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Measuring US Fiscal Capacity Using Discounted Cash Flow Analysis

ABSTRACT We use discounted cash flow analysis to measure the projected fiscal capacity of the US federal government. We apply our valuation method to the Congressional Budget Office (CBO) projections for the US federal government's primary deficits between 2022 and 2052 and projected debt outstanding in 2052. The discount rate for projected cash flows and future debt must include a GDP or market risk premium in recognition of the risk associated with future surpluses. Despite current low interest rates, we find that US fiscal capacity is more limited than commonly thought. 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 interest 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.

Recently, there has been an active debate about the fiscal capacity of the United States and other countries, but there is no consensus on the proper measurement of fiscal capacity. Some economists have argued that we can use the ratio of the government's interest expense over GDP as a

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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 interest rates have substantially increased US fiscal capacity.

We define a country's projected fiscal capacity as the present discounted value (PDV) of that country's projected future primary surpluses. We apply our method using the long-term budget projections from the Congressional Budget Office (CBO) as the point estimate of future cash flows.

In standard models with long-horizon investors, the government's debt is fully backed by future surpluses. The measurement of fiscal capacity then becomes a forward-looking valuation exercise. The country's actual fiscal capacity can differ from our projected measure if the market's valuation of the debt exceeds the PDV of projected surpluses. This means that the market is pricing in a large fiscal correction relative to the projections.

Our definition of fiscal capacity differs from the one commonly used by the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD), and other institutions that use a marginal definition of fiscal capacity or fiscal space: the ability to issue additional debt in response to a shock (Botev, Fournier, and Mourougane 2016). These distinct concepts are connected. If a country's projected fiscal capacity is low relative to the value of debt outstanding, then the country's ability to issue additional debt at low interest rates is impaired. Our approach has a number of advantages. First, our measure is easily quantifiable. We come up with a dollar amount, not a combination of indicators as produced by the IMF or OECD. Second, our approach is founded in modern finance. We rule out free lunches for the government and apply textbook finance to the Treasury's balance sheet.[1]

We propose a simple, easy-to-implement discounted cash flow approach. As in any valuation exercise, this approach requires estimating the discount rate as well as forecasting the underlying cash flows, tax revenues minus non-interest government spending. A proper discount rate for projected surpluses and future debt must reflect the riskiness of the underlying cash flows. Following our previous work (Jiang and others 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 or market portfolio, to discount future taxes, spending, and future debt. This approach implicitly assumes that surpluses are as risky as GDP. That is a conservative assumption because

1. See Lucas (2012) on the importance of proper risk adjustment when evaluating government policies.

the surplus/GDP ratio is pro-cyclical. As a result, our risk adjustment is too small and our measure of projected fiscal capacity will tend to overstate actual fiscal capacity.

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 percent per year. When we use this discount rate, the PDV of future debt is well-behaved even when the risk-free rate is lower than the growth rate.

In the discounted cash flow approach, the PDV of debt outstanding in the distant future converges to zero. The transversality condition (TVC) holds because the discount rate applied to future debt includes a GDP risk premium.[2] Hence our definition of fiscal capacity as the PDV of future primary surpluses. We explore a conservative scenario in which the debt projected by the CBO at the end of the projection horizon is fully backed by subsequent surpluses.

In spite of the secular decline in long rates, we find that US fiscal capacity is limited. The CBO projects average primary surpluses of −3.2 percent of GDP between 2022 and 2052. The PDV of these projected surpluses is −\$21.16 trillion in 2021 dollars. In addition, the CBO-projected debt outstanding in 2052 is 185 percent of GDP. Starting in 2053, the United States would need to generate a steady-state surplus of 2.16 percent 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 surpluses until 2052 of −\$21.16 trillion with the PDV of the projected debt outstanding in 2052 of \$33.5 trillion, we end up with an upper bound on the projected fiscal capacity of \$12.34 trillion. This is our baseline estimate of (an upper bound on) projected fiscal capacity. It falls about \$10 trillion short of the actual \$22.28 trillion value of all US Treasuries outstanding at the end of 2021. This gap occurs even though we assumed a large, permanent fiscal (primary surplus) correction of 5.36 percent of GDP per year after 2055 relative to the 2022–2052 period.

Alternatively, instead of using the CBO-projected debt in 2052, we can back out the annual surplus after 2052 that is required to match the value of outstanding debt at the end of 2021 to the PDV of all surpluses after 2021. We find that the United States would need to run a permanent primary surplus of 2.79 percent of GDP after 2052, a 5.98 percent fiscal correction relative to the pre-2052 path for surpluses.

2. In the discounted cash flow approach, the TVC only fails if the GDP risk premium is smaller than the difference between the growth rate of the economy and the risk-free interest rate. This is not the case for the United States.

An extended measure of the projected fiscal capacity includes the seigniorage revenue earned by the Treasury. US Treasuries earn a convenience yield because they play a special role in the global financial system. Adding the present value of these seigniorage revenues of $4.04 trillion brings our final estimate for the upper bound on fiscal capacity in 2021 to $16.42 trillion, or 73 percent of 2021 GDP. This estimate remains substantially below the observed value of debt to GDP at the end of 2021. Despite the current low interest rates (and hence low debt service), and even after considering the special status of Treasuries, we find that US fiscal capacity is quite limited.

There are three potential explanations for the large gap between the PDV of surpluses we compute and the market's valuation of Treasuries. First, the Treasury market is right and rational market participants anticipate either a large fiscal correction that is not reflected in the CBO's projections or Japan-style financial repression. We quantify this correction in the paper. Second, the market is wrong. Investors—as of the end of 2021—could be overly optimistic about future surpluses or fail to price in future inflation. Mispricing in financial markets can persist for long periods of time. Third, the market may anticipate a switch from the current regime with pro-cyclical primary surpluses to one with countercyclical surpluses. Making tax revenues countercyclical would lower the discount rate on the tax revenue claim, and making non-interest spending pro-cyclical would increase the discount rate on the spending claim. Section V shows that this change is the most potent way of boosting projected fiscal capacity. It is arguably also the most painful and hence least politically feasible way, since it requires belt tightening at the worst possible (high marginal utility) times.

Projected fiscal capacity may be even more limited than what our calculations suggest for three reasons. First, our estimates put only an upper bound on fiscal capacity because we assume that surpluses are only as risky as GDP. 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. This is an adjustment unlike any other in US history. Third, the GDP risk premium estimate used in our discount rate is at the lower end of the empirically plausible range. Each of these assumptions, discussed in detail below, increases our estimate of projected fiscal capacity and shrinks the gap with the observed debt/GDP ratio. Each one makes our calculations conservative and reinforces our conclusion that fiscal capacity is more limited than commonly thought.

Typically, a pension fund 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 US Treasury has not matched the duration of its projected cash inflows, primary surpluses, to the duration of its outflows, coupon and principal payments on the debt portfolio. Because of the back-loading of projected primary surpluses, the duration of its asset claim is very long (283 years in the baseline model), much longer than the duration of its outstanding bond portfolio (around five years in 2021). This creates a large duration mismatch. When rates increase, US 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. As a result, an interest rate increase will require large fiscal adjustments. A mere 1 percentage 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 percent 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 primary surpluses after 2052 to maintain the same projected fiscal capacity: from 2.16 percent per year to 6.24 percent per year.

From an optimal maturity management perspective, that is, to avoid costly variation in tax rates, the Treasury should either front-load surpluses to shorten the duration of its assets or increase the maturity of its outstanding debt or both. In order to eliminate the duration mismatch completely, we find that the Treasury would have to increase the primary surplus by 6 percent 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 a constant share of GDP. In the steady state, fiscal capacity relative to GDP equals the price/dividend ratio on the GDP claim multiplied by the steady-state surplus/GDP ratio. The price/dividend ratio determines the fiscal capacity per dollar of surplus, expressed as a percentage of GDP. This price/dividend 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, a decrease in the risk-free rate, a decrease in the term premium, or a decrease in the GDP risk premium all increase fiscal capacity.

We estimate the price/dividend ratio for the total wealth portfolio to be around 86 at the end of 2021, which implies an estimate for total wealth, including human wealth, of about eighty-six times GDP. To get an upper bound on the fiscal capacity of 99.6 percent of GDP, the size of the debt/GDP ratio at the end of 2021, the United States would need a steady-state primary surplus of 1.16 percent. Relative to the aforementioned CBO projections of average primary surpluses of −3.2 percent between 2022 and 2052, this requires a major fiscal correction.

As in any valuation exercise, our final estimate of fiscal capacity depends on the cash flow projections, including the seigniorage revenue earned on Treasuries, and the discount rate assumptions. Both are subject to considerable uncertainty.

First, our measure of projected 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 or decrease non-interest spending. The CBO does not try to forecast such future fiscal policy adjustments. As we show in recent work (Jiang and others 2021), the CBO projections have systematically overstated realized surpluses over the past two decades. Should this overstatement continue, it would render our estimate of fiscal capacity overly generous. Even taking CBO projections at face value, our estimate of fiscal capacity suggests that large fiscal corrections relative to the CBO baseline are anticipated by US Treasury markets.[3] Alternatively, the market may be pricing in some form of real rate distortions or financial repression in the future.[4]

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 arrive at an estimate of fiscal capacity that matches the current valuation of the outstanding Treasury portfolio, we would need a discount rate that is lower than the projected growth rate of the economy. That would imply an implausibly low GDP risk premium and implausibly high valuations of other assets.[5] Lower discount rates also increase the sensitivity of fiscal capacity to interest

3. In a classic paper, Bohn (1998) argues that increases in the debt/output ratio predict larger future surpluses, but in a longer sample and after correcting for small-sample bias, Jiang and others (2021) find no evidence of this mechanism.

4. See Acalin and Ball (2022) for evidence on the role of real rate distortions through pegged nominal interest rates before 1951 in the postwar US fiscal experience. More recently, the Bank of Japan has been using yield curve control.

5. Put differently, we would need to engineer a violation of the TVC to match the valuation of Treasuries, given the CBO projections.

rate changes and worsen 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.

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 (Hall and Sargent 2011; Mehrotra and Sergeyev 2021). However, this approach is limited because it only considers the realized path of aggregate shocks.

Despite the secular decline in real rates, private investment has stagnated. This phenomenon has been referred to as the secular stagnation (Summers 2015). Economists have explored whether the US economy is dynamically inefficient, perhaps as a result of increased market power (Ball and Mankiw 2021; Aguiar, Amador, and Arellano 2021). Farhi and Gourio (2018) countered that risk premia may have increased as real rates have decreased, explaining the low private investment. When using deterministic models (without risk premia), economists may have mistakenly overestimated the net present value of private investment opportunities. Using stochastic models with substantial risk premia lowers the value of private investment opportunities. We make a related point about the government's fiscal capacity. In spite of the secular decline in real rates, the US government's fiscal capacity is more limited once risk premia are accounted for.

Government Ponzi schemes that look promising in deterministic economies typically do not survive exposure to aggregate risk and the presence of long-lived investors (Jiang and others 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. For example, the United Kingdom, for which we have the longest continuous fiscal time series data, ran primary surpluses of 2.38 percent (1.22 percent) of GDP between 1729 and 1914 (1946). After 1946, the United Kingdom ran primary surpluses of 1.77 percent of GDP (Chen and others 2022). Our paper contributes to the measurement of these limits.

The paper is organized as follows. Section I describes the discounted cash flow analysis approach to measuring projected fiscal capacity and computes the latter in the benchmark scenario. Section II analyzes the effect of interest rate risk. Section III adds convenience yields. Section IV analyzes a front-loaded fiscal adjustment. Section V analyzes the hypothetical case of countercyclical tax revenue. The last section concludes.

I. Discounted Cash Flow Analysis

In a deterministic model without aggregate growth risk, the government can always roll over the debt when the risk-free rate is lower than the growth rate of the economy. The government's fiscal capacity may be unlimited.

This argument used in a deterministic setting does not carry over 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 a claim to GDP (unlevered 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.[6]

Second, in a world with output growth risk, the Treasury portfolio is risk-free and earns the risk-free rate if and only if the tax claim is less risky than the spending claim (Jiang and others 2019). That restriction has teeth, and it appears to be violated in US data (Jiang and others 2020).[7] Our measure of fiscal capacity rules out free lunches for the government and investors. As pointed out by Lucas (2012), it is critically important to properly price risk when evaluating government policies.

In reality, going long in unlevered equity and short in the risk-free bond is quite risky. To be compensated for this risk, investors demand a large risk premium (Mehra and Prescott 1985). We call this the GDP or unlevered equity risk premium. This object plays a key role in our analysis.

In standard asset pricing models, the government debt is fully backed by future primary surpluses. The debt in 2021 is backed by primary surpluses ($\{T - G\}_{2022}^{2021+H}$), because the PDV of future debt, say H = two hundred

6. 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 for a long-lived investor borrowing at the risk-free rate and going long in unlevered equity. The scenario $r_t^f < g_t$ 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 λ_t, which drive Treasury yield below the true risk-free rate: $y_t = r_t^f - \lambda_t$. We discuss these in section III. Convenience yields decline when the debt/output ratio increases.

7. 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 the portfolio of all outstanding Treasuries has exceeded the nominal growth rate of GDP throughout the 1980s and 1990s (Hall and Sargent 2011).

Figure 1. Government Balance Sheet: An Example

Panel A

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

Panel B

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

Source: Authors' calculations.

years from now, in 2021 dollars, is arbitrarily small. This is often referred to as the no-bubble condition or the transversality condition (TVC).[8] Figure 1, panel A, illustrates the government's balance sheet in this standard setting.

Assumption 1: Debt is cointegrated with output. We assume that debt and output evolve together in the long run. Even when the current debt is risk-free (i.e., it has a beta of zero), future debt will be exposed to output risk because it is cointegrated with output. Hence, the discount rate applied to future debt, say in 2221, will include a GDP risk premium rp^y as well as a term premium ($r^f + term + rp^y$). When debt and output are cointegrated, the no-bubble condition is satisfied as long as the discount rate exceeds the growth rate ($r^f + term + rp^y - g > 0$), even when the risk-free rate is lower than the average growth rate ($r^f < g$). If we turned off all aggregate risk and set the risk premia to zero, the TVC condition would be violated when $r^f - g < 0$.

8. The TVC requires that the expected present-discounted value of debt in the far future, $\mathbb{E}_t[M_{t+T}D_{t+H}]$, goes to zero as the horizon H goes to infinity. The TVC is an optimality condition in an economy with long-lived investors. Jiang and others (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.

If we push the horizon out far enough, under mild conditions, the current value of future debt goes to zero, $PV_{2021}(D_{2021+H}) \rightarrow 0$, and the value of debt equals the expected present-discounted value of future primary surpluses:[9]

$$D_{2021} = PV_{2021}\left(\left\{T - G\right\}_{2022}^{\infty}\right). \tag{1}$$

We define a country's projected fiscal capacity at the end of 2021 as the present-discounted value of future projected primary surpluses: $PV_{2021}(\{T - G\}_{2022}^{\infty})$.

This calculation requires an estimate of the future surpluses and an estimate of the discount rate. 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 percent of GDP.

To be clear, there are models, typically without long-lived investors, that can generate bubbles in asset markets for long-lived assets, including bonds. In these models, there are no long-lived investors to enforce the TVC for long-lived assets.[10] Most of these models do not have priced aggregate risk.[11] In these models, the debt may not be fully backed by the PDV of surpluses. Instead, debt may be backed by future debt itself, as the PDV of future debt does not tend to zero. We can think of this as a rational bubble, as illustrated in figure 1, panel B.[12]

We analyze fiscal capacity while ruling out permanent bubbles in the Treasury market. First, many institutional investors with a long horizon such as endowments, pension funds, and sovereign wealth funds are active in US Treasury markets. Second, typically, these bubbles would also appear in other long-lived assets, such as stocks, resulting in implausible valuations for these assets. Third, nothing in these models singles out the United States as an ideal candidate for engineering these bubbles.

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, Roberds, and Sargent (1991). This result, proven in Jiang and others (2019), follows from imposing (1) the government budget constraint in each period, (2) no-arbitrage conditions on individual bond prices, and (3) a transversality condition.

10. See Santos and Woodford (1997) for a classic reference.

11. See Dumas, Ehling, and Yang (2021) for a recent example.

12. Brunnermeier, Merkel, and Sannikov (2022) argue that the government can engineer violations of TVC by providing safe assets that serve uniquely as insurance against idiosyncratic risk.

I.A. Cash Flows

The cash flows we need are primary surpluses from 2022 onwards, that is, 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:

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

PRIMARY SURPLUSES UNTIL 2052 We use the CBO's long-term budget projections for the US federal government (CBO 2021a, 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 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 (CBO 2021a, 2021b). The first column reports government revenue as a percentage of GDP. The second column reports government spending excluding interest as a percentage of GDP. The third column reports the projected primary surplus as a percentage of GDP, given by column 1 minus column 2. The US 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 (CBO 2021c, 2022).[13] After that, we use the projected real GDP growth rate and the long-run projected rate of inflation.[14] We then compute the implied dollar numbers for projected nominal tax revenue and spending in columns 5 and 6. The CBO also projects interest costs and implied debt/GDP ratios for the federal debt held by the public. These are reported in column 10.[15]

13. The CBO provides a supplement to the May 2022 fiscal projection report called *An Update to the Budget and Economic Outlook: 2021 to 2031*.

14. Projections are from the figures in the CBO's May 2022 report *The 2022 Long-Term Budget Outlook*.

15. This excludes nonmarketable debt.

Table 1. Fiscal Capacity: Baseline Estimates

Year	*T/Y* (%) (1)	*G/Y* (%) (2)	*(T – G)/Y* (%) (3)	*Y* ($ billions) (4)	*T* ($ billions) (5)	*G* ($ billions) (6)	$y^{\$}$ (%) (7)	$r^{\$,y}$ (%) (8)	*PV(T – G)* ($ billions) (9)	*D/Y* (10)	*D* ($ billions) (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

Source: Based on CBO projections released May 2022.

Note: Column 8 reports the discount rates used for spending and tax cash flows in that year. Column 9 reports an upper bound on the PDV of projected primary surpluses in 2021 $ billions. Column 10 reports the projected debt/GDP ratio for federal debt held by the public.

While the CBO forecasts GDP, inflation, and interest rates in unrestricted fashion, it 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. However, the CBO projections assume that the federal government continues to pay for Social Security and Medicare even when the trust funds expire.[16]

Jiang and others (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 global financial crisis and the COVID-19 pandemic, the CBO projected a reduction in deficits well after the global financial crisis and before the COVID-19 pandemic that failed to materialize. If this pattern continues, our measure of projected fiscal capacity is likely to overstate the actual capacity.

We do not consolidate the Federal Reserve and the Treasury. Such a consolidation would not change the amount of government liabilities held by the private sector. It would merely imply a shortening of the maturity structure of the debt held by the private sector. Quantitative easing (QE) programs buy long-term Treasuries from the private sector and issue short-term bank reserves in return. The shorter maturity of the debt held by the public would further exacerbate the maturity mismatch we highlight below. The consolidation would not affect the PDV of projected future surpluses.

I.B. Discount Rates

Our approach confronts risk head-on by using discount rates that reflect the cash flow risk in future spending, tax revenue, and future debt outstanding.

RISKINESS OF TAX REVENUES AND NON-INTEREST SPENDING The CBO projections for future non-interest spending and tax revenue in table 1 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

16. The non-payable part of Social Security and Medicare remain liabilities for the government even after the corresponding trust funds are exhausted. We are grateful to Phillip Swagel and Molly Dahl for explaining the CBO's approach: "The CBO's extended baseline projections follow the agency's ten-year baseline budget projections and then extend most of the concepts underlying those projections for an additional twenty years. In accordance with statutory requirements, the CBO's projections reflect the assumptions that current laws generally remain unchanged, that some mandatory programs are extended after their authorizations lapse, and that spending on Medicare and Social Security continues as scheduled even if their trust funds are exhausted."

discount rate needs to reflect the systematic riskiness of the cash flows. The key question then becomes: What is the underlying source of aggregate risk to primary surpluses?

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 capital asset pricing models (CAPM), ranging from the Sharpe-Lintner CAPM to the version of the Breeden-Lucas-Rubenstein consumption-based CAPM with long-run risks developed by Bansal and Yaron (2004). The total wealth return is often proxied in the asset pricing 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.[17] 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 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 countercyclical (Jiang and others 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 stochastic discount factor, M, states). Investors prefer such hedges, bidding up their price, and bidding down their expected return. The tax revenue claim 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.

17. This effectively assumes 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 illiquidity. As a result, our approach provides a lower bound on the market risk premium.

In the long run, spending and taxes are both co-integrated with output, and hence (equally) exposed to long-run output risk.[18]

Assumption 2: Government taxes, spending, and the value of debt are co-integrated with output. Co-integration is a necessary condition for fiscal sustainability. When fiscal policy is sustainable, then taxes, spending, debt, and output are co-integrated with output. As a result, surpluses are more risky than output in the short run and equally risky in the long run.

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.[19]

This gives us the following result: the true discount rate for projected tax cash flows is higher than the discount rate for projected spending cash flows: $\mathbb{E}[r^T] \geq \mathbb{E}[r^y] \geq \mathbb{E}[r^G]$, because tax revenue (spending) is riskier (safer) than GDP.

Importantly, this result immediately implies that the government debt portfolio cannot have a zero beta, that is, it cannot be risk-free. The debt will have a positive beta, that is, it will carry a positive risk premium.

UPPER BOUND ON FISCAL CAPACITY Our approach is to compute an upper bound on fiscal capacity. This upper bound obtains when discounting future non-interest spending and tax revenue at the same discount rate, namely, the expected return on a claim to GDP: $\mathbb{E}[r^T] = \mathbb{E}[r^G] = \mathbb{E}[r^y]$.

Assumption 3: To derive an upper bound, we assume that future spending, tax revenue are all as risky as GDP. We use the following discount rates: $\mathbb{E}[r^T] = \mathbb{E}[r^y] = \mathbb{E}[r^G]$.

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,

18. A strip is a claim to one dividend payment in the future. When taxes (spending) are co-integrated with GDP, then long-run returns on tax strips and output strips converge; see proposition 3 in Jiang and others (2019). See Backus, Boyarchenko, and Chernov (2018) for a general proof. In the long run, the tax claim, the spending claim, and the output claim are all equally risky.

19. As explained by Jiang and others (2019), this rules out that the entire debt portfolio has zero or negative beta. Generating zero-beta debt can be achieved only if the beta of the tax claim is lower than the beta of the spending claim, that is, by rendering the tax claim less risky than the spending claim. The empirical evidence points in the opposite direction. In addition, highly persistent deficits are inconsistent with risk-free debt when the debt/output policy is mean-reverting. See also van Wijnbergen, Olijslagers, and de Vette (2021) and Barro (2020).

thus deriving an upper bound on the fiscal capacity.[20] In other words, our measure will tend to overstate fiscal capacity.

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 un-lever 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 Jiang and others (2019); from survey expectations (Fernandez, Bañuls, and Acin 2021); or from option markets (Andersen, Fusari, and Todorov 2015; van 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 US equities going forward, as of the end of 2021: an earnings-based and a payout yield–based estimate.[21] The earnings-based estimate for the expected real return on US stocks is given by the payout ratio times the earnings/price ratio plus the projected growth rate of earnings:

$$(3) \qquad \mathbb{E}\left[r^{equity}\right] = D/E \times E/P + g_{EPS} = 0.5 \times 2.8\% + 1.5\% = 2.9\%,$$

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

$$(4) \quad \mathbb{E}\left[r^{equity}\right] = D/P + NBY + g_{PAGG} = 1.3\% + 0.2\% + 2.7\% = 4.2\%,$$

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 US 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 percent. The real risk-free

20. Our 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 Jiang and others (2019).

21. The approach was developed by AQR for its capital market assumptions; see Portfolio Solutions Group (2022), for details.

return is estimated to be −1.5 percent. As a result, we obtain an estimate of 5.1 percent in excess of the risk-free rate. This number is very close to the 5.5 percent average (and median) estimate of the US equity risk premium from a recent academic survey (Fernandez, Bañuls, and Acin 2021).

The equity risk premium is the risk premium on a levered claim. We are interested in the risk premium on an unlevered claim. The debt/equity ratio for the US 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 percent from a levered equity premium of 5.1 percent (two-thirds of 5.1 percent is 3.4 percent). This assumes a zero risk premium on corporate debt.

We also compute an expected excess return of long-term bonds of 0.8 percent. This means that unlevered equities earn a risk premium rp^y of 2.6 percent over long-term bonds. This is our measure of the GDP risk premium. The 2.6 percent GDP risk premium we use here is close to the 2.9 percent GDP risk premium that comes out of the calibrated disaster model in Jiang and others (2020). It is also close to the 2.4 percent risk premium on the total wealth claim obtained by Lustig, Van Nieuwerburgh, and Verdelhan (2013).[22]

We argue that 2.6 percent is a low estimate of the annual GDP risk premium for two reasons. First, the average excess return on stocks has been 8 percent over the 1947–2021 period and may have been at a cyclical low at the end of 2021.[23] Hence the unlevered equity risk premium was unusually low at the time of our measurement. Second, using a higher cost of debt for corporations than the risk-free rate (assuming a positive corporate bond risk premium when un-levering) 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 projected fiscal capacity, 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.

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

22. The latter estimate recognizes that 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.

23. Sample averages calculated with data from the Center for Research in Security Prices, LLC, "Data Access Tools," https://www.crsp.org/products/software-access-tools.

and updated by Gürkaynak, Sack, and Wright (2007), and then add the output risk premium of 2.6 percent:

$$\mathbb{E}\left[r^{\$,y}\left(h\right)\right] = y_t^{\$,f}\left(h\right) + rp^y. \tag{5}$$

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.[24]

I.C. Steady-State Fiscal Capacity

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 by the price/dividend ratio on a claim to GDP times the steady-state surplus:

$$PV_{2021}^{upper,ss}\left(\left\{T - G\right\}\right) = \frac{S}{Y}\sum_{j=1}^{\infty}\frac{\mathbb{E}_{2021}\left(Y_{2021+j}\right)}{\left(1 + r^{\$,y}\right)^j} = pd^y \times \frac{S}{Y} \times Y_{2021}. \tag{6}$$

We use the thirty-year zero-coupon yield at the end of 2021 to proxy for the long end of the Treasury yield curve, and we use the CBO's long-run forecast for real growth of 1.5 percent and inflation of 2 percent. The nominal long discount rate minus the nominal growth rate is given by:

$$\begin{aligned} r^{\$,y} - g &= y_{2022}^{\$,f}\left(30\right) + rp^y - g \\ &= 2.07\% + 2.60\% - \left(1.50\% + 2\%\right) = 1.17\%. \end{aligned} \tag{7}$$

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

$$pd^y = \frac{1}{r^{\$,y} - g} = \frac{1}{1.17\%} = 85.8. \tag{8}$$

24. We assume that the yield on a thirty-one-year zero-coupon bond equals the yield on a thirty-year bond.

Table 2. US Treasury Balance Sheet in Steady-State Example

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

Source: Authors' calculations.

Note: Market values are expressed as a multiple of US GDP at the end of 2021. The steady-state example is based on the actual spending/GDP ratio in 2022.

The multiple on a claim to GDP is 85.8.[25] An unlevered company whose cash flows grow at the same rate as the US economy would have a price/dividend ratio of 85.8 in 2021.[26] At this high multiple, total US wealth is about 85.8 times the size of GDP.[27] This historically high multiple reflects low rates and low risk premia at the end of 2021.

Table 2 shows the US 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 primary surplus/GDP ratio, S/Y, is constant, then the surplus inherits the risk properties of a GDP claim. In this simple case, the discount rate for a GDP claim is 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.

Under "Liabilities" in table 2, we start from the 2022 spending ratio of 21.9 percent. We need a steady-state primary surplus of 1.16 percent of GDP to get to an upper bound on fiscal capacity that includes the observed debt/GDP ratio of 99.7 percent as of the end of 2021: 85.8 × 1.16 percent = 99.7 percent of 2021 GDP. Under "Assets," we back out the implied steady-state tax ratio T/Y of 23.06 percent that is needed. The implied value of the tax claim is almost twenty times GDP.

25. Using a different approach with a no-arbitrage term structure model, Lustig, Van Nieuwerburgh, and Verdelhan (2013) obtain an average US wealth/consumption ratio of 83, a similar value.

26. If that company were only expected to exist for fifty years, the multiple would still be 64.5.

27. In 2021, that's about \$5.8 million per American. Most of this is the PDV of future labor income.

The United States gets an additional 85.8 percent of GDP in fiscal capacity (maximum) per 1 percent of steady-state primary surplus 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 surpluses. In addition, the secular decline in real rates over the past decades has boosted US fiscal capacity per percentage point of primary surplus.

However, the CBO does not project any surpluses over its projection horizon. Column 3 in table 1 reports the actual projected primary deficits. The CBO projects an average deficit of 3.19 percent of US GDP between 2022 and 2052. One would need a large, permanent fiscal correction of 4.35 percent of GDP (from –3.19 percent to 1.16 percent) to reconcile this back-of-the-envelope upper bound with the actual value of US Treasury debt/GDP. For this to work out exactly, the steady-state surplus/GDP ratio would have to be acyclical.

I.D. Baseline Estimate of Fiscal Capacity

Next, we carry out our main analysis, which is to compute fiscal capacity as spelled out in equation (11). We discount each CBO projected cash flow, column 5 minus column 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.[28] The sum of the PDV of primary surpluses from 2022–2052 adds up to –\$21.16 trillion:

$$(9) \qquad PV_{2021}^{upper}\left(\left\{T - G\right\}_{2022}^{2052}\right) = \sum_{h=1}^{31} \frac{T_{2021+h} - G_{2021+h}}{\left(1 + r^{\$,y}\left(h\right)\right)^{h}} = -\$21.16 \text{ trillion.}$$

This is the sum of column 9 starting with –\$552 billion, the PDV of deficit in 2022, until and including –\$699.9 billion, the PDV of the 2052 deficit.

According to the CBO debt projections, reported in column 10 of table 1, the debt outstanding will equal 185 percent of US GDP at the end of 2052. This would amount to approximately \$138 trillion in nominal debt, as shown in column 11.

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

28. Alternatively, we could discount projected cash flows in constant dollars using the yields on real zero-coupon bonds. The results are quite similar.

2052, namely, that the projected debt/output ratio in 2052 (see column 10) is fully backed by surpluses:

$$\left(\frac{D}{Y}\right)_{2052} = \frac{S}{Y} \times PV_{2052}\left(\left\{Y\right\}_{2053}^{\infty}\right). \tag{10}$$

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 equation (10). This implied surplus/GDP ratio will be positive since the projected debt/GDP ratio in 2052 is 185 percent of GDP, as shown in the last row of column 10 of table 1.

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 (10)? 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 it 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 percent of GDP, the US federal government would need to generate an annual primary surplus of 2.16 percent after 2052 (2.16 percent × 85.8 = 185 percent).

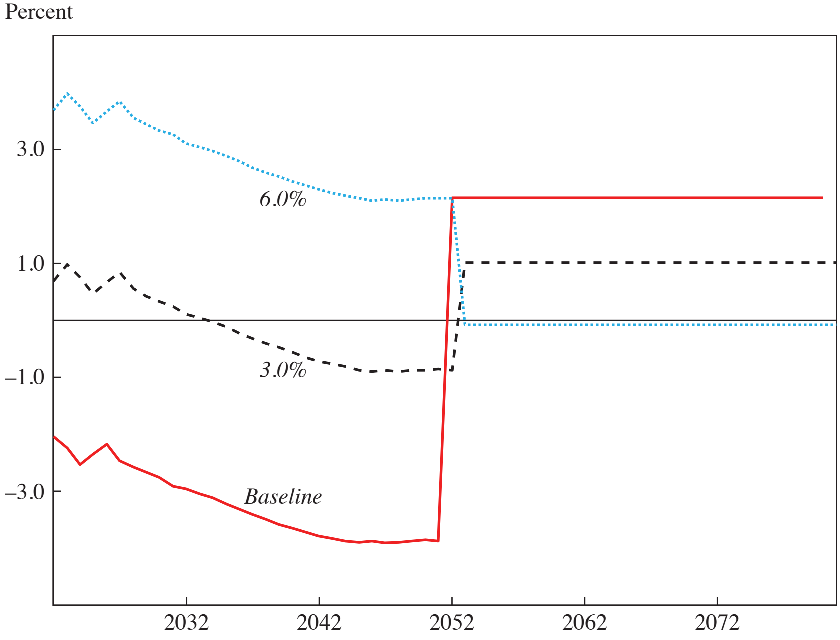
Assuming equation (10), our 2021 fiscal capacity estimate in equation (2) can be rewritten as the sum of the PDV of primary surpluses until the end of the projection horizon and the PDV of outstanding (projected) debt:

$$PV_{2021}\left(\left\{S\right\}_{2022}^{\infty}\right) = PV_{2021}\left(\left\{S\right\}_{2022}^{2052}\right) + PV_{2021}\left(D_{2052}\right). \tag{11}$$

Figure 2 plots the time path of projected primary surpluses; until 2052, it plots the projected primary surpluses from the CBO. After 2052, the primary surplus is assumed to be equal to 2.16 percent, 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 185 percent of GDP, also needs to be discounted back to 2021 using the same discount rate

Figure 2. CBO Projections of Primary Surplus



Sources: CBO and authors' calculations.

Note: Shown are baseline CBO projections of primary surplus for 2022–2052, followed by primary surpluses after 2052 needed to pay back the debt in 2052; primary surpluses between 2022–2052 increased by 3 percent of GDP each year, followed by primary surpluses after 2052 needed to pay back the debt in 2052; and primary surpluses between 2022–2052 increased by 6 percent of GDP each year, followed by primary surpluses after 2052 needed to pay back the debt in 2052.

used for the primary surplus cash flow in 2052. The second term in equation (11) is given by:

$$PV_{2021}^{upper}\left(D_{2052}\right) = \left(\frac{D}{Y}\right)_{2052} \times \frac{\mathbb{E}_{2021}\left(Y_{2052}\right)}{\left(1 + r_{31}^{\$,y}\right)^{2052-2021}} = \$33.54 \text{ trillion.} \tag{12}$$

In our approach, future debt is assumed to be as risky as output. The future debt/output ratio in 2052 is constant across all possible output growth paths, but, of course, the debt itself is subject to GDP growth risk. The discount rate we use is the one appropriate for the stochastically growing GDP claim. Discounted back to the end of 2021, the PDV of D_{2052} is \$33.5 trillion.

When we add up the 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:

$$(13)\qquad PV_{2021}^{upper}\left(\left\{T-G\right\}_{2022}^{2052}\right)+PV_{2021}^{upper}\left(D_{2052}\right)=-\$21.16+\$33.54$$
$$=\$12.38\text{ trillion.}$$

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 projected 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, debt, and realistic discount rates.

This is a 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 United States 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 for projected 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 projected fiscal capacity is conservative—if anything, too high rather than too low.

I.E. Discounting Future Debt

The right discount rate for debt outstanding far in the future includes the GDP risk premium when output and debt are co-integrated. The reason is that GDP in the far future is uncertain, and hence risky.[29] In our calculation, we use 2.07 percent for the nominal long yield, 2.60 percent for the GDP risk premium, and 3.50 percent for the long-run nominal growth rate g. These values imply that the TVC is satisfied (4.67 percent > 3.5 percent).

29. If the debt/output ratio is stationary, the necessary condition for 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 σ is the volatility of output growth; see Jiang and others (2020), for details.

Importantly, this long-run discount rate that includes a GDP risk premium is the right discount rate for future debt regardless of the short-term debt/output, tax, and spending dynamics, and even when the current debt is risk-free, that is, has a zero beta.

If we had used the risk-free yield curve without adding the GDP risk premium when discounting future debt, then the discounted value of future debt in 2052 would have been \$73.15 trillion in 2021 dollars. The present value of the deficits until 2052 would have been –\$33.15 trillion. 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 percent) is lower than the growth rate of output (3.50 percent). This is essentially the $r < g$ approach to fiscal sustainability. As we push the final period T farther 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 is 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 2), even if current debt is risk-free (zero beta). As a result, discounting future debt at the risk-free rate is not consistent with fiscal sustainability. When discounted at a discount rate that 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 farther into the future.

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 projected fiscal capacity would then become:

$$(14) \qquad PV_{2021}^{upper}\left(D_{2052}\right) = \frac{D_{2052}}{\left(1 + r_{31}^{\$,y}\right)^{2052-2021}} = -\$33.74 + \$33.54\,t$$

$$= -\$0.20 \text{ trillion.}$$

We would end up at 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? The answer is 1.37 percent 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:

$$(15)\quad r^{\$,y} - g = y_{2022}^{\$,f}\left(30\right) + rp^{y} - g = 2.07\% + 1.37\% - \left(1.50\% + 2\%\right) < 0.$$

The steady-state multiple on claim to GDP tends to ∞. This has troubling valuation implications. An unlevered firm whose cash flows are expected to grow at the rate of US output growth would have an infinite valuation. We conclude that a value of 1.37 percent or lower for the GDP risk premium is implausibly low. In the baseline scenario, we cannot match the valuation of debt without engineering a violation of the TVC.

I.F. Reverse Engineering

Given our assumptions and and the result noted under assumption 2, the debt cannot be risk-free. The CBO assumes that the debt can be rolled over until 2052 at the projected interest rates. Even though the CBO does project an increase in interest rates in the long term, its projected interest rates may not be consistent with the true risk characteristics of the debt, implied by our analysis. The calculation of our benchmark fiscal capacity measure above, which takes the CBO interest rate projections until 2052 as given, can then be interpreted as consistent with the notion of persistent mispricing.

Alternatively, we can insist that the debt be priced correctly today given the CBO projections. Instead of using the CBO's projected debt/output ratio, we can back out the steady-state surplus after 2052 that is needed in order to obtain an estimate for fiscal capacity at the end of 2021 that equals the market value of outstanding debt:

$$(16)\quad PV_{2021}^{upper}\left(\left\{T - G\right\}_{2022}^{2052}\right) + PV_{2021}^{upper}\left(D_{2052}\right) = -\$21.16 + \$43.45$$

$$= \$22.29 \text{ trillion.}$$

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

$$(17) \qquad PV_{2021}^{upper}\left(\left\{T-G\right\}_{2022}^{2052}\right)\Big/Y_{2052} = \frac{S}{Y} \times PV_{2052}\left(\left\{Y\right\}_{2053}^{\infty}\right)$$

$$= 2.79\% \times 85.8 = 239\%.$$

This can be interpreted as a debt/output ratio in 2052 of 239 percent, instead of the 185 percent projected by the CBO.

What explains the difference with the CBO projection of 185 percent? If we roll over the debt at the GDP discount rate in column 8 of table 1 until 2052, instead of using the CBO projected interest rates, the projected debt/output ratio is 239 percent rather than 185 percent. This reverse engineering exercise imposes that the debt be correctly priced and that the interest rates the Treasury pays on the debt reflect the risk.

II. Interest Rate Risk

II.A. Duration

The duration of the primary surplus claim is very high in the baseline scenario because the surpluses are extremely back-loaded; recall the baseline in figure 2. The Macaulay duration of the surplus claim is 283.2 years.[30] Figure 3 plots the contribution of each payment at horizon k to the total duration $\frac{k \times PV\left(S_{2021+k}\right)}{\sum_{h=1} PV\left(S_{2021+h}\right)}$. The duration is the sum of all bars.

Given this high duration of the surplus claim, US 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.

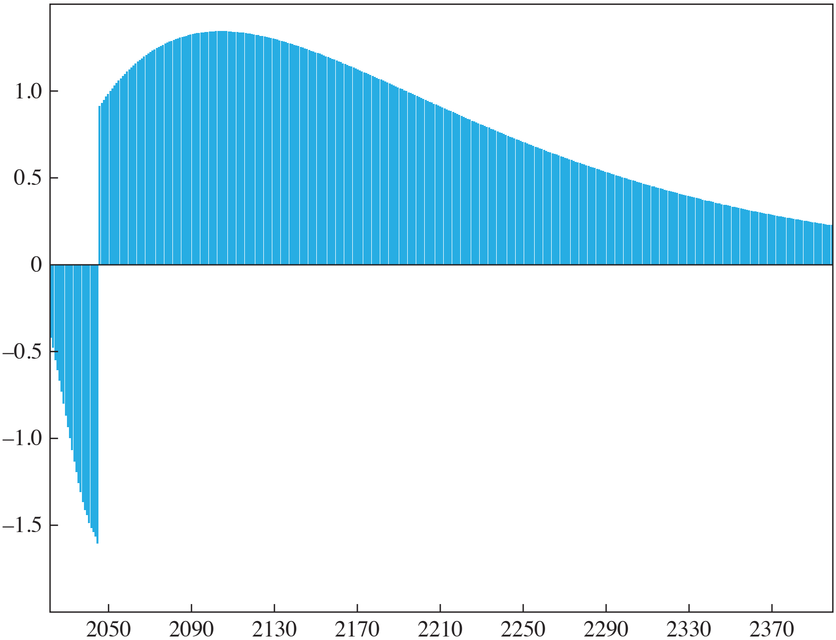
II.B. Parallel Shift in Yield Curve

We study a 100 basis point parallel upward shift in the yield curve, holding constant all other parameters, including nominal GDP growth. Increasing

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

Figure 3. Duration Composition in Baseline Scenario

Contribution of each surplus to total duration (in years)



Source: Authors' calculations.

Note: 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.

interest rates while holding nominal GDP growth constant amounts to an increase in the real growth-adjusted yield, that is, in $r - g$. This increase could reflect, for example, the unwinding of QE programs.[31] The upward shift 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

31. 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 and others 2012; Joyce and others 2011), with estimates ranging from 50–100 basis point 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 in section III.

column 4 of table 3.[32] 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 percent 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 United States now has to generate a steady-state primary surplus of 4.83 percent (= 223 percent ÷ 46.2), an increase of 2.67 percentage points of GDP relative to the corresponding number in the baseline scenario of 2.16 percentage points of GDP, that is, before the interest rate change.[33] Hence, an increase in rates of 100 basis points, holding constant nominal GDP growth, implies an increase of 2.67 percentage points of GDP in annual surpluses starting in 2053. The increase in surpluses starting in 2053 divided by the increase in rates is 2.67. This multiple 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—counterfactually—that the GDP risk premium was 1.37 percent per year rather than 2.60 percent 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 rollover risk are especially high when discount rates are low.

II.C. Higher Interest Rates in 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

32. 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.

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

Table 3. Fiscal Capacity with Higher Interest Rates

Year	*T/Y* (%) (1)	*G/Y* (%) (2)	*(T – G)/Y* (%) (3)	*NI/D* (%) (4)	*Y* ($ billions) (5)	*T* ($ billions) (6)	*G* ($ billions) (7)	$y^{\$}$ (%) (8)	$r^{\$,y}$ (%) (9)	*PV(T – G)* ($ billions) (10)	*D/Y* (11)	*D* ($ billions) (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

Sources: Based on CBO projections and authors' calculations.

Note: 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. Column 10 reports an upper bound on the PDV of projected primary surpluses in 2021 $ billions. Column 12 reports the debt dynamics: $D_{t+1} = D_t \times R_{t+1} + (T_{t+1} - G_{t+1})$. The variable R_{t+1} is taken from column 4.

bond yields rose by 176 basis points, the ten-year bond yield by 133 basis points, and the thirty-year bond yield by 131 basis points. We now explore what this shift in the term structure implies for our measure of fiscal capacity.

In our 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).[34] The fiscal capacity bound becomes:

$$(18) \qquad PV_{2021}^{upper}\left(\left\{S\right\}_{2022}^{2052}\right) + PV_{2021}^{upper}\left(D_{2052}\right) = -\$17.19 + \$22.78$$
$$= \$5.59 \text{ trillion.}$$

We observe a substantial decline in fiscal capacity from the rise in interest rates, from \$12.38 trillion to \$5.59 trillion. At the new, higher rates, the valuation ratio of the GDP claim declines from 85.8 to 40.3. Servicing the same 185 percent debt/GDP after 2052 now requires annual surpluses of 4.59 percent of GDP, compared to 2.16 percent of GDP. 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 CBO would not revise its interest rate forecast when projecting future debt service and future debt in light of these interest rate increases. To consider this additional effect, we add 156 basis points to the CBO's interest rate forecast in each year from 2022 to 2052. This 156 basis point increase is the increase in the five-year bond yield between December 31, 2021, and May 31, 2022, where the five-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 percent in 2022 and rises to 5.72 percent by 2052. We adjust the debt dynamics to account for the extra interest cost.

34. As in the previous exercise, 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 ten-year inflation-indexed Treasury bond yield increased from –1.04 percent on December 31, 2021, to +0.21 percent on May 31, 2022, an increase of 125 basis points. To do full-fledged counterfactual 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 and others (2021). Such a model would need to take a stance on what the fundamental shocks are that give 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.

The debt in 2052 becomes \$187.5 trillion (251.6 percent of GDP) compared to \$137.9 trillion (185.0 percent of GDP) in the baseline. The upper bound on fiscal capacity becomes \$13.79 trillion, but that reflects the assumption that the surplus after 2052 now needs to be 6.24 percent per year compared to 4.59 percent in the previous exercise. In short, the fiscal capacity measure remains similar to the baseline value of \$12.38 trillion, 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 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.

II.D. Debt Management

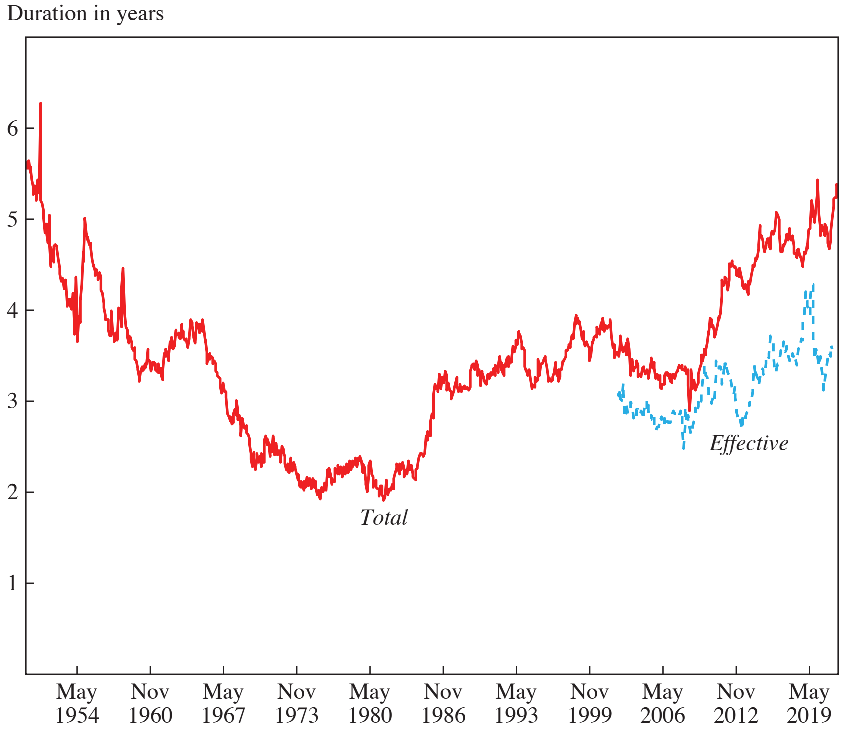
To eliminate duration risk, the Treasury would have to match the duration of its inflows to the duration of its outflows. The duration of the outstanding Treasuries is currently around five years, as shown in figure 4. In the baseline scenario, the US Treasury faces an extreme type of duration mismatch 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 costly variation in future taxes and suggests that the Treasury should shift toward longer-maturity debt (Bhandari and others 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 and others (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.

III. Adding Seigniorage from Convenience Yields

The United States is different from other countries because of its unique role as the world's safe asset supplier. Our calculations capture this by quantifying the seigniorage revenue from convenience yields. Our benchmark analysis abstracted from any convenience yields the Treasury earns on its sales of Treasuries. This section augments our baseline estimate of projected fiscal capacity with the present value of the revenue stream the government earns from convenience yields.

Figure 4. Duration of Treasuries Held by the Public



Source: Based on data from CRSP US Treasury Database. Copyright 2022 Center for Research in Security Prices (CRSP), the University of Chicago Booth School of Business.

As a result of being the world's safe asset supplier, the United States earns seigniorage revenue from its monopoly on the creation of safe, dollar-denominated assets. Jiang and others (2019) estimate that the United States earns around 60 basis points per annum in convenience yields on the entire US Treasury portfolio. The United States had a current debt/output ratio of 99.6 percent at the end of 2021. When the average convenience yield is 0.60 percent per annum, the Treasury collects 0.60 percent × 99.6 percent = 0.598 percent of GDP in convenience yield revenues per year.

Assumption 4: The seigniorage revenue on Treasuries 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 percent of GDP in 2052 in the baseline model). Krishnamurthy and Vissing-Jorgensen (2012) provide evidence on downward-sloping demand curves for safe assets.[35] More recently, Mian, Straub, and Sufi (2021) analyze debt/output ratio dynamics in low interest rate environments when the government earns seigniorage from the convenience yields on government bonds, but faces a downward-sloping demand curve for liquidity and safety.

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 percent 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 upward by this amount to \$16.4 trillion:

$$PV^{upper}_{2021}\left(\left\{T - G\right\}^{2052}_{2022}\right) + PV^{upper}_{2021}\left(D_{2052}\right) + PV^{upper}_{2021}\left(\left\{CS\right\}^{2052}_{2022}\right) = \$12.38 + \$4.04 = \$16.42 \text{ trillion.} \tag{19}$$

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

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 percent (= 2.16 percent – 0.60 percent) of GDP after 2052, rather than 2.16 percent, 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.

Global investors may allocate additional borrowing capacity to the world's safe asset supplier, as argued by He, Krishnamurthy, and Milbradt (2019), not captured by the convenience yields. This may have been the case for the United Kingdom in the nineteenth century, but that privilege proved to be transitory (Chen and others 2022). While we cannot definitively rule out that the US government is one of the only countries to have permanently escaped the intertemporal budget constraint by engineering a bubble in the

35. 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. 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

Year	T/Y (%) (1)	G/Y (%) (2)	Y ($ billions) (3)	T ($ billions) (4)	G ($ billions) (5)	$y^{\$}$ (%) (6)	$r^{\$,y}$ (%) (7)	$PV(T-G)$ (8)	D/Y (9)	CS ($ billions) (10)	$PV(CS)$ (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

Sources: Based on CBO projections released May 2022 and authors' calculations.

Note: Column 10 reports an estimate of the seigniorage revenue collected by the Treasury. We use a convenience yield of 60 basis points per annum. PDV of projected surpluses (column 8) and seigniorage (column 11) are measured at the end of 2021.

bond market, it seems prudent to assume that this is not the case, especially from the perspective of future US generations.

III.A. Broad and Narrow Convenience Yields

In our analysis above, we kept the 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 implied increase in the true risk-free yield (of 60 basis points). Jiang and others (2019) refer to this as a narrow convenience yield—a convenience yield that does not accrue to asset classes other than Treasuries. 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 US Treasuries 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 US 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.

IV. 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 US 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 percent debt/output ratio at the end of 2021. We consider level shifts that raise the surplus/GDP ratio in each year from 2022 until 2052. 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.

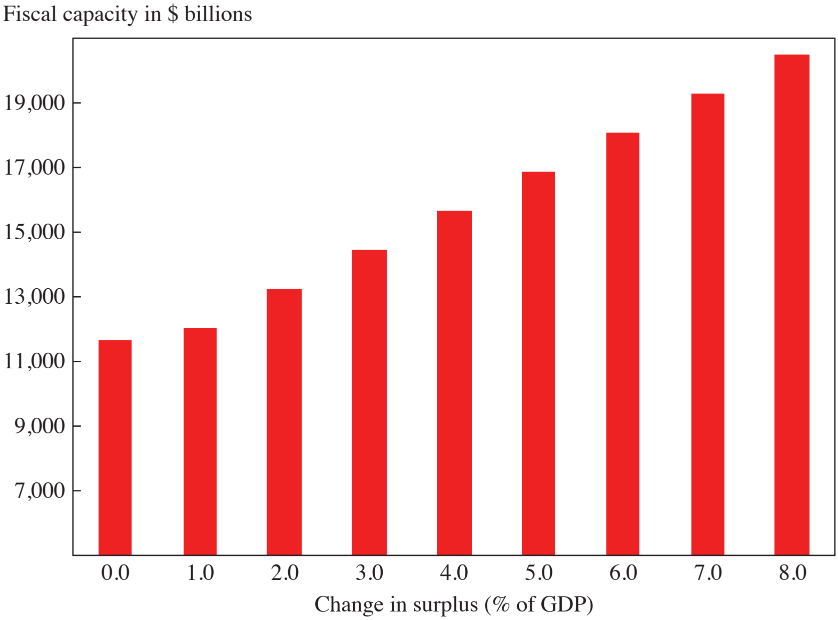
Assumption 5: We assume the surplus changes relative to the CBO baseline do not change the projected growth rate of GDP nor the yield curve. We first consider an increase in the primary surplus by 3 percentage points of GDP in each of the years between 2022 and 2052 relative to the CBO projection. This fiscal adjustment increases the PDV of surpluses between 2022 and 2052 from −\$21.16 trillion in the baseline to −\$0.88 trillion. Hence, a fiscal adjustment of 3 percent per year nearly eliminates all deficits over the next thirty-one years in present value. The higher primary surpluses decrease the value of debt outstanding at the end of 2052 to 87.5 percent of GDP. Discounted back to 2021, that is \$15.86 trillion. Combined, this raises the upper bound on fiscal capacity from \$12.38 trillion in the benchmark to \$14.97 trillion:

$$(20) \qquad PV_{2021}^{upper}\left(\left\{T-G\right\}_{2022}^{2052}\right) + PV_{2021}^{upper}\left(D_{2052}\right) = -\$0.88 + \$15.86$$
$$= \$14.97 \text{ trillion.}$$

In this counterfactual exercise, the US 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 United States only needs a 1.02 percent annual primary surplus after 2052, less than half the 2.16 percent annual surplus number in the baseline. Figure 2 plots this front-loaded path of surpluses. In this scenario, the duration of the surplus claim declines to 126 years from 283 years in the baseline.

Next, we repeat the projected fiscal capacity calculation assuming increases in the surplus/GDP ratio in each of the years between 2022 and 2052 relative to the CBO projection ranging from 0 percent per year (baseline) to 8 percent per year in 1 percentage point increments. Figure 5 plots the projected 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 percent increase lies in the middle of this graph.

Figure 5. Fiscal Capacity for Additional Surpluses in 2022–2052



Source: Authors' calculations.
Note: Change in primary surplus as a percentage of US GDP in each year between 2022 and 2052 is relative to the baseline CBO projection.

To get to an upper bound on fiscal capacity of $18.3 trillion, we need an extra primary surplus of 6 percent 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:

$$PV_{2021}^{upper}\left(\left\{T-G\right\}_{2022}^{2052}\right)+PV_{2021}^{upper}\left(D_{2052}\right)=\$19.39-\$1.09 \tag{21}$$

$$=\$18.30 \text{ trillion.}$$

Once we factor in the $4.04 trillion in convenience yield revenues, this scenario of 6 percent additional surpluses between 2022–2052 produces a fiscal capacity estimate that essentially matches the observed debt outstanding of $22.28 trillion as of the end of 2021. Figure 1 also plots this 6 percent extra surpluses path of completely front-loaded surpluses. In this scenario, the government can run a small primary deficit of 0.07 percent of GDP in each year after 2052.

Figure 6 plots the contribution of each surplus cash flow to the overall duration of the surplus claim in this front-loaded scenario with 6 percent additional surpluses. This surplus claim has a duration of 6.95 years, which is close to that of the outstanding Treasury portfolio.[36] 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 percent per year over the next thirty-one years. Suffice to say that this is a massive fiscal effort.

V. Countercyclical Tax Regime

Can the United States run steady-state deficits and maintain fiscal capacity, as many have claimed? Not according to standard finance, unless the US federal government changes the fiscal regime from countercyclical to procyclical. The US 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 1 above fails. In this case, the US taxpayers would be providing insurance to bondholders (Jiang and others 2020). This insurance premium would allow the United States to run steady-state deficits.

Hence, the only way to reconcile the CBO projections with the value of US Treasuries is to use a much lower discount rate for the tax cash flows than for the spending cash flows. Importantly, this is necessary if we want the entire debt to be zero beta or risk-free. However, this condition is not satisfied in postwar US data because of the pro-cyclical nature of tax revenue and the countercyclical nature of spending (Jiang and others 2019). We explore this hypothetical scenario, but we emphasize that we do not think this regime shift is either likely or desirable.

If the US 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

36. The duration is sensitive to the additional surplus. Raising the additional surplus from 6.0 percent to 6.1 percent per year until 2052 lowers the duration from 6.95 to 3.45 years.

Table 5. Fiscal Capacity with 6 Percent Extra Surplus in 2022–2052

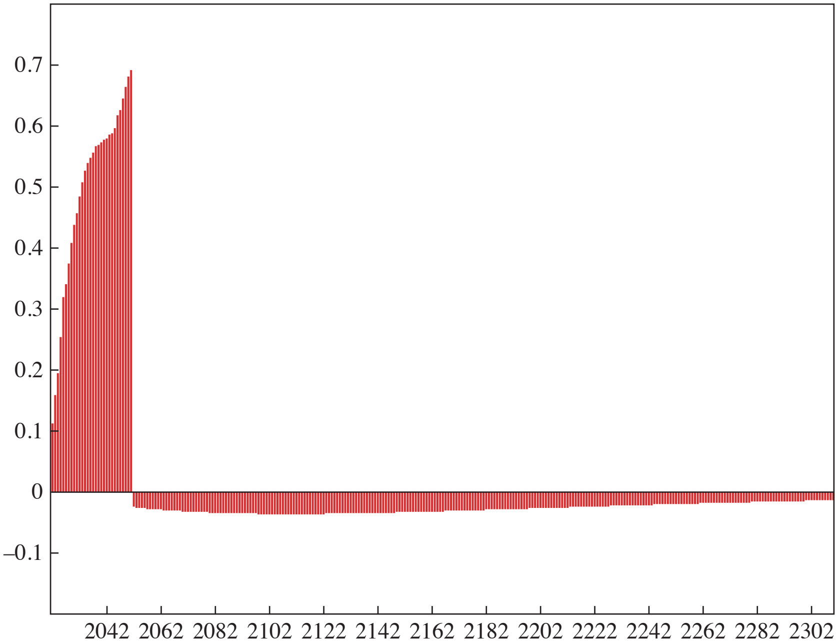
Year	T/Y (%) (1)	G/Y (%) (2)	$(T-G)/Y$ (%) (3)	NI/D (%) (4)	Y ($ billions) (5)	T ($ billions) (6)	G ($ billions) (7)	$y^{\$}$ (%) (8)	$r^{\$,y}$ (%) (9)	$PV(T-G)$ ($ billions) (10)	D/Y (11)	D ($ billions) (12)
2022	25.6	21.9	3.7	1.8	24,694	6,318	5,405	0.42	3.02	885.92	88.2	21,770
2023	24.6	20.7	4.0	1.8	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)

Source: Based on CBO primary surplus projections plus an additional 6 percent of GDP in primary surplus for each year from 2022 until 2052.

Note: 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. 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.

Figure 6. Duration Composition in Front-Loaded Scenario



Source: Authors' calculations.

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

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:

$$PV_{2021}^{upper}\left(\{T - G\}_{2052}^{\infty}\right) = \sum_{h=1}^{\infty} \frac{T_{2021+h}}{\left(1 + r^{\$,t}(h)\right)^{h}} - \sum_{h=1}^{\infty} \frac{G_{2021+h}}{\left(1 + r^{\$,g}(h)\right)^{h}} \tag{22}$$

$$= \left(pd^{t} \times \frac{T}{Y} - pd^{g} \times \frac{G}{Y}\right) \times Y_{2021}.$$

Table 6. US Treasury Balance Sheet in Steady-State Countercyclical Tax Example

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

Source: Authors' calculations.
Note: Market values are expressed as a multiple of US GDP at the end of 2021. The steady-state example is based on the actual spending/GDP ratio in 2022. In this example, the risk premium on the tax claim is 22 basis points lower than the risk premium on the spending claim.

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 US government can run a steady-state deficit of 3.19 percent, 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 percent of GDP. This is counterfactual. In advanced economies, it is the government that typically provides insurance against business cycle risk.[37]

Let's turn to the detailed CBO projections. Suppose that the tax claim's appropriate discount rate is 100 basis points lower than 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 to 2052 adds up to −\$846 billion:

$$(23)\quad PV_{2021}^{upper}\left(\left\{T-G\right\}_{2052}^{2052}\right)=\sum_{h=1}^{31}\frac{T_{2021+j}}{\left(1+r^{\$,y}\left(h\right)-0.01\right)^{h}}-\sum_{h=1}^{31}\frac{G_{2021+j}}{\left(1+r^{\$,y}\left(h\right)\right)^{h}}$$
$$=\$0.85\text{ trillion}.$$

The lower discount rate for the tax revenue claim expands our estimate of fiscal capacity. In this case, the total PDV of deficits, computed

37. See Jiang and others (2020) for evidence on the GDP growth betas of US 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.

Table 7. Fiscal Capacity with Countercyclical Tax Revenues

Year	T/Y (%) (1)	G/Y (%) (2)	$(T-G)/Y$ (%) (3)	Y ($ billions) (4)	T ($ billions) (5)	G ($ billions) (6)	$y^{\$}$ (%) (7)	$r^{\$,y}$ (%) (8)	$PV(T)$ ($ billions) (9)	$PV(G)$ ($ billions) (10)	D/Y (11)	D ($ billions) (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	

Sources: Based on CBO projections released May 2022 and authors' calculations.

Note: Columns 9 and 10 report the PDV of tax revenue and spending, respectively. The discount rate used for the tax claim is 100 basis points lower than that used for the spending claim.

as the difference between the sum of columns 9 and 10, has shrunk from \$21.16 trillion 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.

$$PV_{2021}^{upper}\left(\left\{T - G\right\}_{2052}^{2052}\right) + PV_{2021}^{upper}\left(D_{2052}\right) = \$32.69 \text{ trillion.} \tag{24}$$

This measure of projected 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 magnitude of the projected 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.

VI. Conclusion

We develop a new approach based on textbook finance to assess the government's projected 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 US federal government implied by the May 2022 CBO projections. In spite of the historically low interest rates at the end of 2021, the upper bound on fiscal capacity is only around 56 percent of the observed debt outstanding in 2021.

From the vantage point of standard, neoclassical finance, our findings would imply that the Treasury market has likely priced in a large fiscal correction relative to the CBO baseline projections. In this scenario, future surpluses will increase to close the gap. However, we cannot rule out that Treasuries are mispriced. Treasury investors may be optimistic about future surpluses or they may fail to price in future inflation. In this case, bond yields will need to increase to close the gap.

Many authors have emphasized that low rates create additional fiscal capacity for the United States, 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 the government's assets, its future surpluses, and its liabilities, its promised coupon and principal payments on the Treasury portfolio. Because of the back-loading of future surpluses, the Treasury faces a duration mismatch between its cash inflows and outflows. Modest increases in interest rates, of the kind the US 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 countercyclical primary 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 US 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.

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Comments and Discussion

COMMENT BY

WILLIAM GALE This paper applies modern finance techniques to analyze the federal budget outlook. The main conclusions are consistent with two long-held consensus findings that use more basic techniques. First, the nation has a long-term fiscal problem and will likely need to raise taxes or cut spending growth or both in the future (Auerbach 1994; CBO 2001). Second, higher interest rates make the government's fiscal situation substantially worse, both because the government is a net debtor (CBO 2022; Auerbach and Gale 2022) and—according to the authors—because of a maturity mismatch between government assets and liabilities.

OVERVIEW The main result is that the current market value of federal debt is larger than the present value of expected future primary surpluses, a condition that violates rational models. Proving this relation requires an estimate of the market value of debt, a projected path for future primary surpluses or deficits, and a discount rate.

Although most previous analyses of the fiscal outlook have used the par value of debt, the market value and par value of outstanding federal debt tend to track each other closely over time The market and par values of marketable Treasury debt in December 2021 were 104.7 percent and 101.0 percent of 2021 GDP respectively.[1]

To project budget outcomes, the authors use the Congressional Budget Office's (CBO) "current law" projections, which report primary deficits that average 3.2 percent of GDP over the next thirty years and rise as a share

1. Federal Reserve Bank of Dallas, "Market Value of U.S. Government Debt," https://www.dallasfed.org/research/econdata/govdebt#data.

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of GDP over time. As noted in the paper, the current law baseline is not a forecast of likely outcomes. Rather, it is the result of a variety of required assumptions, including the assumptions that there are virtually no changes in policy except reauthorization of spending programs, continued payment of full benefits in entitlement programs even if the trust funds are exhausted, discretionary spending rising with inflation rather than fixed in nominal terms, and increases in the debt ceiling to accommodate those changes (CBO 2022). For years after 2052, the authors assume the existence of persistent surpluses equal in present value to the value of the outstanding debt in 2052.

There is an extensive discussion of risk-adjusted discount rates. To bias the results against their main finding, the authors understate what they view as the appropriate market-based discount rate by assuming that tax revenues (which in practice are more pro-cyclical than the economy) and spending (which in practice is countercyclical) are both as risky as GDP itself.

In any case, the main point of the paper is that even with optimistic assumptions about future budget outcomes and conservative assumptions about discount rates, the market value of federal debt is (far) greater than the present value of expected future primary surpluses when discounted with risk-adjusted rates. Allowing for the government to collect resources via seigniorage does not change the basic conclusion.

POTENTIAL EXPLANATIONS The authors offer three potential explanations of the results: (1) Treasury market participants expect future fiscal corrections relative to the stated deficit path; (2) participants expect that fiscal policy will become pro-cyclical over time rather than remaining countercyclical; and (3) participants are mispricing Treasury debt. I discuss each of these in turn.

Given the fiscal outlook, the first explanation—that market participants expect fiscal corrections to be larger than posited by the authors—is plausible. This is standard fiscal reform: raise revenues or reduce spending relative to the baseline. It is worth noting that although the market values debt using a risky discount rate, the required fiscal changes to reach a given debt target in a given year are the same as in a non-stochastic framework. For example, the authors show in table 5 that an immediate and sustained 6.0 percent of GDP increase in the primary surplus would reduce the debt to –6.1 percent of GDP by 2052. Calculations using the non-stochastic model in Auerbach and Gale (2022) and the same budget projections generate the same answer. This is because the government's debt dynamics are governed by the rate of the interest the government pays even if investors are discounting the debt at a different, risky rate.

The second possibility—that the automatic stabilizer role of fiscal policy will be eliminated—seems the least plausible. Even if Congress wanted to do this, it would be difficult to implement, given that it would likely require a major redesign of core tax and spending programs. In principle, Congress could instead use discretionary tax and spending changes to more than offset the cyclical effects of the automatic stabilizers, but this seems unlikely. In addition, eliminating the countercyclical nature of fiscal policy would have severe consequences. Automatic stabilizers help stabilize the economy as a whole, and they provide critical assistance to people at precisely the time they need it (Edelberg, Sheiner, and Wessel 2022). It seems like we should be expanding automatic stabilizers; restricting them seems like a cure worse than the disease.

The authors call the third explanation “mispricing,” but I would call it “discounting that is inconsistent with the model,” to allow for the possibility that the discrepancy is due to model misspecification, not errors by market participants. I believe there is a plausible story for why market participants may use a lower discount rate for Treasuries than the authors propose.

Suppose that policymakers adjust primary surpluses in order to be sure to pay back the debt. That is, suppose primary surpluses are endogenous to debt issues (Auerbach and Gale 2009). Note that the current law baseline that the authors use assumes essentially no change in government behavior over the next thirty years and no changes in behavior in the case of unexpected shocks to the debt and thus misses this endogeneity. This seems to have several implications.

First, this policy endogeneity explains why the government can issue debt (at low rates) even if the present value of projected future primary surpluses is far less than current market value of debt: if investors know the government prioritizes debt repayment and avoidance of default, they will rationally expect future policies to adjust.

Second, it means that owning a government bond is different from owning a share of future primary surpluses that are projected assuming no change in policy (as in the current law baseline). When I buy debt, there is a promise that it will be paid back. That promise is embodied in the Fourteenth Amendment of the Constitution and is implicit in government actions. Despite massive fluctuations in primary deficits and surpluses, the government has prioritized paying back debt over other forms of spending since the War of 1812, with the exception of an administrative error in 1979 (Gale 2019).

Third, if policymakers prioritize debt repayment, it means that bondholders are not the residual claimants of risk, future taxpayers are. So, the paper may be showing that the risk-adjusted debt burden on future taxpayers is higher than commonly thought, not that government debt is riskier to market participants than commonly thought. If so, the idea that the correct risk-adjusted discount rate is lower than the authors assume seems plausible (Falkenheim 2021).

FISCAL CAPACITY So far, I have not yet mentioned the term "fiscal capacity," which the authors define differently from the rest of the literature. One would expect that having debt exceed something called "fiscal capacity" would be a bad thing, but that is not necessarily the case with the authors' definition. To be clear, using a different definition is perfectly fine—one can define terms however one would like; but different definitions have different implications, and the definition used by the authors does not have the implications that the authors seem to want to impose on it.

An intuitive definition of fiscal capacity would be the sum of current debt plus fiscal space, where fiscal space is the amount of new debt the government could add to its existing stock without adverse consequences. Those consequences could include, for example, disrupted financial markets, a recession, a default, or major capital outflows—in short, effects above and beyond the usual effects of debt.

These definitions are essentially what the OECD (Botev, Fournier, and Mourougane 2016) and IMF (Heller 2005) use and are grounded in actual, observable debt levels. Moreover, these definitions offer a useful guide to fiscal policy actions. In particular, knowing where the economy stands relative to these definitions would indicate whether the government could safely add new debt, whether issuance of new debt should face a higher bar than existing debt, and so on. In an earlier paper (Jiang and others 2021), the authors define fiscal capacity as "how much debt the government can issue," which I interpret as close to and consistent with this definition.

In this paper, however, the authors use a different definition. They define fiscal capacity as the present value of future primary surpluses (in some cases, adding in the seigniorage from the convenience yield on Treasury debt). Note that, unlike the OECD/IMF definition, this definition does not start with actual, observable debt levels; rather, it is based on infinite time horizon budget projections, which contain enormous amounts of uncertainty.

Second, importantly, this definition does not say that the government should stop issuing debt when it hits fiscal capacity. It does not say that there would be deleterious consequences of issuing debt above fiscal capacity—indeed, there may well be beneficial consequences of having debt exceed fiscal capacity. Suppose, for example, that the United States had zero debt and was expected to run balanced primary budgets starting now for eternity. Everyone would view that as a very strong fiscal position except the authors, who would say that fiscal capacity is zero (or even negative, given that the stream of tax revenues is riskier than the stream of outlays). But the United States clearly could issue new debt in that circumstance. More importantly, for many reasons (such as to provide the convenience that Treasury debt offers investors or to finance infrastructure, anti-recession policies, or wars), the government likely should issue substantial debt in that circumstance.

So it is unclear what the implications are for having the current market value of government debt exceed the authors' definition of fiscal capacity. To the extent that it means there is a chance we will need to raise taxes or reduce spending in the future, this observation is not wrong, but not new either.

CONCLUSION The paper is motivated by a desire to provide a summary assessment of the fiscal stance of the government. But the federal government is the most complicated financial institution in the world, and fiscal policy has many dimensions. For example, the issue is not just the deficit, how the money is raised and spent matters, too—in particular, deficits that finance investment in people or projects may have quite different effects than deficits that finance consumption (Gale 2019).

As a second example, the government could pay off its debt with future primary surpluses, as the paper notes, or with its stock of financial assets, which the paper ignores. Those assets equaled 7.3 percent of GDP at the end of 2021 (CBO 2022). Thus, the correct inequality would compare the present value of future primary surpluses with federal debt net of federal financial assets. The latter (in par value) equals 92.3 percent of GDP, so the authors' main results would still comfortably hold.

Recently, Blanchard (2019) has emphasized the importance of thinking about fiscal policy when interest rates are lower than the growth rate. Furman and Summers (2020) proposed that a useful criterion is to see whether real net interest payments are below 2 percent of GDP. The current paper argues that these criteria do not constitute sufficient statistics for assessing the entire fiscal situation. I agree completely, but I do not believe that the authors' measure of fiscal capacity is a sufficient guide to fiscal policy choices either. I would not want policymakers to base their choices solely on any individual criterion, but each criterion can be useful, helpful, and constructive.

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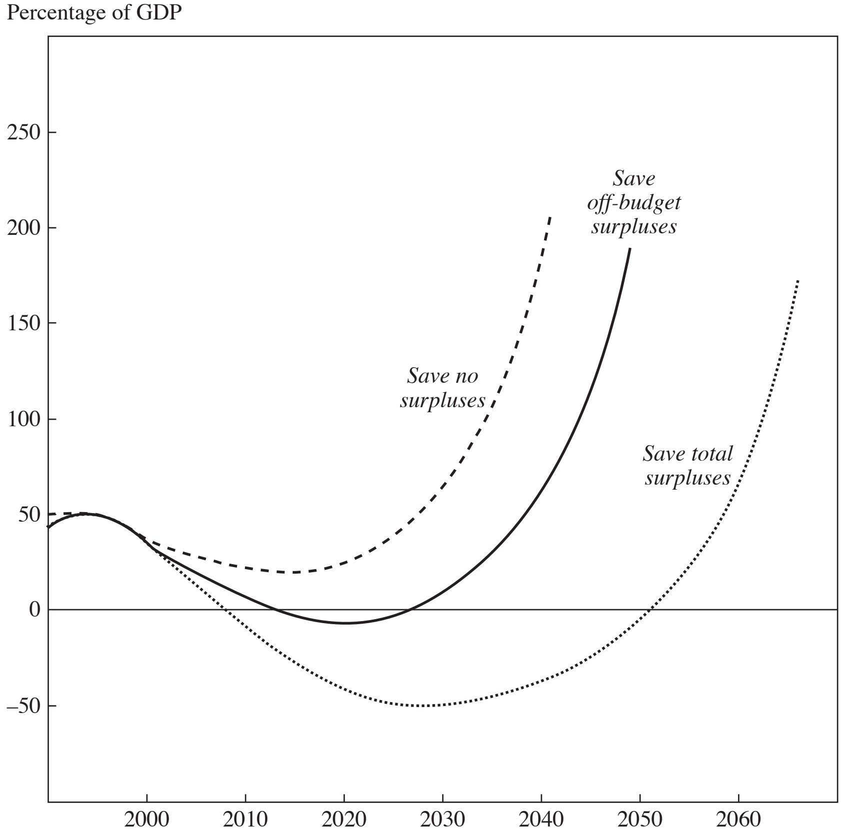
COMMENT BY

DEBORAH LUCAS When I started my new job as chief economist at the Congressional Budget Office (CBO) twenty-two years ago, my first assignment from then CBO director Dan Crippen was to breathe some life

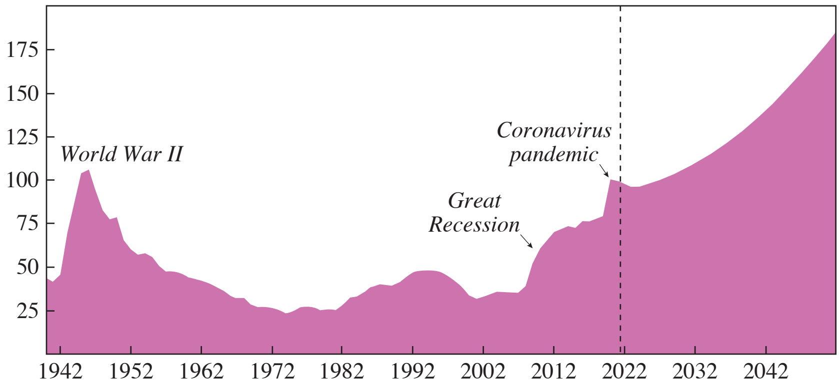
Figure 1. The CBO's Year 2000 Projections of Debt/GDP



Source: Reproduced from Congressional Budget Office (2000).

and urgency into the prose in the CBO's *Long-Term Budget Outlook*. The CBO's projections suggested that the current policy was unsustainable, but what could we say to get citizens and policymakers to pay attention? Most people, I'd venture even the CBO's staff, were largely indifferent. The situation was also a technical headache. When the CBO's equilibrium macro model was calibrated with its fiscal projections, there was nothing that we could do to prevent the model from crashing. Government debt crowded out private investment at an increasing rate over time, interest rates exploded, and the capital stock fell to zero—the real economy essentially vanished. Notably, the worst-case scenario in the CBO's 2000 *Long-Term Budget Outlook* (figure 1) understates the current debt-to-GDP ratio, primarily

Figure 2. The CBO's Year 2021 Projections of Debt/GDP



Source: Reproduced from Congressional Budget Office (2022).

because of elevated spending in response to the Great Recession and the COVID-19 pandemic.

Dire warnings about limits to fiscal capacity and the unsustainable path of projected fiscal policy long predated my initial forays into those issues at the CBO, and I expect they will become even more salient in the years and perhaps decades to come. Certainly, this year's edition of the CBO's long-term budget outlook is a close cousin of that inaugural edition more than two decades ago, and an even more pessimistic one (figure 2).

Assessments of the fiscal capacity of the US government seem to be something of a political Rorschach test. While many influential voices in academia, government, and the private sector continue to warn about the risks of excessive federal indebtedness, there are more than a few prominent economists who take a much more sanguine perspective. A tolerance for historically high debt ratios may arise from a sense of urgency for the federal government to confront pressing or even existential policy challenges today—tackling climate change, updating infrastructure, investments in social justice, and so forth. Recognizing that the only politically feasible way to fund such endeavors is with deficit spending, one might conclude that the best policy is to spend now and deal with the consequences later. There may be the expectation, or at least the hope, that future fiscal adjustments can accommodate the accumulated debt without too much pain, and that the public investments made today will make those high levels of debt more affordable in the future.

A relatively new twist to the question of whether and when deficit spending needs to be reined in, and one that has raised heated arguments on both sides, was ignited by the historically low interest rates of the last decade juxtaposed with high spending levels. I'll call that the $r - g$ debate. That's essentially where this paper comes in. The $r - g$ debate moved the conversation from the costs, benefits, and risks of high deficit spending to a seemingly technical set of issues concerning economic growth rates and appropriate discount rates. If the interest rate, r, on government debt is less than the growth of the economy, g, indefinitely, it is theoretically possible to grow out of high debt levels—ergo a much higher debt capacity.

The analysis here adds to a growing body of work that emphasizes that there is a fundamental problem with directly comparing r and g: the comparison isn't economically meaningful because it ignores the relation between risk and return. Specifically, treating growth opportunities as if their returns are risk-free but greater than the risk-free rate essentially assumes an arbitrage opportunity for the government. That observation is in the spirit of Barro (2020), my *BPEA* discussion earlier this year (Lucas 2021), Reis (2021), and other recent commentaries. A strength of this paper is to take seriously the importance of risk adjustment for fiscal policy evaluation. In that regard, it adds to the literature that estimates the market value of various fiscal obligations.[1]

DISCOUNTING FUTURE SURPLUSES The analysis of fiscal capacity rests on a derivation from the authors' earlier paper (Jiang and others 2019). There they showed that in the absence of bubbles and under rational expectations in a stationary stochastic economy, it is an identity that the value of Treasury debt at any point in time must equal the present value of future net government cash inflows excluding interest payments. In this paper, those net cash inflows are equated with primary surpluses. The authors then define fiscal capacity as the net present value of future primary surpluses.

The authors explore questions that include: How high must long-run primary surpluses be in order to cover the value of current Treasury debt liabilities? And how does risk adjustment affect one's conclusions about the answer? A robust result is that risk adjustment unambiguously reduces the present value of future primary surpluses when surpluses are proportional to GDP. Risk adjustment further reduces the present value of future surpluses when fiscal policy is countercyclical. Risk adjustment therefore suggests

1. To cite one closely related example, Geanakoplos and Zeldes (2010) contrast the market value of Social Security payment obligations, whose risk to the government is related to GDP, with the value calculated on an actuarial basis.

that larger future fiscal adjustments will be necessary than those implied by a similar analysis using Treasury rates for discounting.

Since risk adjustment is central to the analysis, I'll start with a quick reminder of why risk-adjusting discount rates is important, and why it shrinks the present value of primary surpluses. The fundamental economic reason to risk-adjust discount rates is that a unit of future consumption is worth more, in terms of today's consumption, when aggregate resources are scarce than when they're plentiful. That follows directly from decreasing marginal utility of consumption. It explains why the expected return on stocks is higher than on government debt, and why people are willing to pay more than an actuarily fair price for consumption insurance, effectively discounting its payoffs at less than a risk-free rate. The same logic applies when valuing risky fiscal cash flows.

The analysis in the paper rests on what-if experiments based on alternative calibrations of equation (1):

$$\text{(1)} \qquad \text{Debt}\left(\text{year-end 2021}\right) + \text{PV of future deficits}\left(\text{2022 to 2052}\right) = \text{PV of primary surpluses}\left(\text{2052 to } \infty\right).$$

This equation is the identity referred to earlier, which was derived by iterating forward the government's flow budget constraint under the assumption of no bubbles in government debt prices (i.e., satisfying a transversality condition requiring the present value of time t debt to go to zero as t goes to infinity). Note that, like the authors, I've broken out the present value of deficits over the next thirty years from the total primary surplus stream to highlight that the CBO's projections are assumed to hold on average over the next thirty years and that positive surpluses will only start to be realized after that. I will note here that this is a strong assumption, and one I think would be violated if it appeared that confidence in US government debt was eroding.

Surpluses are expected to vary positively with GDP because tax collections are pro-cyclical and spending is countercyclical. The positive correlation with GDP implies a risk-adjusted rate that exceeds the risk-free rate. The simplest case is when surpluses are a constant share of GDP. A claim that is proportional to GDP is valued by discounting at a rate, r_{RA}, that includes a GDP risk-premium. If GDP and hence surpluses grow on average at a rate g, the present discounted value of the surpluses is approximately:

$$\text{(2)} \qquad \frac{\overline{s} \times \text{GDP}}{r_{RA} - g}.$$

The higher the risk-adjusted rate, the lower the present value of the future surpluses. The fact that fiscal policy is countercyclical means that surpluses have a "GDP beta" of greater than one, which would further increase r_{RA}. If the risk-adjusted rate is less than or equal to the growth rate of GDP, debt capacity is infinite.

Plugging in a range of plausible values for r_{RA} and g into equation (2) quickly reveals the enormous sensitivity of estimates of debt capacity that are based on discounted values over infinite horizons to assumptions about rates. While this sort of calculation is useful as a refutation of simple (risk-free) $r - g$ logic, the sensitivity to parameter choices suggests caution in using it to draw sharp conclusions about fiscal capacity.

The bottom line on the authors' choice for a baseline GDP risk premium is that it seems reasonable, and similar to what might be expected to emerge from other estimation approaches. The conclusions that the relevant risk-adjusted discount rate is effectively greater than the growth of GDP and that there is no free lunch in deficit spending when risk is accounted for are consistent with the authors' own previous work and with other analyses such as those mentioned earlier that have examined the implications of risk-adjustment for debt capacity.

Nevertheless, I will briefly quibble with the approach the authors took to identifying the risk-adjusted discount rate for GDP-linked claims. A technical concern is that the GDP risk premium is inferred with reference to unlevered stock returns. A large component of GDP is tied to labor income, which is very weakly correlated with stock market dividends. Dividends account for only a modest portion of capital income. There are two alternative approaches that would more directly link the premium to GDP risk and that would have been more convincing to me. The first would have been to use a utility-based macro model, for instance, like the one just rolled out by Newell, Pizer, and Prest (2022) for evaluating the discount rate for greenhouse gases. As well as ensuring that the risk premium was derived directly from the statistical properties of GDP, it would provide macroeconomists and policymakers with a more familiar point of reference. The second alternative, which could be used as a complement to the first, would be to estimate GDP betas for taxes and revenues using a model similar to the capital asset pricing model.

Beyond choosing a discount rate to apply to cash flows that are proportional to GDP, the authors had to make assumptions about risk associated with future surpluses and future debt levels. They make the important observation that US surpluses are pro-cyclical because spending rises and taxes fall during downturns. That provides valuable consumption insurance to citizens, and it is more costly to the government than a policy where surpluses are proportional to GDP. As the authors note, rich countries with high debt capacity reap considerable welfare benefits from the ability to run a countercyclical fiscal policy. A striking statistic from the International Monetary Fund is that advanced economies spent on average 11 percent of GDP on pandemic relief, whereas emerging markets spent about 4 percent. Preserving fiscal capacity is insurance that such policies will be feasible during the next crisis, and the ones after that.

I am less comfortable with some of the other assumptions that affect the fiscal capacity estimates, and those concerns are noted briefly here.

- The co-integration of debt with GDP is asserted without offering empirical support, and figure 2 suggests it may be counterfactual at least historically.
- It isn't clear to me why a focus on steady states is relevant during a period of unprecedentedly high peacetime debt ratios.
- CBO projections are not forecasts, and they are likely to deviate from expected outcomes, particularly over long horizons. In particular, they don't include legislative actions that reduce out-year deficits, even if such changes are viewed as likely.
- Related, my biggest concern is with the assumption that taxes and spending are on autopilot, whereas in fact policymakers are likely to adjust them in response to emerging stresses in the government debt market. Such adjustments could significantly reduce the risk of the debt and increase surpluses. That issue is further explored in the rest of this discussion.

IS CURRENT TREASURY DEBT OUTSTANDING RISKIER THAN INVESTORS THINK IT IS? The analysis raises the question, If the value of Treasury debt rests on risky primary surpluses in the distant future, can even very short-term Treasury debt rationally be considered by investors to be virtually risk-free? The paper addresses this issue only obliquely, and I found the discussions in the paper related to this issue quite confusing.

Equation (1) above implies that all Treasury debt is potentially risky, and its market price at any point in time should reflect that risk assuming rationality and no bubbles. It is important to emphasize this, as it was a point I didn't fully absorb until the authors pointed it out to me after my partially misleading remarks during the conference. The observations that follow have been revised to be consistent with the fact that the debt pricing model incorporates the possibility of default.

Despite all Treasury debt being risky because of its ultimate backing by uncertain future surpluses, I believe there is a strong case for investors to rationally believe that their current debt holdings are quite safe. Rather than estimating cash flows and evaluating default risk based on the unknowable distribution of possible paths for long-run primary surpluses, investors rationally expect to be paid in full as long as the government can garner the resources to make the promised payments and it has the legal authority to do so. It is reasonable to assume that those conditions will be satisfied in the near to medium term, as they almost always have been in the past. For longer-term Treasury debt, while there is clearly the possibility of a partial or even full default in some eventualities, it is reasonable for investors to expect losses to be small.

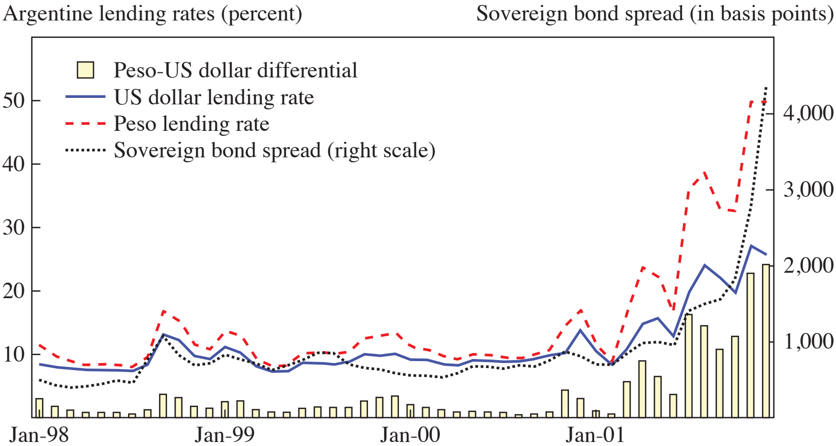
To put it differently, if the government treats public debt as a senior obligation, it will prioritize those payments over other types of spending. As for a firm, the seniority of debt makes it safer, while causing other claims to be riskier. My conjecture is that to reconcile the rationally perceived safety of the current debt with the identity in equation (1), it would require explicitly linking the surplus process to debt payment obligations. That would entail a surplus process that is different than the ones considered in this paper, but it need not violate the transversality condition. Surpluses could continue to be pro-cyclical in most but not all circumstances.

The fact that government debt can carry a very low interest rate even if fiscal capacity is quite limited has an important implication. Policymakers should not look to Treasury interest rates for reassurances that fiscal policies are sustainable or that they will be able to rely on debt-financed spending in the face of the next big crisis. The experience of less developed countries shows that government interest rates can shoot up very suddenly, as happened, for example, in Argentina in 2001 (figure 3). Note that equation (1) doesn't preclude a sharp and sudden downward revaluation of debt. It simply reflects that at any point in time, debt valuations will depend on current expectations about future fiscal policy and the economy. However, because the equation in itself is an accounting identity and not a stochastic model, it can't be used to predict whether and when stresses are likely to materialize.

SHOULD WE BE (MORE) WORRIED? The analysis suggests that the United States is out of fiscal capacity unless future surpluses are assumed to be implausibly large. However, there are a number of reasons to think that the government has more fiscal space than is suggested by these calculations.

My suspicion that fiscal capacity is underestimated is supported by consideration of the differences between reported primary surpluses and the actual resources the government has available to meet its debt obligations. The excess of actual resources over primary surpluses might be thought of as shadow surpluses.

Figure 3. Rapid Rise of Sovereign Debt Rates in Argentina



Source: Daseking and others (2005); reproduced with permission from International Monetary Fund.
Note: Rates are on thirty-day loans to prime customers.

Those shadow surpluses arise from the additional assets the government has available beyond its ability to tax its citizens or generate seigniorage, and from its ability to reduce spending if it is deemed necessary. Note that only capitalized tax revenues and seigniorage appear on the asset side of the federal balance sheet that is shown in the paper. The absence of nontax assets may reflect an implicit assumption that government expenditures are used for consumption rather than for investment.[2] A simple example illustrates how this can lead to an underestimate of government assets. Imagine that the government invests $1 billion in mortgage-backed securities in the open market, and that it funds that investment by issuing Treasury bonds. Under the budgetary rules governing asset purchases, the transaction increases the primary deficit by $1 billion. From an economic perspective the transactions are neutral; true fiscal capacity is unchanged but fiscal capacity as measured by the reported primary surplus falls. In fact, the largest (nontax) financial asset of the government is its $1.3 trillion student loan portfolio. While the market value is considerably less than the reported book value, its value is still substantial and it serves to offset a portion of the debt.[3]

2. Also missing on the liability side is an equity claim that is needed to absorb changes in the value of nontax assets.

3. Unlike for asset purchases, the budgetary accounting for student loans and other government credit programs is on an accrual basis. The use of accrual accounting for credit programs causes the deficit and the change in federal debt outstanding to diverge.

The government also has production technologies that it could use to increase revenues should the need arise. As the authors note, one such technology allows it to produce seigniorage, and its value is taken into account in some of the calculations. It can also produce citizenship rights that could be sold. It could sell public lands and increase prices on mineral and other natural resource rights. It could increase guarantee fees on the $5 trillion of mortgages it insures.

On the expenditure side, it has many levers to reduce costs or increase nontax revenues. For instance, it could increase co-payments in Medicare or end coverage of some expensive procedures. In the event of a war, it could cut military expenditures by reinstating the draft.

Even more dramatic actions could be taken. As the authors note, the government could rely on financial repression to force its citizens or domestic banks to hold its debt at below-market rates. It could take other actions to lower the value of outstanding debt, for instance, by expropriating foreign holders either directly or via a currency devaluation.

Perhaps most importantly, the Federal Reserve owns a large share of the debt held by the public, and it has the capacity to make additional very large purchases. It is difficult to predict what those purchases would imply for the value of the debt. However, the likelihood that the Federal Reserve would step in to prevent a default is a further reason why it is rational for investors to treat the promised payments as low risk in nominal terms.

A few caveats are in order. Many of these possibilities seem like very bad ideas. I also have provided no evidence that these adjustments would create significant additional debt capacity. However, they do suggest the possibility of a much higher debt capacity, and it would be interesting to explore their quantitative importance.

SHOULD THE GOVERNMENT INCREASE THE DURATION OF ITS DEBT? The authors emphasize that the duration of the government's debt liabilities is much shorter than the duration of its surplus assets. That duration mismatch causes fiscal capacity to be highly sensitive to interest rate risk. Lengthening the duration of its debt could reduce that risk, and this is suggested as a policy option.

The practicality of this advice is unclear. Issuing debt at anything close to the estimated duration of the surplus (283 years!) would create an asset that is incredibly risky for investors. Enticing investors to buy it presumably would require paying a substantial term premium. Effectively, the government would be buying insurance against interest rate risk from the private sector, an arrangement that would run counter to the usual presumption that the government has the greater risk-bearing capacity. Issuing very long-term nominal debt would also create a moral hazard problem because of the temptation to inflate away its value. Recognition of that risk could further increase the interest rate demanded by investors. Issuing long-term real debt would avoid the moral hazard problem, but I expect it would lack liquidity and also carry a hefty term premium. The Treasury chooses the maturity structure of the debt so as to minimize long-run funding costs and take into account factors like rollover risk. Adding a surplus hedging objective would complicate what is already a difficult optimization problem.

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GENERAL DISCUSSION Michael Falkenheim argued that a risk-adjusted projection of debt would have been more useful than a model focusing on current capacity; asking what the debt level in the future would have to be, in present value terms, to cover current debt and surpluses between now and 2052. That could have served as an alternative debt projection to the one produced by the Congressional Budget Office (CBO) and would better reflect the Arrow-Debreu considerations brought up by discussant Deborah Lucas. He continued, pointing out that in thinking about the capacity for debt, one may want to start by thinking about the capacity for a primary surplus in terms of economic and political sustainability. Finally, Falkenheim mentioned how, in an overlapping generations model such as that by Peter Diamond, there is an opportunity for the government to enact Pareto improving policies which may be considered a form of arbitrage—in which case the no-arbitrage condition would be violated.[1]

Ricardo Reis suggested that in addition to focusing on GDP risk, the authors may also want to include inflation risk in the model. In light of the inflation risk premium having been essentially zero—or even negative—over the past decade but rising over the last year, one could use the authors' calculations to find the cost of inflation in shrinking capacity through making the nominal debt riskier and having a higher interest rate. Connecting this to the paper by Ball, Leigh, and Mishra, in which a projection of two years of elevated inflation is put forward, Reis argued that using the authors' methods one could analyze how costly the resulting increase in the inflation risk premium would be fiscally.[2]

Henry Aaron commented that while he does not disagree with the notion of needing to narrow the gap between spending and revenues collected, he rejects the use of a current law assumption by the CBO in their projections. He pointed to Medicare hospital insurance and Social Security, where the CBO relies on the statutorily committed levels of spending thirty years into the future, even as the funds are exhausted—which they will be within a few years and about a decade, respectively. There are specific corrections that could be made, Aaron continued, which could bring the CBO numbers closer to what they claim to be—current law—but the more basic point is that the CBO's claim that its current long-term projections are based on current law is false and conceals what CBO really does. The CBO assumes that unreduced social insurance pension and health benefits will be paid even when trust funds are depleted, a policy that Congress has explicitly barred. And it assumes that Congress will cut income tax rates or other taxes to hold constant the tax/GDP ratio even when it projects that

1. Peter A. Diamond, "National Debt in a Neoclassical Growth Model," *American Economic Review* 55, no. 5 (1965): 1126–50.

2. Laurence Ball, Daniel Leigh, and Prachi Mishra, "Understanding US Inflation during the COVID-19 Era," in the present volume of *Brookings Papers on Economic Activity*.

the budget will be hugely in deficit, something that violates established congressional policies for normal times. These violations of the "we base our projections on current law" assumption have important economic and political ramifications.

In response to Aaron's comment Phillip Swagel noted that the CBO can provide the authors with the data Aaron mentioned. Swagel explained that the reason they adhere to the current statutorily committed levels of spending is because the CBO does not engage in predicting what a future Congress will do but, he explained, they do analyze alternative scenarios under which spending is more or less than the current statutorily committed levels.

Louise Sheiner commented that the CBO projections show what expected taxes would have to be for the government to meet its debt obligation under the assumption that this will ultimately fall on the taxpayer. She pointed out that this puts taxpayer risk rather than debt-holder risk in focus. This in turn makes business cycle risk less of a concern but does not eliminate GDP risk and potentially slow growth as important factors. For example, in a world of slow technological progress and low GDP growth where people do not live much longer as a result, Medicare spending may be quite a bit lower, she suggested, and in that case, when considering long-term productivity, some of the government spending may be offset.

Jonathan Parker suggested that one of the fundamental future risks is whether we will see a return of high trend output growth, which comes with higher real interest rates, or the reverse—sluggish productivity growth but low interest rates, which would make the debt easier to roll over but more of a long-term concern. This long-term risk in the growth rate should enter the analysis, he argued. Parker made a second point that there is a government budget constraint that must hold, and he noted that if there is a mis-valuation or lack of sustainability in the authors' analysis, then something in the future would have to fill that hole and that might be inflation, as it has been in many countries in the past.

Donald Kohn responded to the panelists' claim that the market must embody either a large fiscal correction sometime relatively soon or a lot more repression, saying he did not find either persuasive. Kohn pointed out that market expectations on inflation are low—close to the 2 percent target in the long-term. Perhaps there is a shorter horizon than the infinite horizon suggested by the authors or, he asked, are they thinking in terms of debt capacity more in the way the discussants were? Kohn concluded by asking for more discussion on the pattern of market prices.

Steven Davis wondered how the rest of the world fits into the authors' analytical framework. As emphasized by Lucas, the rest of the world holds a lot of US Treasuries, with an associated convenience yield. Davis contemplated a scenario in which the world grows rapidly relative to the United States and demand for US Treasury securities increases as a result—their role as reserves would be affected, effectively introducing risk. He then pointed to the possible emergence of good substitutes for the US dollar, creating more competition and potentially eroding the convenience yield altogether, suggesting that these considerations should have been factored into the authors' model.

Arvind Krishnamurthy reflected on the focus of the paper as not so much trying to establish fiscal capacity but rather providing input that can help us get to the fiscal capacity. He noted that the paper engages in a sort of valuation exercise, asking, What must you believe about the surplus process, and the interest rates applied to that process, in order to reconcile how much investors are willing to pay for US debt? Krishnamurthy pondered the different ways the authors go about reconciling this: to reconcile the government debt with just movements in the risk premium, the latter would have to be incredibly low. He then contemplated how increasing convenience yields may resolve the analysis, referring to the points made by Davis. Finally, Krishnamurthy addressed some of the comments on including inflation in the framework and suggested that the authors may have to relax their rationality assumption for this purpose, noting that if investors were expecting inflation, interest rates would have already adjusted. Therefore, in the authors' framework the assumption would have to be a world in which investors irrationally expect no inflation—which given the paper by Ball, Leigh, and Mishra may not be too far-fetched—and unanticipated inflation could then potentially help reconcile the valuation.

Jonathan Pingle suggested that considering market imperfections to a greater extent and how to reconcile those may be key to understanding the gap between the market pricing and what the optimal trajectory of capacity may be. Pingle argued that the convenience yield, in a sense, is a form of market imperfection. He noted that we tend to think about both Federal Reserve holdings of Treasuries and central bank holdings as having a different rollover risk than the private market and that research shows that central bank holdings put downward pressure on yields. He added that another important issue in the United States is money market reform, shifting the industry to be almost fully government-only funds following the Dodd-Frank reform. Pingle argued that while this won't be reflected in the convenience yield further out on the curve, there is a significant amount of issuance now that faces very little rollover risk and an additional type of market imperfection creating demand for federal government debt.

Justin Wolfers remarked that while the authors suggest that bonds are mispriced, whether this is correct or not does not necessarily affect anything beyond Wall Street. He argued that on Main Street, the average worker will still show up at work every day, regardless of the success of the valuation exercise by the authors.

Hanno Lustig clarified that the analysis indeed implies that debt cannot be risk-free—the debt could only be risk-free if the tax claim is less risky than the spending claim.

Stijn Van Nieuwerburgh commented that the exercise in the analysis was to apply aggregate risk pricing to the issue of fiscal sustainability. Van Nieuwerburgh summarized the feedback as focusing importantly on the gap between the present value of government surplus and the market value of government debt and noted first the issue of the convenience yield and the extent to which demand for US debt may rise in the future. He argued that given a downward sloping demand curve, a higher future convenience yield seemed unlikely.

To that point, Lustig noted that while the United Kingdom was once the world's safe asset supplier, earning large convenience yields, this ended abruptly with World War I after which the UK government had to borrow at a much higher interest rate. He argued that it would be foolish to assume that an alternative to the United States as a safe asset supplier would never exist.

Van Nieuwerburgh mentioned that another option that had been brought up was unexpected inflation and the possibility that bond investors were misunderstanding the inflation risk. He pointed out that bond investors may be systematically overpredicting the surplus, as they are overly optimistic about fiscal rectitude. An additional possibility is the presence of a bubble, which Van Nieuwerburgh found implausible. Finally, fiscal adjustment would be an option that, while politically undesirable, may become necessary in the future.

Zhengyang Jiang responded to the comments on pricing other risks in the model, including inflation and interest rate risk, and noted that the resulting net present value of surpluses comes out even lower in models where these other factors are included—even becoming negative. Thus, the question of what would close the gap remains, but presumably lies in some of the possibilities listed by Van Nieuwerburgh.