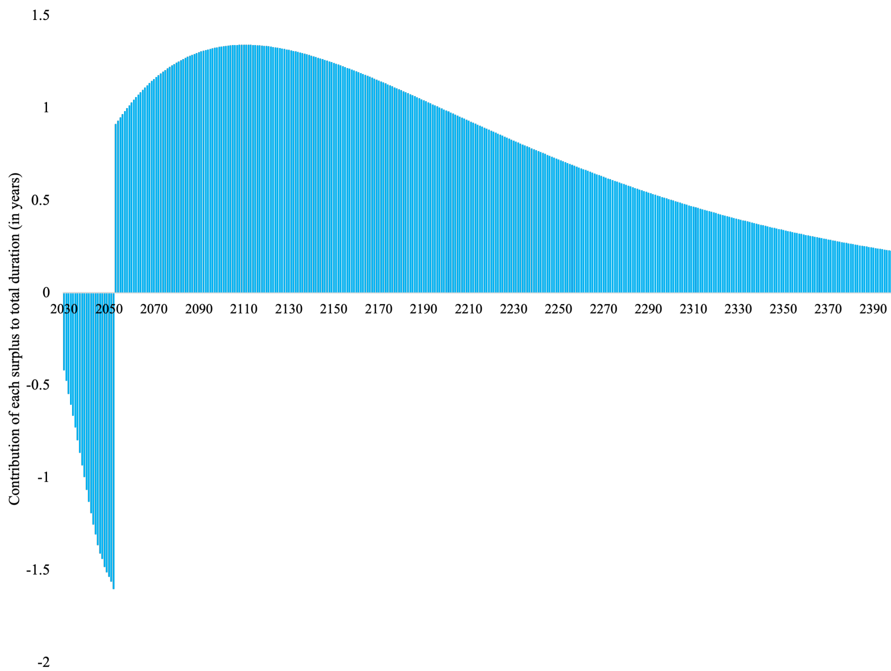


Figure 2: Duration Composition in Baseline Scenario. Contribution of each payment $\frac{k \times PV(S_{2021+k})}{\sum_{h=1} PV(S_{2021+h})}$ to the total duration in the CBO baseline projection. The duration (measured in years) is the sum of the plotted contributions.

### 2.6 Duration

The duration of the primary surplus claim is very high in the baseline scenario because the surpluses are extremely back-loaded; recall the red line in Figure 1. The McCauley duration of the surplus claim is 283.2 years.[25] Figure 2 plots the contribution of each payment at horizon $k$ to the total duration $\frac{k \times PV(S_{2021+k})}{\sum_{h=1} PV(S_{2021+h})}$. The duration is the sum of all bars.

Given this high duration of the surplus claim, U.S. fiscal capacity is very sensitive to the yield curve. We present two sets of calculations, one for a hypothetical 100 basis point parallel shift up in the yield curve, and one for the actually observed changes in the yield curve in the first five months of 2022.

#### 2.6.1 Parallel Shift in Yield Curve

To see this, we study a 100 basis points parallel upward shift in the yield curve, holding constant all other parameters, including nominal GDP growth. Increasing interest rates while holding nominal GDP growth constant amounts to an increase in the real growth-adjusted yield, i.e., in $r - g$. This

[25] If we (somewhat implausibly) assume that the Treasury pays back all outstanding debt at the end of 2052 in one large bullet payment rather than with gradual future surpluses, then the duration of the surplus claim becomes 44.7 years.

increase could reflect, for example, the unwind of Quantitative Easing programs.[26] The upward shifts in yields increases the discount rate of future surpluses and of future debt by 100 basis points, as shown in columns (8) and (9) of Table 3. 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 2052, as shown in column (4) of Table 3.[27] This extra interest cost affects the debt dynamics via $D_{t+1} = D_t \times R_{t+1} + S_{t+1}$. We compute these projected debt dynamics using the original projected primary surpluses and the CBO's interest rate projections plus 100 basis points.

The projected debt outstanding in this high-rate scenario grows to 223.0% of GDP in 2052 or to \$166.17 trillion, as shown in columns (11) and (12). Because of the 100 basis point rate increase, the steady-state multiple of a claim to GDP decreases from 85.8 to 46.2. Starting in 2053, the U.S. now has to generate a steady-state primary surplus of $4.83\% = \frac{223\%}{46.2}$, an increase by 2.67% of GDP relative to the corresponding number in the baseline scenario of 2.16%, i.e., before the interest rate change.[28] Hence, an increase in rates of 100 basis points, holding constant nominal GDP growth, implies a 2.67% of GDP increase in annual surpluses starting in 2053. The increase in surpluses starting in 2053 divided by the increase in rates is 2.7×. This is the signature of the duration mismatch on the Treasury's balance sheet.

A dramatic increase in long-run future surpluses is one adjustment mechanism in response to the interest 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.

As mentioned, one can reverse-engineer the GDP risk premium that sets the fiscal capacity equal to the market value of debt. If we had assumed—counter-factually—that the GDP risk premium were 1.37% per year rather than 2.60% per year, the duration of the surplus claim would be 651, more than twice the baseline value. While a lower GDP risk premium increases fiscal capacity, it increases the sensitivity of that fiscal capacity to increases in interest rates. From a policy perspective, this means that duration and roll-over risk are especially high when discount rates are low.

[26]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. The assumption that the GDP risk premium does not change is consistent with a narrow convenience yield view, as discussed further below.

[27]The CBO reports net interest /GDP and GDP projections from which we back out an estimate of the effective interest rate on debt $R_t$ .

[28]The estimate of the upper bound on fiscal capacity is now at \$12.03 tr, which is close to the baseline number. The key point, however, is that this assumes 4.83% of GDP in primary surplus starting in 2053 compared to 2.16% of GDP in the baseline case.

Table 3: Fiscal Capacity with Higher Interest Rates

Based on CBO projections . Column (8) reports the discount rates used for spending and tax cash flows in that year, a 100 basis point increase relative to baseline. Column (4) reports the projected CBO's Net Interest Cost over Debt plus 100 basis points. Columns (5), (6), (7), and (12) are 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 | 19.6% | 21.9% | -2.3% | 2.8% | $24,694 | $4,836 | $5,405 | 1.42% | 4.02% | ($546.95) | 95.1 | $23,475 |
| 2023 | 18.6% | 20.7% | -2.0% | 2.8% | $26,240 | $4,889 | $5,419 | 1.76% | 4.36% | ($486.24) | 94.0 | $24,669 |
| 2024 | 18.0% | 20.3% | -2.2% | 3.1% | $27,291 | $4,924 | $5,535 | 1.99% | 4.59% | ($534.13) | 95.4 | $26,040 |
| 2025 | 17.6% | 20.1% | -2.5% | 3.3% | $28,271 | $4,982 | $5,696 | 2.15% | 4.75% | ($593.15) | 97.7 | $27,615 |
| 2026 | 18.0% | 20.4% | -2.3% | 3.5% | $29,266 | $5,280 | $5,962 | 2.27% | 4.87% | ($538.31) | 100.0 | $29,256 |
| 2027 | 18.3% | 20.4% | -2.2% | 3.6% | $30,332 | $5,548 | $6,201 | 2.36% | 4.96% | ($488.39) | 102.1 | $30,967 |
| 2028 | 18.2% | 20.6% | -2.4% | 3.8% | $31,487 | $5,716 | $6,486 | 2.43% | 5.03% | ($545.90) | 104.5 | $32,907 |
| 2029 | 18.1% | 20.7% | -2.6% | 3.9% | $32,716 | $5,934 | $6,773 | 2.49% | 5.09% | ($563.74) | 107.0 | $35,022 |
| 2030 | 18.1% | 20.8% | -2.7% | 4.0% | $33,996 | $6,161 | $7,066 | 2.55% | 5.15% | ($575.94) | 109.8 | $37,322 |
| 2031 | 18.1% | 20.9% | -2.7% | 4.1% | $35,318 | $6,402 | $7,371 | 2.59% | 5.19% | ($584.25) | 112.7 | $39,810 |
| 2032 | 18.2% | 21.1% | -2.9% | 4.1% | $36,680 | $6,662 | $7,722 | 2.63% | 5.23% | ($604.69) | 115.9 | $42,519 |
| 2033 | 18.2% | 21.2% | -3.0% | 4.2% | $38,081 | $6,938 | $8,062 | 2.67% | 5.27% | ($607.14) | 119.3 | $45,432 |
| 2034 | 18.3% | 21.3% | -3.0% | 4.2% | $39,519 | $7,217 | $8,413 | 2.71% | 5.31% | ($610.82) | 122.9 | $48,556 |
| 2035 | 18.3% | 21.4% | -3.1% | 4.3% | $40,996 | $7,506 | $8,779 | 2.74% | 5.34% | ($614.50) | 126.6 | $51,904 |
| 2036 | 18.4% | 21.6% | -3.2% | 4.3% | $42,514 | $7,801 | $9,166 | 2.77% | 5.37% | ($622.61) | 130.6 | $55,504 |
| 2037 | 18.4% | 21.7% | -3.3% | 4.3% | $44,074 | $8,110 | $9,567 | 2.80% | 5.40% | ($628.07) | 134.7 | $59,374 |
| 2038 | 18.4% | 21.8% | -3.4% | 4.4% | $45,680 | $8,423 | $9,975 | 2.83% | 5.43% | ($631.58) | 139.1 | $63,531 |
| 2039 | 18.5% | 22.0% | -3.5% | 4.4% | $47,335 | $8,749 | $10,391 | 2.85% | 5.45% | ($631.12) | 143.6 | $67,989 |
| 2040 | 18.5% | 22.1% | -3.6% | 4.5% | $49,035 | $9,082 | $10,827 | 2.88% | 5.48% | ($633.61) | 148.4 | $72,784 |
| 2041 | 18.6% | 22.2% | -3.6% | 4.6% | $50,782 | $9,426 | $11,272 | 2.90% | 5.50% | ($632.63) | 153.5 | $77,943 |
| 2042 | 18.6% | 22.3% | -3.7% | 4.6% | $52,581 | $9,782 | $11,727 | 2.92% | 5.52% | ($629.12) | 158.8 | $83,495 |
| 2043 | 18.7% | 22.4% | -3.8% | 4.7% | $54,443 | $10,158 | $12,208 | 2.94% | 5.54% | ($625.67) | 164.3 | $89,472 |
| 2044 | 18.7% | 22.5% | -3.8% | 4.8% | $56,372 | $10,539 | $12,685 | 2.96% | 5.56% | ($618.12) | 170.1 | $95,891 |
| 2045 | 18.7% | 22.6% | -3.9% | 4.8% | $58,371 | $10,939 | $13,193 | 2.98% | 5.58% | ($612.45) | 176.1 | $102,791 |
| 2046 | 18.8% | 22.7% | -3.9% | 4.9% | $60,444 | $11,359 | $13,709 | 3.00% | 5.60% | ($602.20) | 182.3 | $110,186 |
| 2047 | 18.8% | 22.7% | -3.9% | 5.0% | $62,594 | $11,798 | $14,219 | 3.01% | 5.61% | ($585.45) | 188.6 | $118,078 |
| 2048 | 18.9% | 22.8% | -3.9% | 5.0% | $64,824 | $12,260 | $14,782 | 3.03% | 5.63% | ($575.36) | 195.2 | $126,517 |
| 2049 | 19.0% | 22.8% | -3.9% | 5.0% | $67,132 | $12,726 | $15,328 | 3.04% | 5.64% | ($559.89) | 201.9 | $135,508 |
| 2050 | 19.0% | 22.9% | -3.9% | 5.1% | $69,514 | $13,217 | $15,900 | 3.05% | 5.65% | ($544.63) | 208.7 | $145,085 |
| 2051 | 19.1% | 22.9% | -3.8% | 5.1% | $71,970 | $13,733 | $16,500 | 3.07% | 5.67% | ($529.80) | 215.8 | $155,287 |
| 2052 | 19.1% | 23.0% | -3.9% | 5.2% | $74,505 | $14,254 | $17,130 | 3.07% | 5.67% | ($521.22) | 223.0 | $166,174 |
| Total PV | | | | | | | | | | $(18,077) | | $30,109 |

### 2.6.2 Higher Interest Rates of 2022

The first several months of 2022 saw a dramatic increase in interest rates. Between December 31, 2021 and May 31, 2022, the two-year zero-coupon bond yields rose by 176 basis points, the 10-year bond by 133 basis points, and the 30-year bond by 131 basis points. We now explore what this shift in the term structure implies for our measure of fiscal capacity.

In a first exercise, we assume that this interest rate change only affects the rate at which we discount future surpluses but leaves future debt projections unchanged (as well as tax revenue, spending, and GDP projections).[29,30] The fiscal capacity bound becomes:

$$PV_{2021}^{upper}(\{S\}_{2022}^{2052}) + PV_{2021}^{upper}(D_{2052}) = -\$17.19 + \$22.78 = \$5.59 \text{ tr.}$$

We observe a substantial decline in fiscal capacity from the rise in interest rates, from \$12.38 tr to \$5.59 tr. At the new, higher rates, the valuation ratio of the GDP claim declines from 85.8 to 40.3. Servicing the same 185% debt/GDP after 2052 now requires annual surpluses of 4.59% of GDP compared to 2.16% of GDP. So, even though the fiscal adjustment after 2052 is more than twice as large, the fiscal capacity estimate falls by more than half.

Arguably, it is implausible that the large rise in interest rates would not lead the CBO to revise its interest rate forecast when projecting future debt service and future debt. To consider this additional effect, we add 156 basis points to the CBO's interest rate forecast in each year from 2022–2052. This 156 basis points is the increase in the 5-year bond yield between 12/31/2021 and 5/31/2022, where the 5-year maturity is chosen since it corresponds to the average maturity of the outstanding government bond portfolio. Under this assumption, the interest rate on the debt portfolio is 3.35% in 2022 and rises to 5.72% by 2052. We adjust the debt dynamics to account for the extra interest cost. The debt in 2052 becomes \$187.5 tr (251.6% of GDP) compared to \$137.9 tr (185.0% of GDP) in the baseline. The upper bound on fiscal capacity becomes \$13.79 tr, but that reflects the assumption that the surplus after 2052 now needs to be 6.24% per year compared to 4.59% in the previous exercise. In short, the fiscal capacity measure remains similar to the baseline value of \$12.38 tr but now the annual surpluses that need to be produced after 2052 are nearly triple what they were in the baseline. The massive change in required future fiscal adjustment

[29] As in the previous section, increasing interest rates while keeping nominal GDP growth rates constant amounts to an increase in the real growth-adjusted return $r - g$. Such an increase in real rates is consistent with the data. The 10-year inflation-indexed treasury bond yield increased from -1.04% on 12/31/2021 to +0.21% on 05/31/2022, an increase of 125 basis points. The 10-year TIPS yield continued to increase to 0.65% by 6/30/2022.

[30] To do full-fledged counter-factual exercises, one would ideally like to use a general equilibrium model where GDP, inflation, interest rates, and fiscal policy are endogenously determined. A recent paper along these lines is Elenev, Landvoigt, Shultz, and Van Nieuwerburgh (2021). Such a model would need to take a stance on what the fundamental shocks are that gave rise to the changes in equilibrium interest rates: short-term or long-term productivity shocks, demand shocks, fiscal policy shocks, monetary policy shocks, etc. This is outside the scope of the current paper.

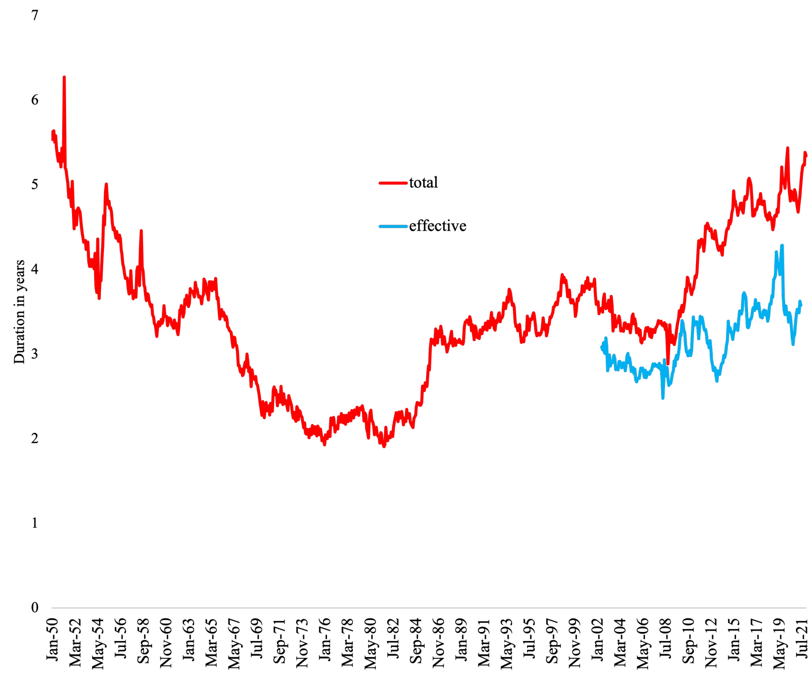


Figure 3: Duration of Treasurys held by the public. Data from CRSP Treasurys.

reflects the high duration of the surplus claim at the end of 2021, when rates were very low, and the realization of a substantial increase in rates since then.

#### 2.6.3 Debt Management

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 mismatch between its cash inflows (the surpluses) and cash outflows (the principal and coupon payments), a direct result of the back-loading 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. This section augments our baseline estimate of fiscal capacity with the present value of the revenue stream the government earns from convenience yields.

JLVX (2019) estimate that the U.S. earns around 60 basis points per annum in convenience yields on the entire U.S. Treasury portfolio. The U.S. has a current debt/output ratio of 99.6% at the end of 2021. When the average convenience yield is 0.60% per annum, the Treasury collects $0.60\% \times 99.6\% = 0.598\%$ of GDP in convenience-yield revenues per year. 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 increases (to 185% of GDP in 2052 in the baseline model). Krishnamurthy and Vissing-Jorgensen (2012) provide evidence on downward-sloping demand curves for safe assets.[31,32]

Table 4 reports the detailed calculations that account for convenience yields. Column (10) reports the seigniorage revenue in billions of dollars equal to 0.598% of GDP. Column (11) then discounts the seigniorage revenue back to 2021 dollars using the baseline discount rates. The sum of all this discounted seigniorage revenue between 2022 and 2052 is \$ 4.04 trillion in 2021 dollars. The upper bound on fiscal capacity is revised upwards by this amount to \$16.4 trillion:

$$PV_{2021}^{upper}\left(\{T-G\}_{2022}^{2052}\right) + PV_{2021}^{upper}\left(D_{2052}\right) + PV_{2021}^{upper}\left(\{CS\}_{2022}^{2052}\right) = \$12.38 + \$4.04 = \$16.42 \text{ tr..}$$

This number is still almost \$6 trillion short of the actual December 2021 value of government debt of \$22.28 tr.

Under the assumption that seigniorage revenue continues to be a constant share of GDP after 2052, the government needs to run a smaller annual surplus of 1.56% ($= 2.16\% - 0.60\%$) of GDP after 2052, rather than 2.16%, to service the debt outstanding at the end of 2052. The smaller surpluses after 2052 also mean that the duration of the surplus claim is shorter than in the benchmark analysis.

[31] 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.

[32] Under the higher interest rate scenarios considered in the previous section, seigniorage revenue from convenience yields would be constant as a fraction of GDP even though convenience yields (seigniorage revenue divided by debt outstanding) would be falling as the debt/GDP ratio increased.

## Table 4: Fiscal Capacity with Convenience Yields

Based on CBO projections released in May of 2022. (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 | $y^{\$}_j$ | $r^{\$,y}_j$ | PV(T-G) | D/Y | CS | PV(CS) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| 2022 | 19.6% | 21.9% | $24,694 | $4,836 | $5,405 | 0.42% | 3.02% | ($552.26) | 97.9 | $147.63 | $143.30 |
| 2023 | 18.6% | 20.7% | $26,240 | $4,889 | $5,419 | 0.76% | 3.36% | ($495.70) | 96.0 | $156.87 | $146.85 |
| 2024 | 18.0% | 20.3% | $27,291 | $4,924 | $5,535 | 0.99% | 3.59% | ($549.75) | 96.1 | $163.15 | $146.79 |
| 2025 | 17.6% | 20.1% | $28,271 | $4,982 | $5,696 | 1.15% | 3.75% | ($616.35) | 97.5 | $169.01 | $145.87 |
| 2026 | 18.0% | 20.4% | $29,266 | $5,280 | $5,962 | 1.27% | 3.87% | ($564.72) | 98.8 | $174.97 | $144.71 |
| 2027 | 18.3% | 20.4% | $30,332 | $5,548 | $6,201 | 1.36% | 3.96% | ($517.27) | 100.0 | $181.33 | $143.63 |
| 2028 | 18.2% | 20.6% | $31,487 | $5,716 | $6,486 | 1.43% | 4.03% | ($583.70) | 102.0 | $188.24 | $142.72 |
| 2029 | 18.1% | 20.7% | $32,716 | $5,934 | $6,773 | 1.49% | 4.09% | ($608.55) | 103.2 | $195.59 | $141.89 |
| 2030 | 18.1% | 20.8% | $33,996 | $6,161 | $7,066 | 1.55% | 4.15% | ($627.67) | 105.3 | $203.24 | $141.02 |
| 2031 | 18.1% | 20.9% | $35,318 | $6,402 | $7,371 | 1.59% | 4.19% | ($642.81) | 107.5 | $211.14 | $140.05 |
| 2032 | 18.2% | 21.1% | $36,680 | $6,662 | $7,722 | 1.63% | 4.23% | ($671.66) | 109.6 | $219.28 | $138.99 |
| 2033 | 18.2% | 21.2% | $38,081 | $6,938 | $8,062 | 1.67% | 4.27% | ($680.82) | 112.0 | $227.66 | $137.83 |
| 2034 | 18.3% | 21.3% | $39,519 | $7,217 | $8,413 | 1.71% | 4.31% | ($691.49) | 114.4 | $236.26 | $136.57 |
| 2035 | 18.3% | 21.4% | $40,996 | $7,506 | $8,779 | 1.74% | 4.34% | ($702.29) | 117.0 | $245.09 | $135.22 |
| 2036 | 18.4% | 21.6% | $42,514 | $7,801 | $9,166 | 1.77% | 4.37% | ($718.35) | 119.8 | $254.16 | $133.79 |
| 2037 | 18.4% | 21.7% | $44,074 | $8,110 | $9,567 | 1.80% | 4.40% | ($731.56) | 122.7 | $263.49 | $132.29 |
| 2038 | 18.4% | 21.8% | $45,680 | $8,423 | $9,975 | 1.83% | 4.43% | ($742.66) | 125.8 | $273.09 | $130.74 |
| 2039 | 18.5% | 22.0% | $47,335 | $8,749 | $10,391 | 1.85% | 4.45% | ($749.19) | 129.1 | $282.98 | $129.15 |
| 2040 | 18.5% | 22.1% | $49,035 | $9,082 | $10,827 | 1.88% | 4.48% | ($759.32) | 132.5 | $293.15 | $127.51 |
| 2041 | 18.6% | 22.2% | $50,782 | $9,426 | $11,272 | 1.90% | 4.50% | ($765.37) | 136.1 | $303.59 | $125.84 |
| 2042 | 18.6% | 22.3% | $52,581 | $9,782 | $11,727 | 1.92% | 4.52% | ($768.38) | 139.9 | $314.35 | $124.15 |
| 2043 | 18.7% | 22.4% | $54,443 | $10,158 | $12,208 | 1.94% | 4.54% | ($771.44) | 143.9 | $325.48 | $122.46 |
| 2044 | 18.7% | 22.5% | $56,372 | $10,539 | $12,685 | 1.96% | 4.56% | ($769.40) | 148.0 | $337.01 | $120.79 |
| 2045 | 18.7% | 22.6% | $58,371 | $10,939 | $13,193 | 1.98% | 4.58% | ($769.60) | 152.3 | $348.96 | $119.13 |
| 2046 | 18.8% | 22.7% | $60,444 | $11,359 | $13,709 | 2.00% | 4.60% | ($763.93) | 156.7 | $361.36 | $117.49 |
| 2047 | 18.8% | 22.7% | $62,594 | $11,798 | $14,219 | 2.01% | 4.61% | ($749.74) | 161.2 | $374.21 | $115.88 |
| 2048 | 18.9% | 22.8% | $64,824 | $12,260 | $14,782 | 2.03% | 4.63% | ($743.84) | 165.8 | $387.54 | $114.29 |
| 2049 | 19.0% | 22.8% | $67,132 | $12,726 | $15,328 | 2.04% | 4.64% | ($730.74) | 170.5 | $401.34 | $112.71 |
| 2050 | 19.0% | 22.9% | $69,514 | $13,217 | $15,900 | 2.05% | 4.65% | ($717.59) | 175.2 | $415.58 | $111.14 |
| 2051 | 19.1% | 22.9% | $71,970 | $13,733 | $16,500 | 2.07% | 4.67% | ($704.70) | 180.1 | $430.26 | $109.57 |
| 2052 | 19.1% | 23.0% | $74,505 | $14,254 | $17,130 | 2.07% | 4.67% | ($699.91) | 185.0 | $445.42 | $108.37 |
| Total | | | | | | | | $ (21,161) | $ 33,540 | | $ 4,041 |

**Broad and narrow convenience yields.** In our analysis above, we kept the discount rate used to discount future surpluses and future debt unchanged when introducing convenience yields. Implicitly, this assumed that there was a decline in the risk premium (of 60 basis points) that exactly offset the increase in the true risk-free yield (of 60 basis points). JLVX (2019) refer to this as a *narrow convenience yield*, a convenience yield which does not accrue to asset classes other than Treasurys. By not increasing the discount rate when the true risk-free rate increased, we did not decrease the present value of the seigniorage revenue from convenience yields as well as the present value of primary surpluses, If anything, this overstated the extra fiscal capacity that convenience yields generated. Since we showed that this generous upper bound on fiscal capacity inclusive of convenience yields is still too low, our results are conservative.

Recently, Reis (2021) has convincingly argued that convenience yields on U.S. Treasurys could be much larger than 60 basis points per year. While larger convenience yields generate an additional source of revenue that expands fiscal capacity, they also generate a discount rate effect that shrinks fiscal capacity. The reason is that large convenience yields are likely *broad convenience yields*, which apply to assets beyond U.S. Treasuries. Such broad convenience yields raise the true risk-free interest rate (on risk-free assets without convenience) but also the discount rate on risky assets such as the GDP claim. Risk premia declines do not fully offset the risk-free rate effect. Higher discount rates lower the present value of the seigniorage revenue stream and the primary surplus stream, all else equal. Hence, it is not clear that even much larger convenience yields actually result in more fiscal capacity.

# 4 Front-loaded Fiscal Adjustment

So far, we have established that the current level of debt is higher than our upper bound on fiscal capacity, even after including seigniorage revenue from convenience yields. This raises the question how the U.S. economy can increase its fiscal capacity. A natural answer is that it must increase its surpluses.

This section implements a counterfactual exercise by asking by how much CBO primary surplus projections have to rise in order to obtain a fiscal capacity estimate consistent with the 99.7% debt/output ratio at the end of 2021. We consider level shifts that raise the surplus/GDP ratio in each year from 2022 until 2031. This policy change also affects the debt dynamics. We compute these projected debt dynamics, $D_{t+1} = D_t \times R_{t+1} + S_{t+1}$, using the new projected primary surpluses and the CBO's interest rate projections. When performing this counterfactual, we make the following assumption.

**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.

We first consider an increase in the primary surplus by 3.0% points of GDP in each of the years between 2022 and 2052 relative to the CBO projection. This fiscal adjustment increases the PDV of surpluses between 2022 and 2052 from -$21.16 tr in the baseline to -$0.88 tr. Hence, a fiscal adjustment of 3.0% per year nearly eliminates all deficits over the next 31 years in present value. The higher primary surpluses decreases the value of debt outstanding at the end of 2052 to 87.5% of GDP. Discounted back to 2021, that is $ 15.86 tr. Combined, this raises the upper bound on fiscal capacity from $12.38 tr in the benchmark to $ 14.97 tr:

$$PV^{upper}_{2021}(\{T-G\}^{2052}_{2022}) + PV^{upper}_{2021}(D_{2052}) = -\$0.88 + \$15.86 = \$14.97 \text{ tr.}$$

In this counter-factual exercise, the U.S. Treasury front-loads the fiscal adjustment, compared to the benchmark case in which the government waits until after 2052 before running primary surpluses. In this front-loaded case, the U.S. only needs a 1.02% annual primary surplus after 2052, less than half the 2.16% annual surplus number in the baseline. Figure 1 plots this front-loaded path of surpluses in black. In this scenario, the duration declines to 126 years from 283 years in the baseline.

Next, we repeat the fiscal capacity calculation assuming increases in the surplus/GDP ratio ranging from 0.5% per year to 8.0% per year in each of the years between 2022 and 2052 relative to the CBO projection. Figure 4 plots the total fiscal capacity on the y-axis against the increase in the projected surplus/GDP ratio for the period 2022–2052. The previous example of a 3.0% increase lies in the middle of this graph.

To get to an upper bound on fiscal capacity of $ 18.3 trillion, we need an extra primary surplus of 6.0% of GDP in all years between 2022 and 2052. Table 5 provides all of the details of the calculation. This scenario pushes the debt/GDP ratio into negative territory by 2050. The fiscal capacity bound reaches:

$$PV^{upper}_{2021}(\{T-G\}^{2052}_{2022}) + PV^{upper}_{2021}(D_{2052}) = \$19.39 - \$1.09 = \$18.30 \text{ tr.}$$

Once we factor in the $4.04 tr in convenience yield revenues, this scenario of 6.0% additional surpluses between 2022–2052 produces a fiscal capacity estimate that essentially matches the observed debt outstanding of $22.28 tr as of the end of 2021. Figure 1 also plots this 6.0% extra surpluses path of completely front-loaded surpluses in blue. In this scenario, the government can run a small primary deficit of 0.07% of GDP in each year after 2052.

Figure 5 plots the contribution of each surplus cash flow to the overall duration of the surplus claim in this front-loaded scenario with 6% additional surpluses. This surplus claim has a

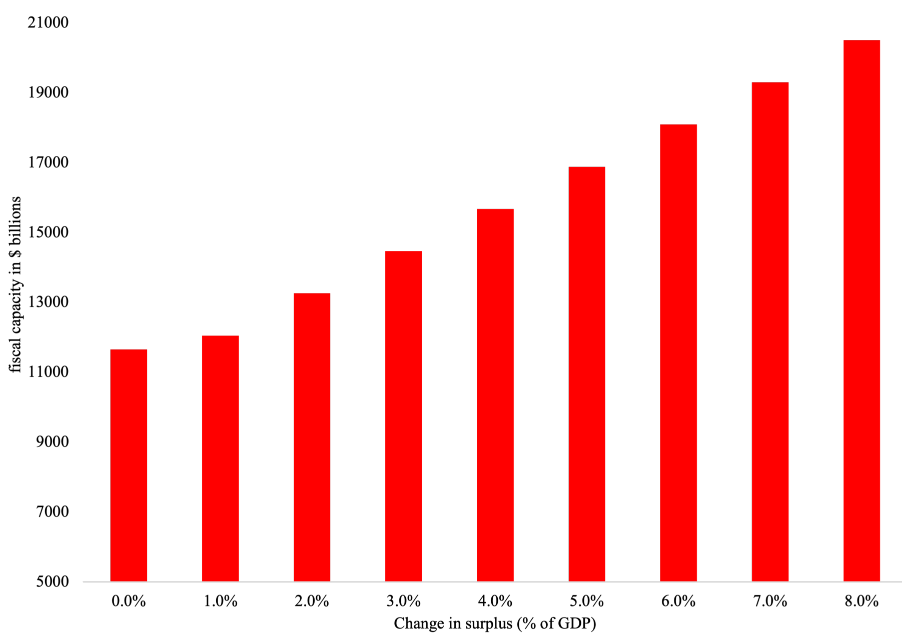


Figure 4: Fiscal Capacity For Additional Surpluses in 2022–52

Fiscal Capacity in $ billions on vertical axis. Horizontal axis: Change in primary surplus as % of U.S. GDP in each year between 2022 and 2052 relative to the Baseline CBO Projection.

## Table 5: Fiscal Capacity with 6% Extra Surplus in 2022–52

Based on CBO primary surplus projections plus an additional 6.0% of GDP in primary surplus for each year from 2022 until 2052. 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: $D_{t+1} = D_t \times R_{t+1} + (T_{t+1} - G_{t+1})$, where $R_{t+1}$ 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 | 25.6% | 21.9% | 3.7% | 1.8% | $24,694 | $6,318 | $5,405 | 0.42% | 3.02% | $885.92 | 88.2 | $21,770 |
| 2023 | 24.6% | 20.7% | 4.0% | 1.8% | $26,240 | $6,464 | $5,419 | 0.76% | 3.36% | $978.13 | 80.5 | $21,124 |
| 2024 | 24.0% | 20.3% | 3.8% | 2.1% | $27,291 | $6,561 | $5,535 | 0.99% | 3.59% | $923.46 | 75.3 | $20,538 |
| 2025 | 23.6% | 20.1% | 3.5% | 2.3% | $28,271 | $6,678 | $5,696 | 1.15% | 3.75% | $847.66 | 70.8 | $20,029 |
| 2026 | 24.0% | 20.4% | 3.7% | 2.5% | $29,266 | $7,036 | $5,962 | 1.27% | 3.87% | $887.63 | 66.5 | $19,450 |
| 2027 | 24.3% | 20.4% | 3.8% | 2.6% | $30,332 | $7,368 | $6,201 | 1.36% | 3.96% | $924.26 | 62.0 | $18,792 |
| 2028 | 24.2% | 20.6% | 3.6% | 2.8% | $31,487 | $7,605 | $6,486 | 1.43% | 4.03% | $848.70 | 57.8 | $18,195 |
| 2029 | 24.1% | 20.7% | 3.4% | 2.9% | $32,716 | $7,897 | $6,773 | 1.49% | 4.09% | $815.51 | 53.8 | $17,595 |
| 2030 | 24.1% | 20.8% | 3.3% | 3.0% | $33,996 | $8,201 | $7,066 | 1.55% | 4.15% | $787.59 | 50.0 | $16,985 |
| 2031 | 24.1% | 20.9% | 3.3% | 3.1% | $35,318 | $8,521 | $7,371 | 1.59% | 4.19% | $762.76 | 46.3 | $16,356 |
| 2032 | 24.2% | 21.1% | 3.1% | 3.1% | $36,680 | $8,863 | $7,722 | 1.63% | 4.23% | $723.27 | 42.9 | $15,729 |
| 2033 | 24.2% | 21.2% | 3.0% | 3.2% | $38,081 | $9,223 | $8,062 | 1.67% | 4.27% | $702.49 | 39.6 | $15,073 |
| 2034 | 24.3% | 21.3% | 3.0% | 3.2% | $39,519 | $9,588 | $8,413 | 1.71% | 4.31% | $679.15 | 36.4 | $14,387 |
| 2035 | 24.3% | 21.4% | 2.9% | 3.3% | $40,996 | $9,965 | $8,779 | 1.74% | 4.34% | $654.79 | 33.3 | $13,671 |
| 2036 | 24.4% | 21.6% | 2.8% | 3.3% | $42,514 | $10,352 | $9,166 | 1.77% | 4.37% | $624.36 | 30.4 | $12,937 |
| 2037 | 24.4% | 21.7% | 2.7% | 3.3% | $44,074 | $10,754 | $9,567 | 1.80% | 4.40% | $596.13 | 27.6 | $12,182 |
| 2038 | 24.4% | 21.8% | 2.6% | 3.4% | $45,680 | $11,164 | $9,975 | 1.83% | 4.43% | $569.46 | 25.0 | $11,406 |
| 2039 | 24.5% | 22.0% | 2.5% | 3.4% | $47,335 | $11,589 | $10,391 | 1.85% | 4.45% | $546.99 | 22.4 | $10,599 |
| 2040 | 24.5% | 22.1% | 2.4% | 3.5% | $49,035 | $12,024 | $10,827 | 1.88% | 4.48% | $520.44 | 19.9 | $9,772 |
| 2041 | 24.6% | 22.2% | 2.4% | 3.6% | $50,782 | $12,473 | $11,272 | 1.90% | 4.50% | $497.62 | 17.6 | $8,918 |
| 2042 | 24.6% | 22.3% | 2.3% | 3.6% | $52,581 | $12,937 | $11,727 | 1.92% | 4.52% | $477.64 | 15.3 | $8,033 |
| 2043 | 24.7% | 22.4% | 2.2% | 3.7% | $54,443 | $13,424 | $12,208 | 1.94% | 4.54% | $457.62 | 13.1 | $7,114 |
| 2044 | 24.7% | 22.5% | 2.2% | 3.8% | $56,372 | $13,921 | $12,685 | 1.96% | 4.56% | $442.89 | 10.9 | $6,147 |
| 2045 | 24.7% | 22.6% | 2.1% | 3.8% | $58,371 | $14,441 | $13,193 | 1.98% | 4.58% | $426.05 | 8.8 | $5,135 |
| 2046 | 24.8% | 22.7% | 2.1% | 3.9% | $60,444 | $14,986 | $13,709 | 2.00% | 4.60% | $415.28 | 6.7 | $4,058 |
| 2047 | 24.8% | 22.7% | 2.1% | 4.0% | $62,594 | $15,553 | $14,219 | 2.01% | 4.61% | $413.25 | 4.6 | $2,885 |
| 2048 | 24.9% | 22.8% | 2.1% | 4.0% | $64,824 | $16,150 | $14,782 | 2.03% | 4.63% | $403.18 | 2.5 | $1,633 |
| 2049 | 25.0% | 22.8% | 2.1% | 4.0% | $67,132 | $16,754 | $15,328 | 2.04% | 4.64% | $400.44 | 0.4 | $274 |
| 2050 | 25.0% | 22.9% | 2.1% | 4.1% | $69,514 | $17,388 | $15,900 | 2.05% | 4.65% | $397.83 | -1.7 | ($1,203) |
| 2051 | 25.1% | 22.9% | 2.2% | 4.1% | $71,970 | $18,051 | $16,500 | 2.07% | 4.67% | $394.96 | -3.9 | ($2,803) |
| 2052 | 25.1% | 23.0% | 2.1% | 4.2% | $74,505 | $18,724 | $17,130 | 2.07% | 4.67% | $387.75 | -6.1 | ($4,513) |
| Total PV | | | | | | | | | | $19,393 | | $(1,098) |

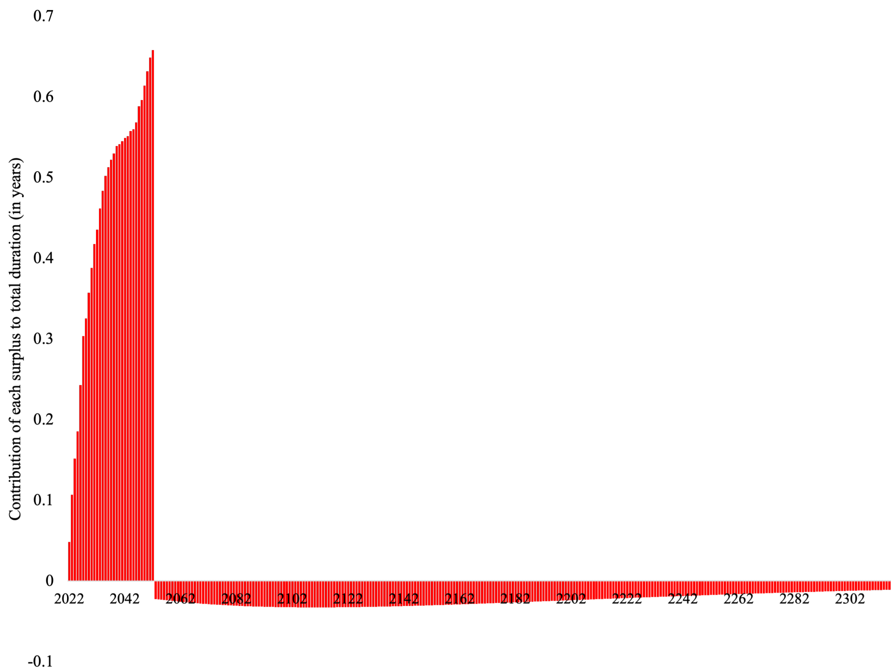


Figure 5: Duration Composition in Front-loaded Scenario

Contribution of each payment $\frac{k \times PV(S_{2021+k})}{\sum_{h=1} PV(S_{2021+h})}$ to total duration. Primary surplus: CBO Baseline Projection +6% of GDP in each year between 2022 and 2052. The duration (in years) is the sum of the bars shown.

duration of 6.95 years, which is close to that of the outstanding Treasury portfolio.[33] In sum, if the government wants to match the duration of the surpluses (cash inflows) to the duration of the outstanding portfolio of Treasury debt (cash outflows), it needs to raise annual surpluses relative to the CBO scenario by about 6.0% per year over the next 31 years. Suffice to say that this is a massive fiscal effort.

## 5 Counter-cyclical Tax 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 (JLVX (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,

[33] The duration is sensitive to the additional surplus. Raising the additional surplus from 6.0% to 6.1% per year until 2052 lowers the duration from 6.95 to 3.45 years.

Table 6: U.S. Treasury Balance Sheet in Steady-State Counter-cyclical Tax Example

Treasury Balance Sheet in Market Values. Steady-State Example. Expressed as a multiple of U.S. GDP at the end of 2021. Example based on actual spending/GDP ratio in 2022. In this example, the risk premium on the tax claim is 22 bps. lower than the risk premium on the spending claim.

| Assets | | Liabilities | |
|---|---|---|---|
| $PV_{2021}(\{T\})/Y_{2021}$ | $19.71 = 18.71\% \times 105.3$ | $PV_{2021}(\{G\})/Y_{2021}$ | $18.79 = 21.9\% \times 85.8$ |
| | | $D/Y_{2021}$ | $0.99 = 18.71\% \times 105.3 - 21.9\% \times 85.8$ |
| Total | 19.71 | Total | 19.71 |

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 (JLVX (2019)).

If the U.S. government were to radically change its future fiscal policy and raise more tax revenue as a share of GDP in recessions, this would make the tax claim less risky than the spending claim. We entertain this possibility because this regime change can sustain (modest) steady-state deficits. In this regime, taxpayers and transfer recipients provide insurance against business cycle risk to the bondholders. Taxpayers pay more taxes as a fraction of GDP in recessions, while transfer recipients receive less. To make this concrete, when taxpayers wake up in a recession, the CBO should be projecting larger tax revenue as a fraction of GDP in PDV, and smaller spending as a fraction of GDP than in an expansion, meaning that the bottom row of column (9) in Table 1 increases (decreases) when a recession (expansion) starts .

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:

$$PV_{2021}^{upper}(\{T-G\}_{2052}^{\infty}) = \sum_{h=1}^{\infty} \frac{T_{2021+h}}{(1+r^{\$,t}(h))^h} - \sum_{h=1}^{\infty} \frac{G_{2021+h}}{(1+r^{\$,g}(h))^h} = (pd^t \times \frac{T}{Y} - pd^g \times \frac{G}{Y}) \times Y_{2021}.$$

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. Table 6 provides a simple example, starting from the actual spending/output ratio for 2022. If the multiple on the tax claim is boosted to 105.3, then the U.S. government can run a steady-state deficit of 3.19%, the CBO-projected average deficit. The implied debt/output ratio is still 0.99. The government can engineer this outcome by committing to a pro-cyclical fiscal policy (leaning with the wind) that raises taxes $T/Y$ in bad times, thus lowering the risk premium. However, this is not a free lunch. Taxpayers are being asked to bear more business cycle risk in order to provide insurance to bondholders, allowing the government to earn an insurance premium each year that is 3.19% of GDP. This is counterfactual. Governments in advanced economies typically provide

## Table 7: Fiscal Capacity with Counter-Cyclical Tax Revenues

Based on CBO projections released in May of 2022. Columns (4), (5), (6), and (12) are in $ billions. Columns (9) and (10) report the PDV of tax revenue and spending in 2021 $ billions, respectively. The discount rate used for the tax claim is 100 basis points lower than that used for the spending claim.

| 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 | 19.6% | 21.9% | -2.3% | $24,694 | $4,836 | $5,405 | 0.42% | 3.02% | $4,740.22 | $5,246.47 | 97.9 | $24,173 |
| 2023 | 18.6% | 20.7% | -2.0% | $26,240 | $4,889 | $5,419 | 0.76% | 3.36% | $4,667.08 | $5,072.90 | 96.0 | $25,193 |
| 2024 | 18.0% | 20.3% | -2.2% | $27,291 | $4,924 | $5,535 | 0.99% | 3.59% | $4,560.75 | $4,979.69 | 96.1 | $26,217 |
| 2025 | 17.6% | 20.1% | -2.5% | $28,271 | $4,982 | $5,696 | 1.15% | 3.75% | $4,469.39 | $4,915.89 | 97.5 | $27,561 |
| 2026 | 18.0% | 20.4% | -2.3% | $29,266 | $5,280 | $5,962 | 1.27% | 3.87% | $4,583.17 | $4,931.48 | 98.8 | $28,925 |
| 2027 | 18.3% | 20.4% | -2.2% | $30,332 | $5,548 | $6,201 | 1.36% | 3.96% | $4,657.12 | $4,911.99 | 100.0 | $30,326 |
| 2028 | 18.2% | 20.6% | -2.4% | $31,487 | $5,716 | $6,486 | 1.43% | 4.03% | $4,636.87 | $4,917.44 | 102.0 | $32,105 |
| 2029 | 18.1% | 20.7% | -2.6% | $32,716 | $5,934 | $6,773 | 1.49% | 4.09% | $4,650.55 | $4,913.48 | 103.2 | $33,760 |
| 2030 | 18.1% | 20.8% | -2.7% | $33,996 | $6,161 | $7,066 | 1.55% | 4.15% | $4,662.85 | $4,902.70 | 105.3 | $35,808 |
| 2031 | 18.1% | 20.9% | -2.7% | $35,318 | $6,402 | $7,371 | 1.59% | 4.19% | $4,676.14 | $4,889.04 | 107.5 | $37,949 |
| 2032 | 18.2% | 21.1% | -2.9% | $36,680 | $6,662 | $7,722 | 1.63% | 4.23% | $4,695.09 | $4,894.36 | 109.6 | $40,213 |
| 2033 | 18.2% | 21.2% | -3.0% | $38,081 | $6,938 | $8,062 | 1.67% | 4.27% | $4,715.35 | $4,881.23 | 112.0 | $42,636 |
| 2034 | 18.3% | 21.3% | -3.0% | $39,519 | $7,217 | $8,413 | 1.71% | 4.31% | $4,728.10 | $4,863.04 | 114.4 | $45,219 |
| 2035 | 18.3% | 21.4% | -3.1% | $40,996 | $7,506 | $8,779 | 1.74% | 4.34% | $4,738.61 | $4,843.22 | 117.0 | $47,975 |
| 2036 | 18.4% | 21.6% | -3.2% | $42,514 | $7,801 | $9,166 | 1.77% | 4.37% | $4,744.45 | $4,824.82 | 119.8 | $50,926 |
| 2037 | 18.4% | 21.7% | -3.3% | $44,074 | $8,110 | $9,567 | 1.80% | 4.40% | $4,749.69 | $4,803.35 | 122.7 | $54,088 |
| 2038 | 18.4% | 21.8% | -3.4% | $45,680 | $8,423 | $9,975 | 1.83% | 4.43% | $4,749.26 | $4,775.27 | 125.8 | $57,472 |
| 2039 | 18.5% | 22.0% | -3.5% | $47,335 | $8,749 | $10,391 | 1.85% | 4.45% | $4,748.01 | $4,742.30 | 129.1 | $61,087 |
| 2040 | 18.5% | 22.1% | -3.6% | $49,035 | $9,082 | $10,827 | 1.88% | 4.48% | $4,742.43 | $4,709.73 | 132.5 | $64,963 |
| 2041 | 18.6% | 22.2% | -3.6% | $50,782 | $9,426 | $11,272 | 1.90% | 4.50% | $4,735.76 | $4,672.62 | 136.1 | $69,115 |
| 2042 | 18.6% | 22.3% | -3.7% | $52,581 | $9,782 | $11,727 | 1.92% | 4.52% | $4,727.50 | $4,631.66 | 139.9 | $73,568 |
| 2043 | 18.7% | 22.4% | -3.8% | $54,443 | $10,158 | $12,208 | 1.94% | 4.54% | $4,721.94 | $4,593.42 | 143.9 | $78,343 |
| 2044 | 18.7% | 22.5% | -3.8% | $56,372 | $10,539 | $12,685 | 1.96% | 4.56% | $4,711.61 | $4,546.68 | 148.0 | $83,447 |
| 2045 | 18.7% | 22.6% | -3.9% | $58,371 | $10,939 | $13,193 | 1.98% | 4.58% | $4,702.92 | $4,504.00 | 152.3 | $88,909 |
| 2046 | 18.8% | 22.7% | -3.9% | $60,444 | $11,359 | $13,709 | 2.00% | 4.60% | $4,696.07 | $4,457.38 | 156.7 | $94,734 |
| 2047 | 18.8% | 22.7% | -3.9% | $62,594 | $11,798 | $14,219 | 2.01% | 4.61% | $4,689.75 | $4,403.10 | 161.2 | $100,911 |
| 2048 | 18.9% | 22.8% | -3.9% | $64,824 | $12,260 | $14,782 | 2.03% | 4.63% | $4,685.91 | $4,359.44 | 165.8 | $107,481 |
| 2049 | 19.0% | 22.8% | -3.9% | $67,132 | $12,726 | $15,328 | 2.04% | 4.64% | $4,676.48 | $4,304.70 | 170.5 | $114,436 |
| 2050 | 19.0% | 22.9% | -3.9% | $69,514 | $13,217 | $15,900 | 2.05% | 4.65% | $4,669.42 | $4,252.18 | 175.2 | $121,798 |
| 2051 | 19.1% | 22.9% | -3.8% | $71,970 | $13,733 | $16,500 | 2.07% | 4.67% | $4,664.32 | $4,201.80 | 180.1 | $129,588 |
| 2052 | 19.1% | 23.0% | -3.9% | $74,505 | $14,254 | $17,130 | 2.07% | 4.67% | $4,670.11 | $4,167.90 | 185.0 | $137,852 |
| Total | | | | | | | | | | $(846.4) | $ 33,540 | |

insurance against business cycle risk.[34]

Let's turn to the detailed CBO projections. Suppose that the tax claim's appropriate discount rate is 100 basis points lower than that the discount rate for the output claim. Table 7 reports the calculations. Now, the sum of (the upper bound on) the PDV of the tax revenue minus spending cash flows from 2022-2052 adds up to -\$847 billion dollars:

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2052}) = \sum_{h=1}^{31} \frac{T_{2021+j}}{(1+r^{\$,y}(h)-0.01)^h} - \sum_{h=1}^{31} \frac{G_{2021+j}}{(1+r^{\$,y}(h))^h} = -\$0.85 \text{ tr.}$$

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 \$21.16 tr to \$ 0.85 trillion. If we combine this with the \$33.54 trillion in PDV of future debt, we end up with a total value of \$32.7 trillion for the value of debt at the end of 2021.

$$PV_{2021}^{upper}(\{T-G\}_{2022}^{2052}) + PV_{2021}^{upper}(D_{2052}) = \$32.69 \text{ tr.}$$

This measure of fiscal capacity comfortably 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, where tax rates go up in recessions, seems unlikely because of the pain it would inflict on taxpayers.

## 6 Conclusion

We develop a new approach based on textbook finance to assess the government's fiscal capacity and we apply this framework to the CBO's projections of the federal government's primary surpluses. Using plausible discount rate assumptions, we measure the fiscal capacity of the U.S. federal government implied by the May 2022 CBO projections. In spite of the historically low current rates, the upper bound on fiscal capacity is only around 56% of the observed debt outstanding in 2021. In light of these results, we conclude that the Treasury market has likely priced in a large fiscal correction relative to the CBO baseline projections or future real rate distortions (financial repression), or a combination of both.

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. The back-loading of surpluses creates a large duration mismatch between

[34] See JLVX (2020) for evidence on the GDP growth betas of U.S. taxes and spending over longer horizons. They find large positive GDP growth betas for taxes at shorter horizons, and negative GDP growth betas for spending.

the government's assets, its future surpluses, and its liabilities, its promised coupon and principal payments on the Treasury portfolio. Because of the backloading of future surpluses, the Treasury faces a duration mismatch between its cash inflows and outflows. Modest increases in interest rates, of the kind the U.S. economy experienced in the first half of 2022, then lead to sharp increases in the size of required fiscal adjustments.

Our analysis highlights a shortcoming in the standard fiscal sustainability analysis, namely the practice of discounting future primary surpluses and future debt at the risk-free interest rate to measure fiscal capacity. This standard practice ignores a basic insight from finance that the discount rate should always reflect the risk of the cash flows. Fiscal cash flow projections are always made relative to GDP projections. But the future course of the economy is unknown, and hence fundamentally risky. Future primary surpluses inherit the risk in future GDP and are at least as risky as future GDP unless the government chooses counter-cyclical surpluses. Hence, future surpluses should be discounted at a rate that includes a risk premium that is at least as large as the GDP risk premium.

To be clear, there is considerable uncertainty about the GDP risk premium. Our baseline estimate for the total wealth valuation multiple is 85. A lower risk premium and a higher multiple leads to higher estimates of fiscal capacity, but this would imply counterfactual valuation multiples well in excess of 100 for unlevered companies growing at the same rate as the U.S. economy. Lower discount rates also lead to an even larger duration mismatch between the government's assets and liabilities, and hence even larger fiscal vulnerability to the risk of rising interest rates. Model uncertainty is not a panacea to get us out of the fiscal conundrum.

The U.S. is different because of its unique role as the world's safe asset supplier. Our calculations capture this by quantifying the seigniorage revenue from convenience yields. Global investors may allocate additional borrowing capacity to the world's safe asset supplier, as argued by He, Krishnamurthy, and Milbradt (2019). This may have been the case for the UK in the 19th century, but that privilege proved to be transitory (CJLVX (2022)). While we cannot definitively rule out that the U.S. government is one of the only countries to have permanently escaped the intertemporal budget constraint by engineering a bubble in the bond market, it seems prudent to assume that this is not the case, especially from the perspective of future U.S. generations.

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