PENN WHARTON
UNIVERSITY of PENNSYLVANIA
Budget Model

When Does Federal Debt Reach Unsustainable Levels?

Summary: PWBM estimates that---even under myopic expectations---financial markets cannot sustain more than the next 20 years of accumulated deficits projected under current U.S. fiscal policy. Forward-looking financial markets are, therefore, effectively betting that future fiscal policy will provide substantial corrective measures ahead of time. If financial markets started to believe otherwise, debt dynamics would "unravel" and become unsustainable much sooner.

Key Points

- The U.S. "public debt outstanding" of $33.2 trillion often cited by media is largely misleading, as it includes $6.8 trillion that the federal government "owes itself" due to trust fund and other accounting. The economics profession has long focused on "debt held by the public", currently equal to about 98 percent of GDP at $26.3 trillion, for assessing its effects on the economy.
- We estimate that the U.S. debt held by the public cannot exceed about 200 percent of GDP even under today's generally favorable market conditions. Larger ratios in countries like Japan, for example, are not relevant for the United States, because Japan has a much larger household saving rate, which more-than absorbs the larger government debt.
- Under current policy, the United States has about 20 years for corrective action after which no amount of future tax increases or spending cuts could avoid the government defaulting on its debt whether explicitly or implicitly (i.e., debt monetization producing significant inflation). Unlike technical defaults where payments are merely delayed, this default would be much larger and would reverberate across the U.S. and world economies.
- This time frame is the "best case" scenario for the United States, under markets conditions where participants believe that corrective fiscal actions will happen ahead of time. If, instead, they started to believe otherwise, debt dynamics would make the time window for corrective action even shorter.

Introduction

This introduction to this brief is, by necessity, a bit more technical than found in most PWBM briefs. We provide a small "primer" for policymakers and other readers to understand how PWBM analyzes the impact of debt on the U.S. economy. These insights generally apply to the workings of other dynamic models used by government scoring agencies.

As we have discussed elsewhere, government debt reduces economic activity by crowding out private capital formation and by requiring future tax increases or spending cuts to accommodate future interest payments. The dynamic "overlapping-generations (OLG) model", originally based on the seminal work by Diamond (1965) and Auerbach and Kotlikoff (1987), is the workhorse framework for analyzing the impact of government debt on the economy through both, tax and spending channels. The Penn Wharton Budget Model (PWBM) and the Congressional Budget Office use versions of the OLG model largely based on the papers by Nishiyama and Smetters (2005, 2007, 2014),[1] subsequently modified in various ways over time. The Joint Committee on Taxation also has access to its own OLG model for assessing dynamics.

It is generally not well understood outside tight academic and DC modeling circles that these models effectively crash when trying to project future macroeconomic variables under current fiscal policy. The reason is that current fiscal policy is not sustainable and forward-looking financial markets know it, leading to the economy "unraveling" through "backward induction".[2]

Dealing with this problem has sometimes led scoring agencies to also use additional models where financial markets follow simple, adaptive (backward-looking) rules-of-thumb. In some cases, these alternative models---in particular, the standard neoclassical growth model---do not include a role for government debt under the strong assumption of "Ricardian" consumers. To be sure, obtaining insights from alternative models can often provide meaningful information. However, for understanding novel debt dynamics with no historical precedent, such alternative "reduced form" models are unsuitable and generally provide projections that are optimistically biased.

Instead, in practice, the workhorse OLG model is generally "fixed" by augmenting it with an additional assumption---namely, a future fiscal policy action that is *not* actually contained in current law. This modelling fix (also called "closure rule") springs into action at a future date to stabilize the amount of debt held by the public relative to GDP. It often takes one of several alternative forms: a broad-based value-added tax (VAT); a proportional wage tax (not subject to any payroll tax ceiling); a proportional income tax; a broad-based reduction in spending; or, some combination of each. Broad-based closure rules introduce very small economic distortions relative to other alternatives, such as a narrow-based, progressive tax on capital income. Importantly, broad-based closure rules allow model sustainability with the maximum amount of debt relative to GDP before needing to be activated.

Both PWBM and CBO typically have this rule kick in the year 2050 or later, potentially with some gradual introduction. As it turns out, the exact form of the broad-based closure rule---for example, whether it is a VAT or some other tax---is not that important in terms of economic effects.[3] What *is* important is that a large broad-based future corrective change in fiscal policy happens in *any* form to stabilize the debt-GDP ratio, and that such a correction action is anticipated by financial markets. Otherwise, forward-looking financial markets would unravel much sooner---a process known as "backward induction"---to cause a sovereign debt crisis.

Existing dynamic OLG models also face a second encumbrance: For reasons that go beyond this brief, OLG models used in policymaking typically do not properly distinguish between risk-free assets (government bonds)

and risky assets (e.g., stocks). That lack of distinction usually creates only a minor loss in model fidelity when analyzing the economic impact of many fiscal policies such as pre-K education or infrastructure. The lack of distinction is more problematic at higher levels of government debt that materially change financial market prices. Now, we want to estimate the amount of government debt that the economy can handle while being consistent with household investment risk-taking preferences and the effects of distortionary taxes and changes to productive spending.

Over the past several years, PWBM has built a second OLG model---the PWBM "moonshot" OLG model---that solves a "state space" 20,000 times larger than the PWBM standard OLG model referenced above. While simpler in some dimensions to our standard model, the moonshot model combines mathematical advances with large-scale computing to solve the "curse of dimensionality" commonly found in quantum computing problems. The moonshot model allows us to compute interactions of debt with financial markets with much greater confidence to ensure consistency with investor risk preference in more extreme, boundary settings.

Even with a closure rule discussed above added to the moonshot model, there is only so much federal debt that financial markets can handle, that is, at *any* government borrowing rate. We will explore this issue in more detail in a future brief. Succinctly, for now, the increase in debt "crowds out" private capital formation, which lowers GDP growth and the size of tax bases. This crowding out is especially pronounced in the moonshot OLG when reaching limits of the economy's debt carrying capacity. At the same time, more tax revenue is needed to implement the closure rule that stabilizes debt relative to GDP. Even when using an efficient VAT, the tax distortions shrink the economy even more so that interest payments can no longer be made. In effect, the economy collapses under the sheer weight of government debt.

As of September 30, 2023, the federal "debt held by the public" (herein, "debt") stood at $26.3 trillion, or about 98 percent of projected GDP. The "public debt outstanding" of $33.2 trillion often cited in media is largely misleading and not relevant for assessing economic impact; about $6.8 trillion of that amount is from the federal government holding its own debt for accounting purposes. The economics profession has long focused on "debt held by the public."

Still, even with the most favorable of assumptions for the United States, PWBM estimates that a maximum debt-GDP ratio of 200 percent can be sustained even if investors believe (maybe myopically) that a closure rule will then prevent that ratio from increasing into the future. Countries like Japan with an even larger debt-GDP ratio more-than offset their government debt with a household saving rate that is much larger than that found in the United States. This 200 percent value is computed as an outer bound using various favorable assumptions: a more plausible value is closer to 175 percent, and, even then, it assumes that financial markets believe that the government will eventually implement an efficient closure rule. Once financial markets believe otherwise, financial markets can unravel at smaller debt-GDP ratios.

Government Debt Projections Have Risen Sharply Over Time

Federal debt has increased consistently since the late-2000s. Figure 1 shows the Congressional Budget Office's 10-year projections (labeled by the month and year of publication) of federal debt held by the public as a share of the Gross Domestic Product (GDP) in percent since 2007.[4] Each line in Figure 1 represents a time series of 12 numbers: In each, the first value shows actual debt-GDP ratio at the end of the year before the year of publication.

The second value shows debt held by the public expected as of the end of the current calendar year, and the following 10 values are CBO's projection of debt-GDP ratio at the end of each year during the next decade.

Figure 1: CBO 10-year Projections of Debt Held by the Public as a Share of GDP 2007-2023 (fiscal years, percent)

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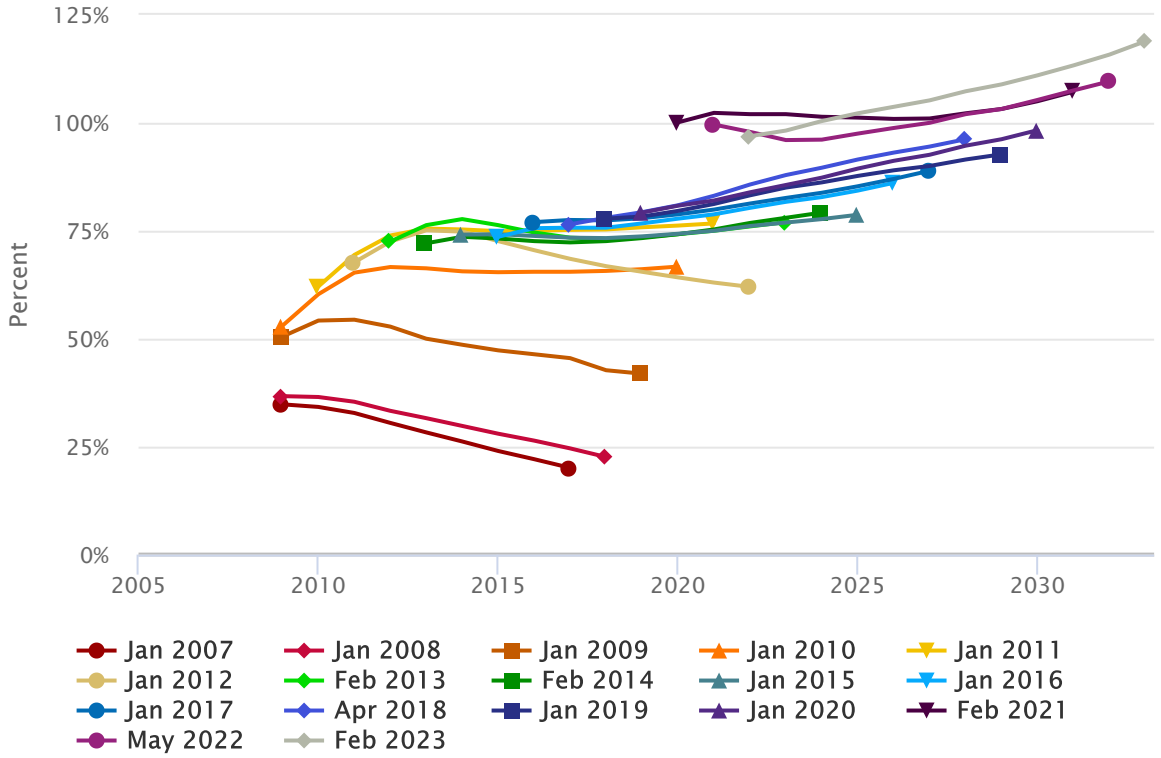

Some of the increase in debt is well understood and driven by policy changes, including in response to 2007 – 2010 Great Recession, the Tax Cuts and Jobs Act of 2017, and more recent Covid-19 stimulus. Some of the projected debt increase was due to underestimates in entitlement program spending arising from faster-than-expected growth in the population of retirees and their Social Security and Medicare benefits. A decomposition of the exact causes goes beyond this brief. What Figure 1 clearly documents, however, is the secular rise in the debt-GDP ratio relative to past projections rather than an up-and-down relationship consistent with counter-cyclical policy. Put differently, U.S. debt is on secular upward path and past projections have, if anything, underestimated that increase, regardless of the reason.

How Long Does the United States Have?

Financial markets demand a higher interest rate to purchase government debt as the supply of that debt increases, controlling for other macroeconomic shocks that might simultaneously increase the demand for debt. Forward-looking financial markets should demand an even higher return if they see debt increasing well into the future. Those higher borrowing rates, in turn, make debt grow even faster ("snowball"), potentially producing a

downward spiral in the price that the government can sell debt in exchange for a promise of a fixed set of future payments. Modeling this behavior can often become circular, with key drivers such as closure rules lacking transparency.

In this brief, we take a more cautious and transparent approach, leaving presentation of our more sophisticated analyses to future briefs. Toward this end, Table 1 uses the PWBM microsimulation model to project future debt-GDP ratios at different levels of interest rates without explicit debt feedback effects on interest rates.

For the PWBM Baseline rate, we use future interest rates that are currently used by the Social Security Administration (their "medium" cost projection) for estimating future trust fund balances. These real interest rates start at around -1.0 percent today and gradually increase to 2.3 percent by the 10th year where they remain steady thereafter. The rate at the 10th year is currently smaller than the 30-year real interest rate as of October 4, 2023. In contrast, CBO assumes CBO real rate that increases from -0.9 percent today to 1.53 in 10 years and then keeps rising to 2.21 percent by 2053. We present values based on their numbers in the Appendix.

Importantly, in theory, the SSA interest rate projections are not intended to include the impact from historically unprecedented, mounting future government debt itself. Candidly, however, at this point, some arguments about debt and future rates become circular in modeling discussions. However, both authors are experts in SSA estimation methods---with one of the authors currently serving on the Social Security Advisory Board and the other author serving on its most recent technical panel. The larger SSA rate is mostly guided by historical averages rather than forward-looking estimates that incorporate future debt. Indeed, SSA generally does not attempt to incorporate federal debt into its own forecasts even though this debt can erode the size of the payroll tax base that supports benefits. We will return to this topic in another brief.

Table 1 then shows the impact on the debt-GDP ratio if financial markets start to demand a larger return before unraveling, equal to an additional 50 basis points (b.p.), 100 b.p, 150 b.p. and 200 b.p. Even the highest return at 200 b.p. is not far-fetched. However, additional rates closer to 50 to 100 b.p. are more reasonable in the short run, as some borrowing rates are already locked in at a weighted average duration of about 6 years.

Table 1: Projected Federal Debt Held by the Public as a Share of GDP

Percent

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Year	CBO	PWBM Baseline	+50 b.p.	+100 b.p.	+150 b.p.	+200 b.p.	+ 250 b.p.
2023	98	97	98	98	98	99	99
2025	102	100	101	102	104	105	107
2030	108	107	111	115	119	123	128
2035	120	125	131	139	146	154	162
2040	134	144	154	165	177	190	204
2045	150	163	177	192	210	228	249
2050	169	188	207	229	253	280	310

Source: "CBO" column from CBO's Long-Term Budget Outlook (June 2023); Other columns are authors' calculations.
Table 1 percentages updated on October 24, 2023.

Table 1 shows that between 2040 and 2045---or in about 20 years---the U.S. debt-GDP ratio will hit between 175 and 200 percent under current fiscal policy, depending on the assumed interest rates. The Appendix shows very little difference when instead using CBO's projections.

Appendix

Appendix Table 1: Projected Federal Debt Held by the Public as a Share of GDP under alternative future interest rate assumptions

Percent

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Year	CBO	PWBM Baseline	+50 b.p.	+100 b.p.	+150 b.p.	+200 b.p.	+250 b.p.
2023	98	98	99	99	100	100	101
2025	102	104	105	107	108	110	111
2030	108	117	121	125	129	134	139
2035	120	133	141	148	157	165	174
2040	134	148	158	170	182	196	210
2045	150	162	176	191	209	228	248
2050	169	183	202	223	247	273	303

Source: "CBO" column from CBO's Long-Term Budget Outlook (June 2023); Other columns are authors' calculations.

This analysis was produced by Jagadeesh Gokhale and Kent Smetters. Mariko Paulson prepared the brief for the website.

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1. Nishiyama, S., & Smetters, K. (2005). Consumption taxes and economic efficiency with idiosyncratic wage shocks. *Journal of political Economy,* 113(5), 1088-1115. Nishiyama, Shinichi, and Kent Smetters. "Does social security privatization produce efficiency gains?." *The Quarterly Journal of Economics* 122, no. 4 (2007): 1677-1719. Nishiyama, S., & Smetters, K. (2014). Analyzing fiscal policies in a heterogeneous-agent overlapping-generations economy. In Handbook of Computational Economics (Vol. 3, pp. 117-160). ↩

2. Economist PhD students typically learn about this concept during their first macroeconomics course, often referred to as the "no Ponzi game" (NPG) condition. NPG, in turn, implies the "transversality condition" commonly found in systems of differential equations to avoid under-identification (to produce a point instead of a manifold). ↩

3. The linked CBO report considers closure at year 10. For a longer period of debt accumulation before mandatory closure, PWBM has verified that few differences emerge across rules that are broad based. ↩

4. In each calendar year, information is taken from the earliest available Budget Outlook published by the CBO. ↩