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The Limit of Interest Rates Under a High Debt Environment

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ABSTRACT

Discussed many times throughout America's history, the issue of mounting debt levels has yet again become a front-page issue of the United States economy. "A $1 Trillion Conundrum: The U.S. Government's Mounting Debt Bill," "America faces a debt nightmare," "America's 'Debt Spiral' is Nearing a Critical Threshold" are but a few examples (Wallerstein, 2024; The Economist, 2023; Mohsin & Press, 2024). America's national debt is currently standing at $34 trillion and rising. Simultaneously, the Fed hiked interest rates 11 times between 2022-2023 after cutting rates in 2020 to deal with COVID-19. Overall, the Fed raised the federal funds rate by over 5 percentage points from a rate of almost zero at the beginning of 2022. While these hikes were effective in dealing against inflation, this meant that federal debt was also rolled over at higher rates during this time. Soon, the US will be spending more on interest than what it spends on national defense. Given that net interest costs are putting pressure on the government's current spending categories, a natural question arose; what, if any, is the limit of rising interest rates under a high debt environment? This paper explores the question by analyzing government spending and revenues based on the Congressional Budget Office's data and the historical record. Projections of what would happen to the government's spending power given different interest rate scenarios are assessed. Results conclude that the limit of interest rates stands around a 5-percentage point increase.

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ACKNOWLEDGEMENTS

To Professor Mihail Velikov and Professor Brian Davis,

I could not have completed this without you.

To my father and mother,

I would not have made it this far without you.

To my friends, family, and the above,

Thank you all kindly for your support.

INTRODUCTION

Before the pandemic, deflation was the major concern among many central bankers, especially the U.S. Federal Reserve System. Loose monetary policies that generated economic growth were then set in place to combat it. Although these policies were later cut in 2019, the pandemic soon hit, and additional money was printed alongside the aftereffects of the loose monetary policies addressing deflation. As the high tide of the pandemic started to pass, the underlying combined factors of supply chain issues, rushed demand for recovery, and need for financial aid quickly flipped deflation into rampant inflation. This resulted in the Fed switching from a loose to a tight monetary policy, more specifically by the traditional method of raising interest rates to fight inflation (Friedman, 2000). With each interest rate hike the Fed imposed, stock markets responded fiercely and entered bear markets rapidly (Peter G. Peterson Foundation, 2022). With the national debt standing at $34 trillion and the additional pressure of mounting debt rising in the US, a natural question arises: What, if any, is the limit of rising interest rates under a high debt environment?

Chapter 1

The Historical Literature

The relationship between federal debt and interest rates is not a relatively new concept. In fact, there has been much literature already completed upon their backgrounds. Starting in 1995, researchers Laurence Ball and N. Gregory Mankiw investigated the question, “What do budget deficits do?” (Ball & Mankiw, 1995). In this paper, Ball and Mankiw assess the effects of the budget deficit on the economy through four different avenues. First, they present a standard theoretical discourse about how budget deficits influence savings, investment, the trade balance, interest rates, exchange rates, and long-term growth. They then calculate a rough estimate of how the budget deficit would affect these categories. Third, they discuss how budget deficits would impact economic welfare; and finally, Ball and Mankiw examine the possibility that continuing budget deficits could result in a “hard landing” in which demand for a country’s assets suddenly stops.

Their results are enlightening. To answer the first question regarding the effects of budget deficits, there is one effect that is of utmost importance and the root of all other effects: “deficits reduce national saving” (Ball & Mankiw, 1995). But why does reduced national savings matter? The answer is presented through a simple economic equation. Where Y denotes gross domestic product, T for taxes, C for consumption, and G for government purchases, then private savings equals [Y - T - C], and public savings equals [T - G]. Put together, these yields equal national savings, S:

$$S = Y - C - G.$$

In other words, national saving is the current income not used immediately to finance consumption by households or purchases by the government (Ball & Mankiw, 1995). The second crucial equation is the one that accounts for GDP through four different types of spending:

$$Y = C + I + G + NX$$

Where output Y is equal to the sum of consumption C, investment I, government purchases G, and net exports NX. When substituting this expression for Y in the previous equation for national savings, the result is

$$S = I + NX.$$

Now this equation is what depicts the key effects of budget deficits. To put it in simple terms, it means that national savings equals the sum of investment and net exports. Hence, when budget deficits reduce national savings, investment will reduce, net exports will decrease, or both will decrease. Regardless of which decreases, the total decrease of investment and net exports must exactly equal the fall in national savings. With the reduction of net exports, or the increase in the trade deficit, another effect immediately follows, which is the flow of assets abroad. This effect occurs because deficits raise interest and the value of the currency in the market for foreign exchange (Ball & Mankiw, 1995).

As for the long-run effects, it is known that an economy's output is determined by its productive capacity, which is partly influenced by capital stock. However, when deficits reduce investment, capital stock grows at a slower pace than it otherwise would. Over the short-term, these effects are negligible, but if the deficit continues for a decade or more, the crowding out of investment can "substantially" reduce the economy's ability to produce goods and services and reduce the nation's ability to compete globally (Ball & Mankiw, 1995). As a result, national income falls because less is produced. However, if the budget deficit leads to a trade deficit, production remains the same, but income instead flows overseas in the form of interest, rent, and profit. Domestic residents do also accrue some of the profit, but obviously less than before. Finally, deficits alter factor prices such as wages and profits because lower capital stock leads to lower real wages and higher rates of profit (Ball & Mankiw, 1995).

By far the most important conclusion is this, the long-run effects of deficits, which is future taxes. Besides macroeconomic effects, government debt may also force the government to raise taxes when that debt is due. Otherwise, if the government does not increase taxes, then they may be forced to cut payment or some other spending in order to make up for that lack of funding. Of course, these two scenarios are only given if the government does not decide to simply roll its debt by issuing new debt. Rolling debt is usually the go-to method for the government, and while it may seem unsustainable, it is a viable solution so long as the rate of GDP growth is *higher* than the interest rate. Once the opposite is true however, the government may face a "hard landing" that could harbor unknown detrimental effects to the economy (Ball & Mankiw, 1995).

With the effects of government debt established, this literature moves on to examine the question "Does government debt affect interest rates?" (Engen & Hubbard, 2004). While a substantial amount of research had been conducted on the relationship, there had been no concrete conclusion on the magnitude of the effect of government debt on interest rates. Thus, researchers Eric M. Engen and R. Glenn Hubbard sought to answer this question in their paper, "Federal Government Debt and Interest Rates" (Engen & Hubbard, 2004). In their study, Engen and Hubbard decided to not compare results across various studies given the difference in assumptions. Instead, they used a standard set of data and a simple analytical framework to assess the effect of federal government debt and interest rates. Based on their analytical derivation, they find that an increase in government debt equivalent to a percentage point of GDP would lead to an increase in the real interest by about two to three basis points (Engen & Hubbard, 2004).

Other studies have found similar results, but there have also been studies that found larger effects. Researcher Thomas Laubach found "New Evidence on the Interest Rate Effects of Budget Deficits and Debt" with the help of the Board of Governors of the Federal Reserve system (Laubach, 2007). In order to isolate the effect from the business cycle and the associated monetary policy actions on debt, deficits, and interest, Laubach examines the relationship between long horizon expected government debt and deficits against expected future long-term interest rates (Laubach, 2007). This paper was first published in April of 2003 but then republished in May 2007. The projections used in the first paper were taken from the Congressional Budget Office (CBO) and the Office of Management and Budget (OMB), but in the second paper the only projections used were the CBOs. Hence this paper will also mostly focus on the CBO's projections.

The results of Laubach's research concluded that a percentage point increase in the projected deficit-to-GDP ratio is estimated to raise long-term interest rates by roughly 25 basis points, and a percentage point increase in the projected debt-to-GDP ratio is expected to raise long-term interest rate by an estimate of 3 to 4 basis points. (Laubach, 2007). The results of this study are statistically and economically significant and align with predictions from the neoclassical growth model. Given that Laubach's conclusions are similar to Engen and Hubbard's, the effect of budget deficits and debt on interest rates is assumed to be set. However, it is important to note that these two different conclusions exemplify how estimating the effect of government debt on Treasury yields is a complex process, and assumptions are key in determining the answer.

While Engen, Hubbard, and Laubach concluded the effect of government debt on interest rates, researchers Michael Bordo and Mickey Levy surveyed a two-century-long historical record on the connection between expansionary fiscal policy and inflation to explore the relationship between fiscal deficits and inflation (Bordo & Levy, 2021). In order to better assess the fiscal deficits financed by monetary expansion, which are being utilized to combat COVID induced economic stress right now, these researchers inspected earlier Keynesian and quantity-theoretic approaches, modern approaches incorporating expectations and forward-looking behavior, unpleasant monetarist arithmetic, and fiscal theory on the price level. They then briefly survey historical wartime records like the Napoleonic Wars and modern wars like Korea and Vietnam before moving onto peacetime periods that link fiscal expansion to inflation. These periods include the Great Inflation of the 1960s-70s, the Global Financial Crisis of 2008-09 and then the experience of the pandemic.

Through their analyses of historical records, Bordo and Levy found that during the two different peacetime periods in the early 20th century, bond-financed fiscal deficits that were not backed by future taxes were found to possibly have contributed to inflation. Their results conclude with many common practice measures today to avoid inflation, which include, avoiding war, avoiding fiscal dominance, keeping inflationary expectations anchored, maintaining central bank independence, and pursuing pro-growth economic policies. Another conclusion they found was being cautious of sustained monetary accommodation of fiscal deficits. Given the significance of the researchers' other conclusions, this conclusion can be used as strong support for the theory that fiscal deficits have an effect on inflation (Bordo & Levy, 2021).

While a relationship between fiscal deficits and inflation has been established, what is the relationship between inflation and fiscal policy? Francesco Bianchi and Leonardo Melosi explore this dynamic by analyzing inflation as an interest rate limit in their paper, "Inflation as a fiscal limit" (Bianchi & Melosi, 2022). They first build off the known paradigm that low and stable inflation requires an appropriate fiscal framework aimed at stabilizing government debt; this paradigm also further supports the relation between inflation and government debt. By working with this paradigm in their model, Bianchi and Melosi assess inflation reaction. Because an appropriate fiscal framework is assumed, actual or perceived changes to this framework can be credited to critically influence trend inflation, and cost-push shocks were found to cause short-lasting movements in inflation. However, recent fiscal interventions due to COVID have altered beliefs about the fiscal framework, leading to an increase in fiscal inflation. Consequently, the researchers investigated how to avoid inflation outside of tightening money policies by building an estimative model that allows for changes in the monetary/fiscal policy mix. Results found that inflation could be combated with a double-pronged approach of monetary and fiscal policies to avoid fiscal stagflation. This provides support that inflation influences interest rates, and fiscal policy also plays a part in the macro-relationship (Bianchi & Melosi, 2022).

Given a significant relationship, to what extent does fiscal policy affect interest rates? Qiang Dai and Thomas Philippon pursue this question in their paper, "Fiscal Policy and the Term Structure of Interest Rates" (Dai & Philippon, 2005). They attempt to shed light on 2 issues: the effects of fiscal policy on interest rates, and what factors drive the dynamics of the yield curve. Term structure is important because it explains the relationship between interest rates and different maturities. This relationship, once graphed, becomes the well-known yield curve, and it plays a crucial role in depicting the current state of an economy. As such, the researchers of this paper created an empirical macro-finance model that combines a no-arbitrage affine term structure model with a set of structural restrictions that allows identification of fiscal policy shocks. It also allows for the observation of shock effects on the prices of bonds of different maturities. This modeling is different from the standard VAR because it has the advantage of incorporating information embedded in a large cross-section of bond prices. Furthermore, the valuation equations provide new ways of assessing the model's ability to capture risk preferences and expectations as well.

Based on their empirical analyses, the researchers found that A) government deficits affect long term interest rates - specifically, a one percentage point increase in the deficit to GDP ratio lasting for 3 years will eventually increase the 10-year rate by 40-50 basis points; B) the aforementioned increased is partly due to higher expected spot rates and also partly due to higher risk premia on long term bonds; and C) fiscal policy shocks account near up to 12% of forecast error variance in bond yields. Based on these findings, we can conclude that government deficits not only affect interest rates, but more specifically long-term interest rates. This relationship then leads to the next, which is that fiscal policy shocks do have an effect on interest rates, premising the beginning of a cyclical relationship (Dai & Philippon, 2005).

While a long-term interest rate effect has been established, a look at short-term interest rates must also be examined. In "The causal relationship between short- and long-term interest rates: An empirical assessment of the United States," Enrico Levrero and Matteo Deleidi explored the Fed's ability to affect the structure of interest rates by assessing the causal relationship between short and long-term interest rates (Levrero & Deleidi, 2019). These rates include the Effective Federal Funds Rate, the Moody's Seasoned Aaa Corporate Bond Yield, and the 10-Year Treasury Constant Maturity Rate. The researchers utilized structural vector autoregressive (SVAR) models on monthly data provided by the Federal Reserve Economic Data (FRED) and outlined an asymmetry in the relationship between short and long-term interest rates. It was found that monetary policy is able to permanently affect long-term interest rates both in the short run and the long run; thus, long-term interest rates appear to be strongly influenced by the Fed (Levrero & Deleidi, 2019). Furthermore, even though the Federal Funds Rate is weakly affected by long-term interest rate shocks, the estimated Forecast Error Variance Decomposition (FEVD) shows that it's mainly determined by its own shock, allowing us to assume that the central bank has a certain degree of freedom in setting the levels of short-run interest rates. Based on the Fed's current actions in shocking the short-run interest rates, these findings suggest an impact on both short-term and long-term interest rates (Levrero & Deleidi, 2019).

Given how the level of federal debt in relation to GDP is projected to significantly rise over the next decade, "The Effect of Government Debt on Interest Rates" analyzes the effect of this debt on interest rates through reduced-form regression (Gamber & Seliski, 2019). Through this process, researchers Edward Gamber and John Seliski estimate the relationship between projected federal debt and expected long-term interest rates. Results suggest that the average long-run effect of debt on interest rates ranges from about 2-3 basis points for each increase of 1% point in debt as a percentage of GDP. Results also suggest a fiscal policy that contains few to no incentives towards investing in additional private capital or supplying additional labor elicits a larger interest rate response than that suggested by the reduced-form estimates. Based on these findings, it can be understood that as government debt continues to rise, so will the basis range for inflation.

Chapter 2

The Debt Issue

Rising Federal Debt

It is no secret that federal debt has been increasing, as it seems to be a global trend within developed economies. However, regarding the U.S., for the past 4 decades, government debt as a percentage of GDP has been on a steep upward trajectory that approximates the levels reached around World War II (Yared, 2019). These levels are projected to continue increasing, and significantly, over the coming decade. Currently, the United States government debt stands at over $34 trillion, which, as a percentage of GDP, is 124.3% (CEIC, 2023). This government debt % was calculated from monthly government debt and rolling sum of quarterly nominal GDP. Being over 100%, this means that the debt the US has incurred surpasses the amount of income we are earning annually as a country.

How have we reached this high debt point, however? While normal macroeconomic theories can account for the increase in debt over short periods as a response to macroeconomic shocks, they do not explain the broad-based long-run trend of debt accumulation. This deficit has largely been the result of secular expansion of government spending, such as Social Security, Medicare, and Medicaid (Yared, 2019). But the issue is not as simple as excessive spending - it is also because tax revenue is not rising as rapidly. To be more specific, while spending on the three categories has increased by an average annual rate of 2.4% (as a share of GDP), tax revenue has only grown by an average annual rate of 0.16% (CBO, 2018). Thus, there is an extra increase in government debt due to tax revenues not being able to keep pace with expansionary government spending (Yared, 2019).

COVID-19 has also significantly impacted the economy. Due to the disastrous and wide-scale consequences of a global pandemic, aggressive monetary policies were implemented to help the economy stay afloat (Joyce & Prabowo, 2020). Before COVID, the CBO projected the debt-to-GDP ratio to be around 102% under policies at the time. However, post-COVID studies estimate that the ratio will rise to 190% in 2050 under new policies (Auerbach & Gale, 2020). In summary, COVID has had the biggest impact on the economy in the short run since national emergencies like major wars and the Great Depression, and further highlights the stress of our country's debt issue.

The Debt Limit

The main problem with rising debt is that there is a debt limit. The debt limit, also known as the debt ceiling, is the maximum amount of debt that the Department of Treasury is legally allowed to issue to the public or to other federal agencies (CBO, 2023). While it is true the government could vote out the debt ceiling or even default, neither are long-term solutions that will solve the debt issue. More importantly, just like any other entity, the government cannot keep borrowing money perpetually. This statutory limit on borrowing started in 1917, when the Second Liberty Bond Act was passed. It was passed in order to simplify the borrowing process for Congress and enhance flexibility; previous to this ceiling being enacted, Congress would have to approve of each issuance of debt with legislation, which was timely and tedious (CRFB). The statutory limit is set by law and has either been increased or suspended to allow for additional borrowing needed to finance the government's operations. Debt that is subject to this statutory limit, also referred to as debt subject to limit, consists of debt held by the public and debt held by government accounts (CBO, 2023).

Recently, on December 16, 2021, lawmakers raised the debt limit by $2.5 trillion to a total of $31.4 trillion (CBO, 2023). Following the crisis of the COVID-19 pandemic, much capital was poured into sustaining the economy, hence the approval of this raise. However, on January 19, 2023, the limit set in 2021 was reached, and the Treasury announced a "debt issuance suspension period" that will last until January of 2025 (U.S. Department of the Treasury, 2023). In lieu of breaching the debt ceiling, the Treasury uses "extraordinary measures" to borrow additional funds (CBO, 2023). This means that the Treasury relies on both cash on hand and a variety of accounting maneuvers in order to avoid defaulting on government obligations (CRFB). Some examples include the Treasury prematurely redeeming Treasury bonds held in federal employee retirement savings accounts, although to be later replaced with interest, halting contributions to certain government pension funds, suspending state and local government series securities, and borrowing from money set aside to manage exchange rate fluctuations (CRFB).

If the debt ceiling is hit and the Treasury's cash on hand and extraordinary measures are exhausted, then the government will have to delay making various payments, default on their debt obligations, or both. Given annual deficits, and that no more debt is allowed to be issued, the current revenue supply would not be sufficient to pay the millions of daily obligations that are due. In other words, the federal government would have to default on many of its obligations, even if temporary. Regardless, even the perceived threat of a default by the American government is catastrophic. Never in the history of the United States has the federal government defaulted. If they were to now, global financial markets and institutions would fall into chaos, given that both domestic and international markets depend on the relative economy and political stability of the US economy and debt instrument (CRFB). Interest rates would further rise as demand for Treasuries dropped, interest rates across the economy would also follow suit, affecting aggregate demand, and the macroeconomic effects would be monstrous and long-lasting. Overall, the consequences would be immense, devastatingly ruinous, and dire.

While the federal government defaulting is simply a hypothetical consequence in this paper, the threat is very real. On November 10 of 2023, Moody's Investors Service, a leading risk assessment agency, lowered its outlook on the United States' credit rating from "stable" to "negative." While it maintains an AAA rating on its credit, the degradation in their outlook is still noteworthy. Standard & Poor's and Fitch, other leading risk assessors have also downgraded their rating of the United States' credit, as shown in Table 1 below (PGPF). Moody's two main

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Moody's is the only rating agency that maintains the US' AAA credit rating, but downgraded the outlook to negative

Rating Agency	Fitch	Moody's	Standard & Poor's
United States' Credit Rating	AA+	AAA	AA+
United States' Outlook	Stable	Negative	Stable

SOURCE: Fitch Ratings, *Rating Action Commentary: Fitch Downgrades the Unites States' Long-Term Ratings to 'AA+' from 'AAA'; Outlook Stable*, August 2023.

PGPF.ORG

Table 1. United States' Credit Rating by Rating Agencies

reasons for downgrading their outlook were political polarization and debt affordability. The increased polarization will complicate the ability of policymakers to enact solutions to the nation's fiscal challenges. Jointly, rising interest rates have also caused the cost of financing the federal debt to severely increase. And with no policies to address the underlying drivers of debt, Moody's fears that federal deficits will remain significantly large.

As such, it is easy to see that the current financial state of the federal government is in a precarious position. Given that the debt limit has already been breached and we are in a debt suspension period, this research will run all stress-test scenarios under an assumption that further borrowing is not possible. This means that in each given year, the federal debt subject to limit is the amount of capital we are allowed to spend in a year with no further debt issuance. This will allow us to better understand pressure that is put onto government spending categories given a change in the interest rate variable. However, it is important to note that even without any additional stress to the current interest rate, federal debt is already in a dire situation.

Federal Deficit

The federal deficit is when the federal government spends more than it earns in a given fiscal year. In order to pay its dues and continue government programs, the government will then borrow money by selling Treasury securities. This debt, including interest, is what makes up the national debt, which is the total accumulation of past deficits, minus surpluses. A surplus is when the government spends less than it earns in a given fiscal year (FiscalData). Deficits are of importance because they will total the cost of the national debt for the present and the future.

Based on the Congressional Budget Office's baseline budget projections, the federal budget deficit for the fiscal year of 2024 is expected to stand at around $1.58 trillion, which is down by 5.95% from the previous fiscal year of 2023 which stood at $1.68 trillion. While this may seem like good news, the total deficit is expected to increase by an annual average of 4% and almost double by 1.7x to reach $2.6 trillion in 2034. In essence, the deficit is expected to accumulate to a total of around $20 trillion in the next decade of 2024-2034. Refer to the graph below for the projected annual deficit over the next decade.

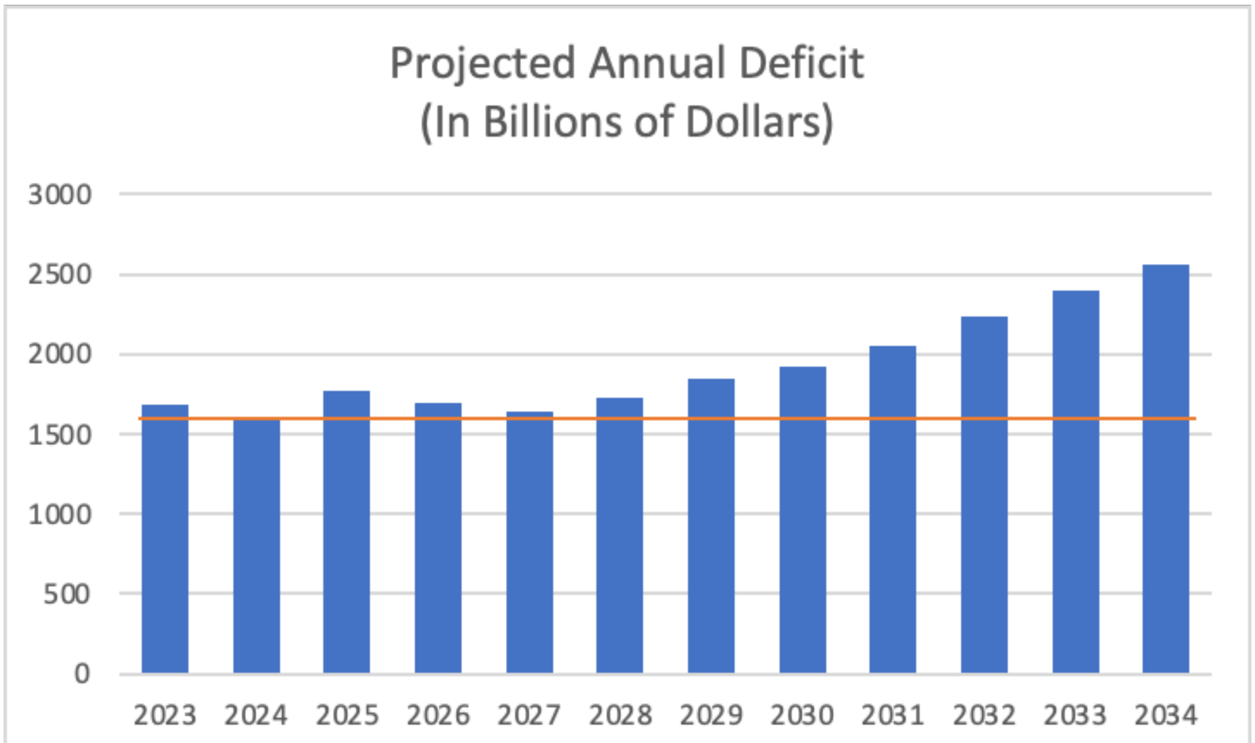

Figure 1. Projected Annual Federal Deficit in Billions of Dollars

It is unsurprising that the overall trend of the projected annual deficit is a positive incline. However, it is surprising that the deficit for the fiscal year of 2024 is the lowest value, as depicted by the orange line. This is most likely because the government is in a debt suspension period, as the debt limit set by the Treasury was surpassed back in 2023. In 2028 however, the deficit starts to pick up, as the government is projected to increase spending on all categories.

Back to 2024, relative to the size of the economy, the deficit is equal to 5.3% of GDP. Again, while this may not seem like a significant amount, it is important to note that the historical average of the annual deficit over the past 50 years has been 3.7%. Observe the historical annual deficit from 1962-2023 depicted in the graph below.

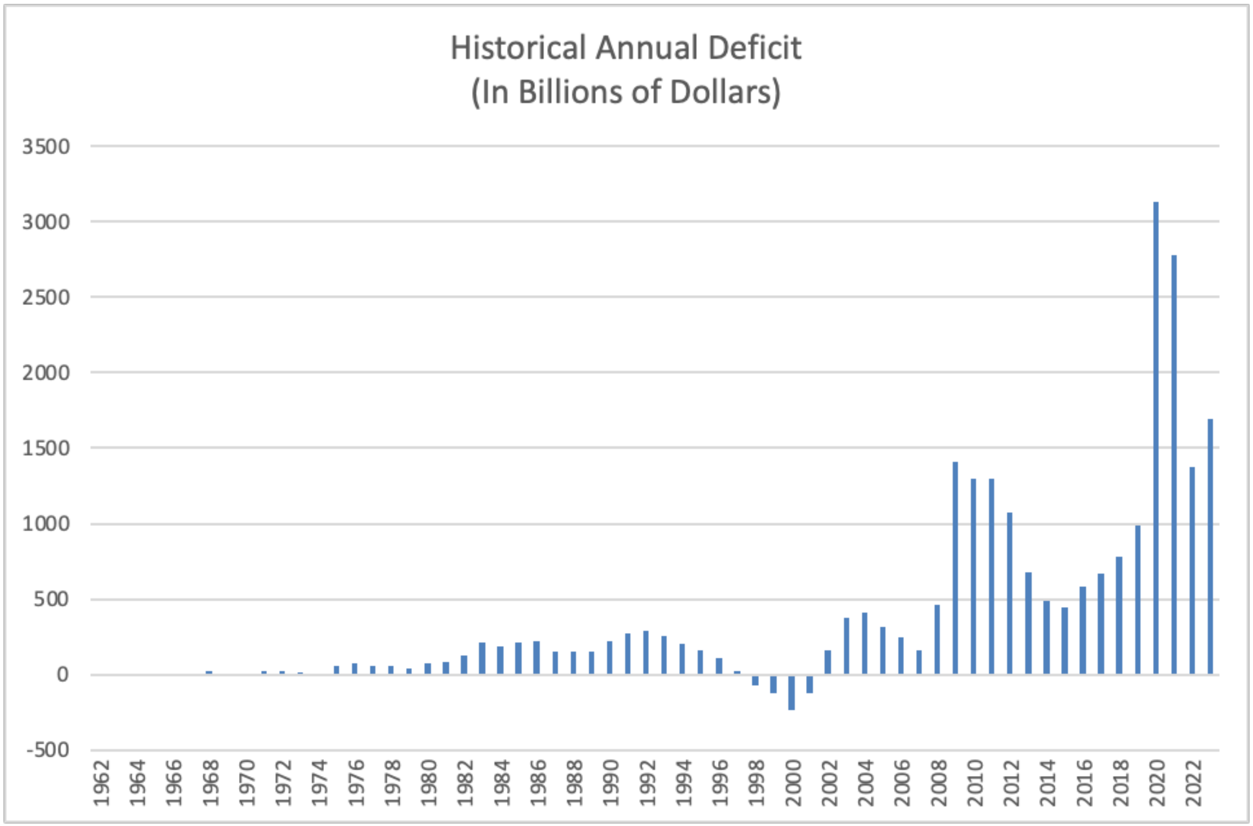

Figure 2. Historical Annual Federal Deficit from 1962-2023

Unsurprisingly, the deficit did not start to pick up until the 1970's, when the Vietnam War took place. However, the deficit does not rise alarmingly high, the government even had a surplus in the late 1990's. Unfortunately, it is in the 2000's when the national deficit starts to pick up due to 9/11, the housing crisis, and eventually, increased spending on public welfare. In fact, in 2016, the government started to spend more on Social Security, health care, and interest on federal debt than what they were earning from federal revenues (FiscalData). However, the most notable deficit starts in 2020, with the arrival of the COVID-19 pandemic. While the enormous spike has downturned a bit since then, the annual deficit is expected to increase over the next decade with an alarming average of 5.7%. That is more than a 50% increase compared to the past half century. As the deficit climbs at an alarming rate, so too does the gross national debt.

Federal Debt Held by the Public

While deficits are of concern, the main concern is debt held by the public. Debt held by the public is all federal debt held by individuals, corporations, state or local governments, Federal Reserve banks, foreign governments, and other entities outside the United States government. The type of securities that make up this debt consist of Treasury bills, notes, bonds, TIPS, United States savings bonds, and state and local government series securities. However, it does not include the Federal Financing Bank securities because they are considered intragovernmental transactions that have no effect on net interest cost or the budget deficit. (TreasuryDirect). Debt held by the public stood at a whopping 97.3% of GDP in 2023, making it the highest expense out of all government categories (CBO, 2024). It is expected to increase to 99% of GDP in 2024, which is not a dramatic increase. However, future projections are concerning. Refer to Figure 3 below for a historical analysis of debt held by the public.

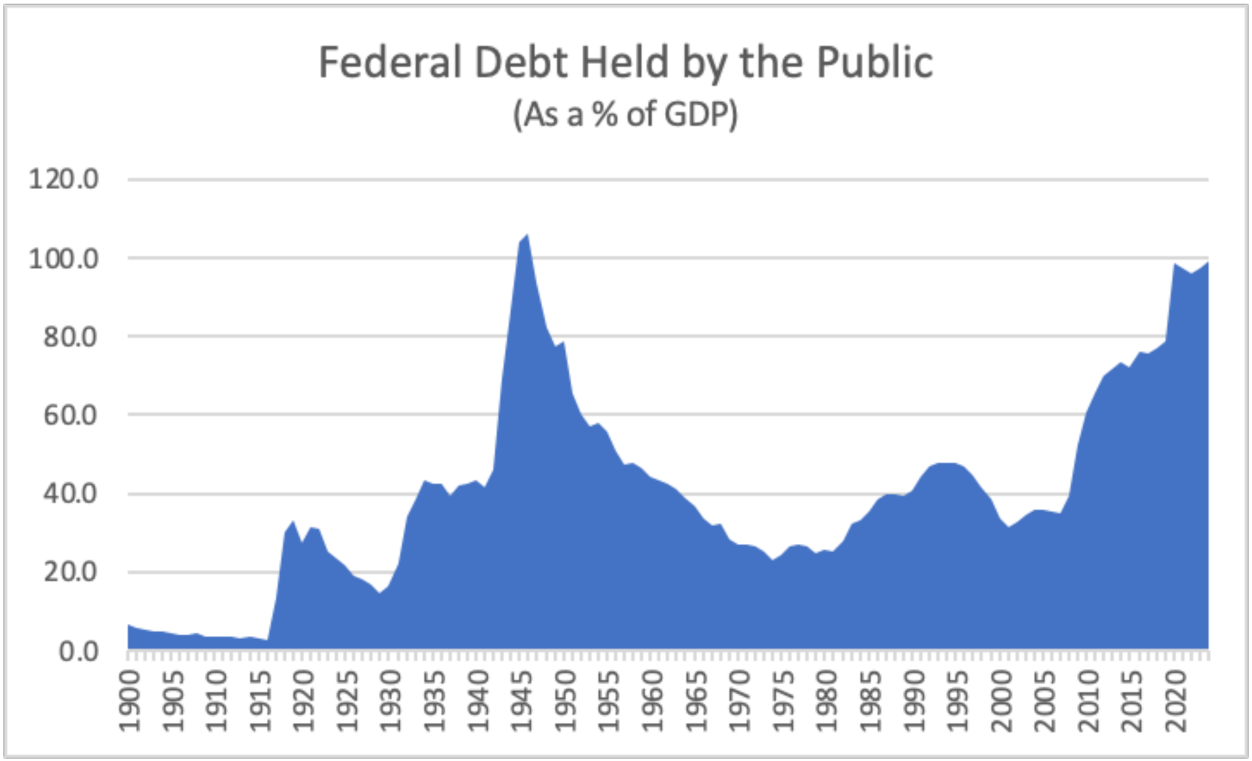

Figure 3. Federal Debt Held by the Public as a % of GDP from 1900-2024

In the graph shown above, federal debt held by the public as a percentage of GDP from 1900-2024 is depicted. Notable spikes took place during the 1940's, when World War II took place, and the current decade of 2020, when COVID-19 took over the world. While the federal debt today has not yet reached the amount accumulated during World War II, it is getting alarmingly close. In fact, the Congressional Budget Office has projected that by the end of 2034, debt held by the public as a percentage of GDP will reach 116% - the highest level ever recorded. To understand this conclusion visually, the Congressional Budget Office's expectations are graphed below.

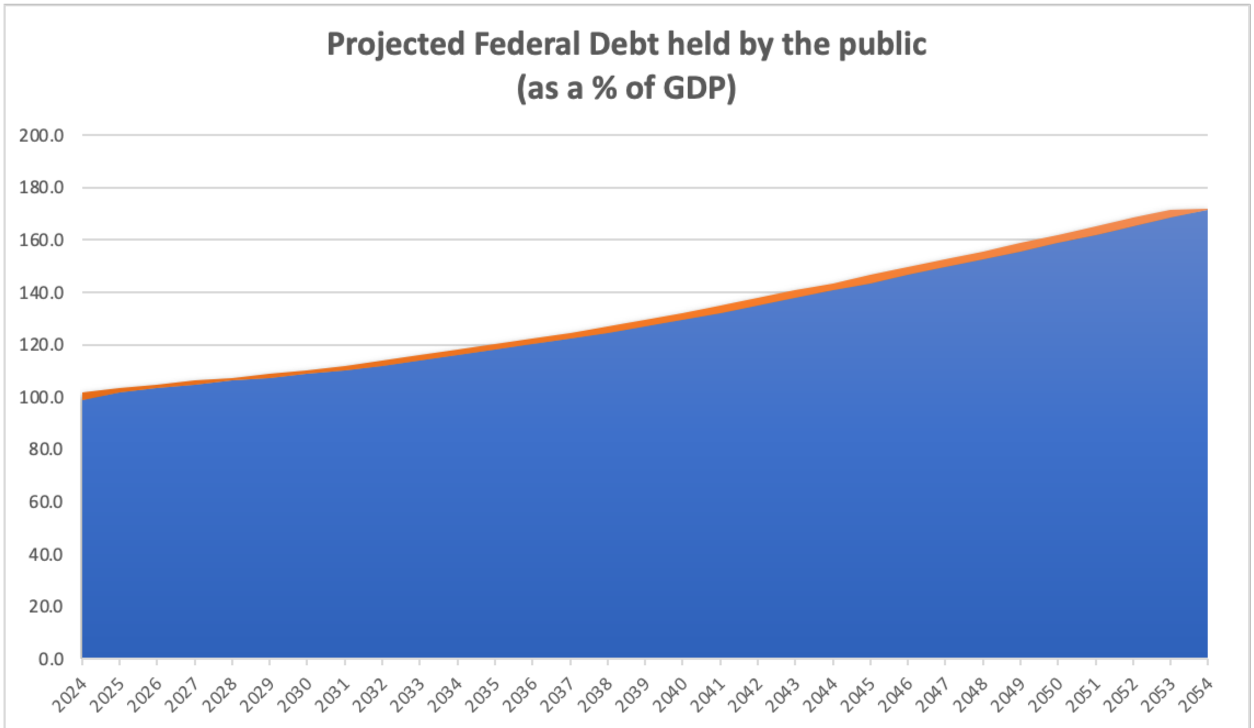

Figure 4. CBO's Projected Federal Debt Held by the Public as a % of GDP in 2024-2034

The blue area represents the amount of debt projected to accumulate over the next three decades from 2024-2054 while the orange line represents the curved slope. As seen in the graph, the debt steadily climbs at an increasing rate, with an average of 2.3. This means that with each year, the projected federal debt held by the public as a percentage of GDP can be estimated to increase by 2.3%. This is a significant difference from the slope average between 1900-2024. By finding the slope using the equation

$$(y2 - y1)/(x2 - x1)$$

between each data point and then taking the average of all slope points, the overall average slope was calculated to be 0.76 for 1900-2024. This means that for each year between 1900-2024, the estimated increase of federal debt held by the public as a percentage of GDP is 0.76%. This means that the average annual increase of federal debt held by the public as a percentage of GDP from the 3 decades between 2024-2054 is expected to increase 202.63% from that of the century-long average spanning 1900-2000. If this trend continues, it is unsure what the future will hold for the economic dominance of the United States.

Federal Revenue & Spending

In order to understand how much pressure federal debt places on the interest, an analysis of government revenue must first be looked at. Government revenues mainly come from taxes, with the top earning categories being individual income taxes and payroll taxes. After that, corporate income taxes and other miniscule earning tax categories such as excise taxes, federal reserve remittances, customs duties, estate and gift taxes, and miscellaneous fees and fines make up the rest of government income (CBO). In the year of 2023, the USA brought in a total GDP of $26.974 trillion. Government revenues came out to 16.5% of GDP, and it was amassed from revenues such as individual income taxes, payroll taxes, corporate income taxes, and others, as depicted in Figure 5 below.

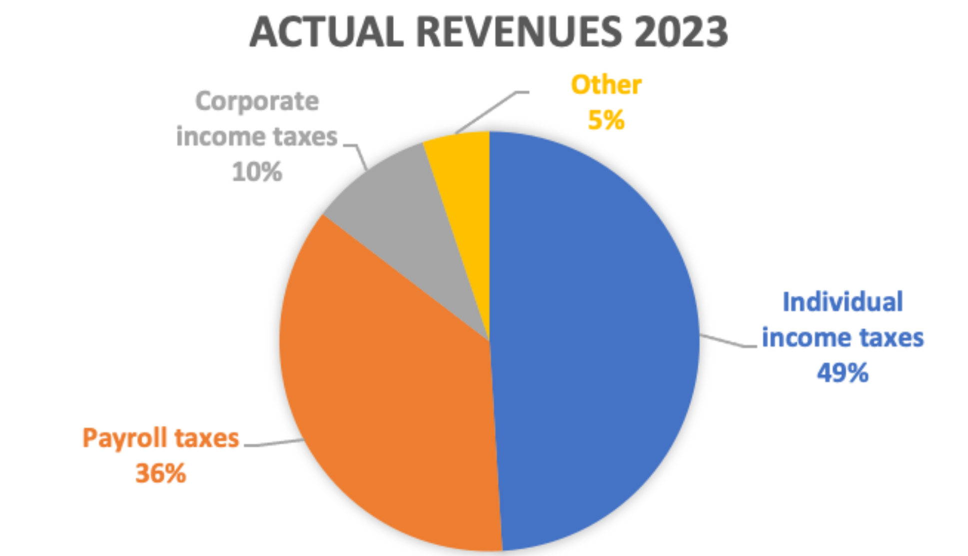

Figure 5. Actual Federal Revenues in 2023

Overall, tax revenues summed up to a total of $4.439 trillion. Individual income taxes stood at around $2.176 trillion, which makes it the highest earning category as it alone makes up almost 50% of tax revenue. Second comes payroll taxes at $1.614 trillion, corporate income taxes at $0.420 trillion, and finally, others at $0.229 trillion. However, while total revenues equated $4.439 trillion for the fiscal year of 2023, total outlays, or government expenditures, came out to be 38.21% greater at $6.135 trillion. Federal spending has three main categories: mandatory, discretionary, and net interest. Mandatory spending categories are primarily payments for benefit programs whose eligibility rules and benefits are set by law. This category includes Social Security, major health care programs like Medicare, Medicaid, and Children's Health Insurance Program, income security programs, federal civilian and military retirement, veterans' programs, and other programs such as higher education, agriculture, and etc. Discretionary spending includes spending that lawmakers control annually through appropriation acts such as defense spending and nondefense spending. Finally, net interest is the interest payments the government must pay for debt held by the public, offset by the interest income that the government receives. In Figure 6 below, the percentage split of different spending categories in 2023 is shown.

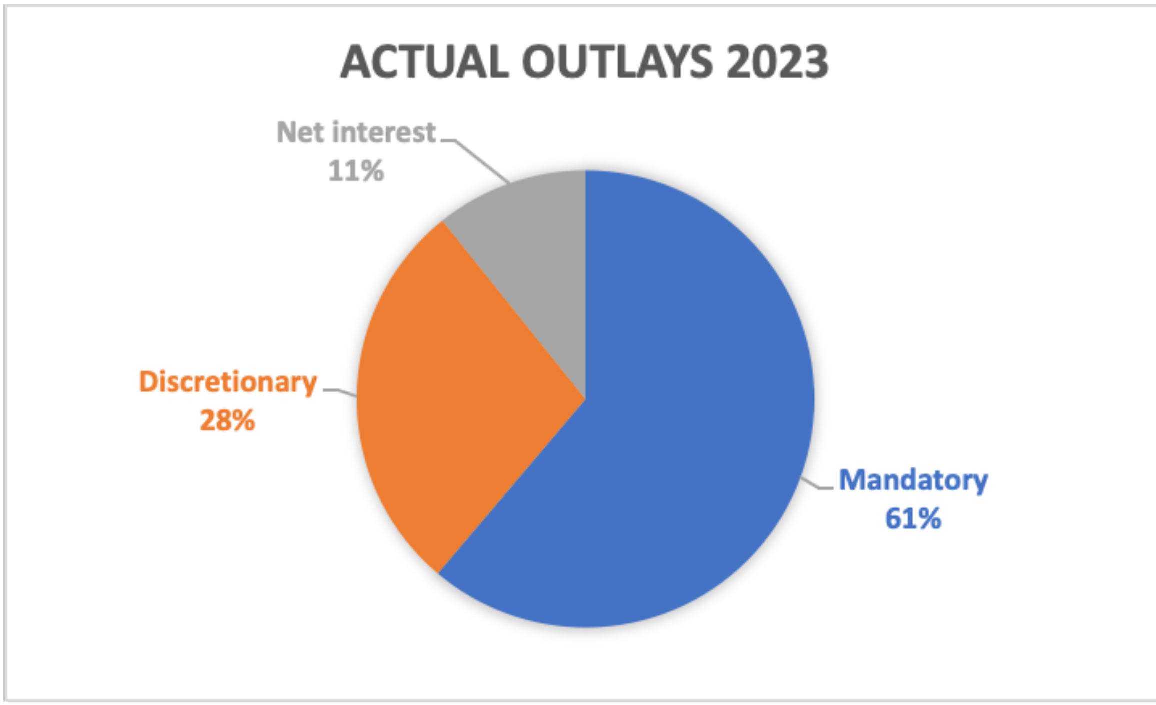

Figure 6. Actual Federal Spending in 2023

Mandatory outlays stood at $3.753 trillion, discretionary outlays totaled $1.722 trillion, and net interests cost $0.659 trillion. While mandatory outlays make up the majority of government spending, net interest is expanding to take up a more significant portion of government spending. As a percentage of GDP, net interest took up 2.4% in the year of 2023. Compared to the historical average of 2.1% of GDP, the net interest cost of 2023 is relatively within bounds. But by 2034, government spending on net interest is expected to rise to 3.9% of GDP. The evolution of net interest over the next decade is graphed in Figure 7 below.

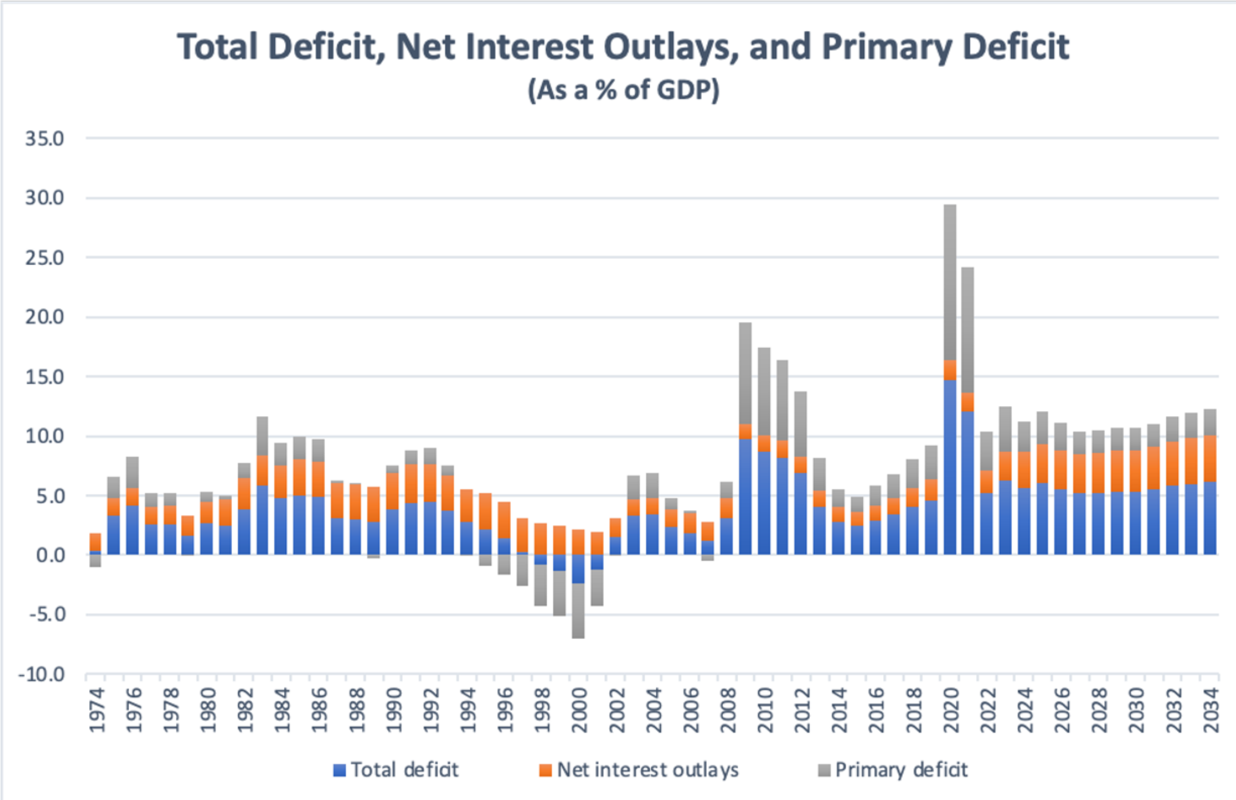

Figure 7. Historical Deficit and Net Interest Outlays as a % of GDP (1974-2034)

In the graph, total deficit, net interest outlays, and the primary deficit are depicted. The primary deficit is the difference between revenues and outlays, not considering net interest. In other words, it is (revenue - outlays), hence why there is no historical record of revenues and outlays on the graph. That means for every single year, except the time period of 1995-2001, the government has been in a deficit and had to borrow money for the funds it lacks. While the primary deficit does not account for net interest, the total deficit is the primary deficit in addition to the net interest. Based on this graph, it is noticeable that the total deficit has severely grown since the housing crisis of 2008. Even more noticeable is the deficit spike in 2020 due to the COVID-19 pandemic which has far surpassed any other crisis in this historical data. Starting in 2022 however, net interest starts to make up more of the total deficit. In fact, it seems towards the end of the next decade, net interest almost equals the same amount as the total deficit. As the trend continues, it is palpable that net interest will eventually take over deficit costs.

Chapter 3

The Interest Rate

The Federal Funds Rate

The interest rate in question is the federal funds rate. This rate is set by the Federal Open Market Committee (FOMC) and is commonly known as the federal funds target rate. The federal funds rate guides the overnight lending rate among U.S. banks and is set as a range between a lower and upper limit; it is currently set to 5.25%-5.50% (Curry, 2023). This rate is significant because it affects the whole economy besides just interest rates. Expectations surrounding the federal funds rate is what shifts Treasury yields, which builds into the pricing of many other business, government, and mortgage-backed securities. It determines what banks charge each other, which effectively influences how much they charge the average customer.

The stock market is also highly sensitive to the federal funds rate, as we have seen recently, with hikes sending stock markets into bear markets as the borrowing cost rose, making it more expensive to expand business and raise earnings. While the federal funds rate annual volatility is much smaller than the stock market and other similar rates, it has had a wide range over its historical trajectory. In 1980, it reached a peak of 20%, and in 2008, it reached a low of 0% (Curry, 2023). It continues to change in response to the economy because its purpose is to help the central bank manage the supply of money in the economy. The central bank, also known as the Federal Reserve, has a “dual mandate” assigned to them by Congress, which is to 1) keep inflation under control and 2) support maximum employment. The Fed's mandate has expanded to include maintaining moderate long-term interest rates and a stable financial system, but it is still mainly known for the dual mandate (Curry, 2023).

As such, by changing the federal funds rate, the Fed is able to boost or reduce short-term interest rates throughout the economy, which in turn reduces or increases the supply of money and makes it more expensive or cheaper to borrow money. Because of the federal funds rate significance and impact over the economy, it will be the interest of research.

Net Interest

The main interest cost we are concerned about is net interest. As defined by the Congressional Budget Office, net interest consists of the government's interest payments on debt held by the public, offset by certain types of interest income that the government receives. Net interest outlays primarily reflect the interest that needs to be paid to holders of the debt that the Department of the Treasury issues to the public. These government securities usually consist of bills, notes, bonds, and inflation-protected securities. The Treasury also issues debt to trust funds and other government accounts, but the interest payments on these accounts are considered intragovernmental transactions that have no effect on net interest cost or the budget deficit.

Overall, the net interest largely depends on the interest rate and the amount of debt that is held by the public. Remember, the interest percentage is based on the debt held by the public, and the net interest is based on the federal funds rate. Interest costs are affected by the rate of inflation and the maturity structure of outstanding securities. For example, long-term bonds tend to have higher interest rates than short-term bills; the issuing of more or less of these higher priced assets can significantly increase or decrease net interest. While interest rates are determined by a combination of market forces, the main factors tend to be the supply of Treasury securities, the demand for fixed-income investments, and the policies of the Federal Reserve

System. Debt held by the public is determined by cumulative budget deficits, as mentioned previously. These deficits depend on policy choices about spending and revenues, economic conditions, and other factors. Their maturity structure is determined by the borrowing policies of the Treasury, which issue the range of short and long-term debt securities (CBO, 2020).

Chapter 4

The Relationship between Government Debt and the Interest Rate

Given the significance of the federal funds rate and government debt, how does it all tie in together? As we know, adjusting the federal funds rate is how the Federal Reserve is able to fulfill their dual mandate of stable prices and maximum employment. This is because the federal funds rate acts as a benchmark for common short-term securities like the Treasury bill, which can be clearly seen in Figure 4.1 below.

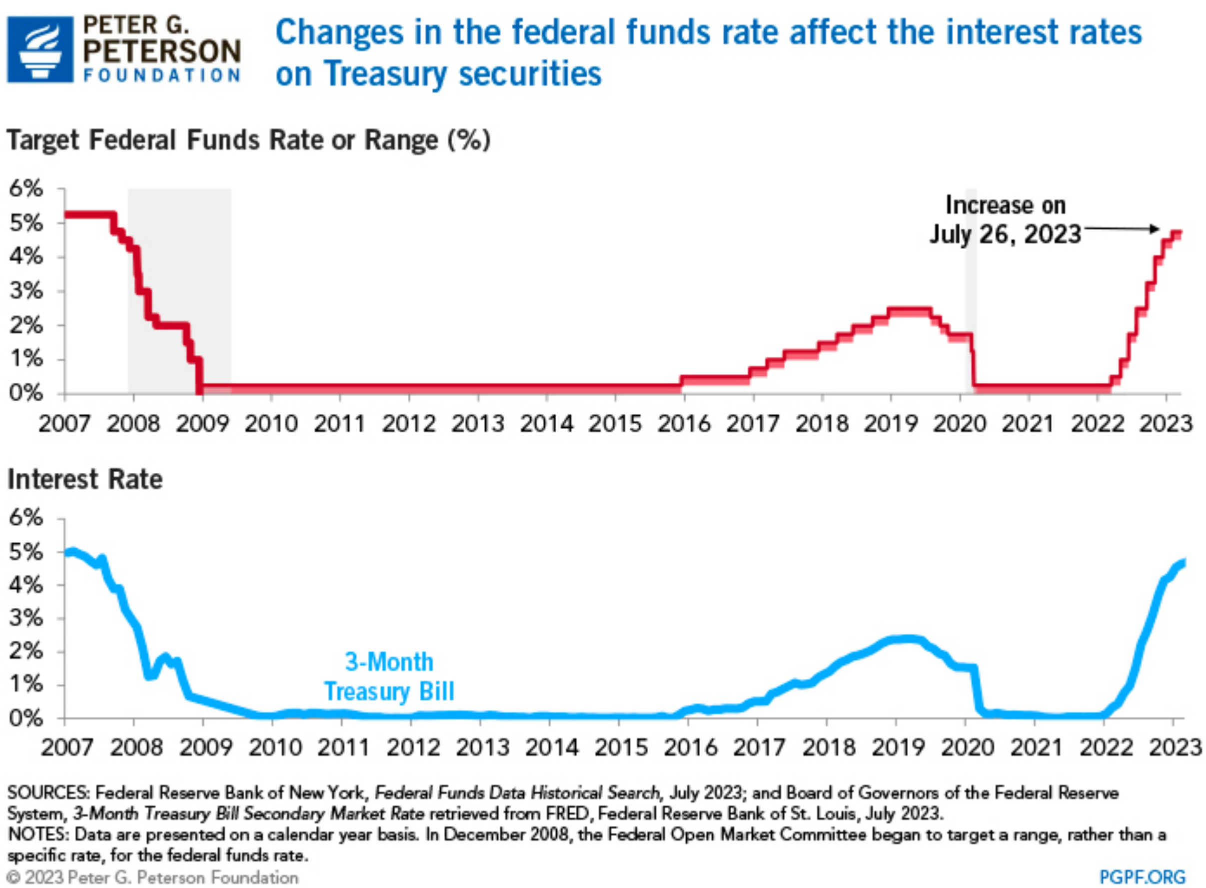

Figure 4.1 Comparison of Changes in the Federal Funds Rate Against the Interest Rate on Treasury Securities

Note: Graph of how changes in the federal funds rate affect the interest rates on treasury securities. Adapted from Peter G. Peterson Foundation, Higher Interest Rates will Raise Interest Costs on the National Debt, 2023, PGPF.

Notice when the Fed hiked interest rates on July 26, 2023, the 3-month Treasury bill interest rates closely followed that surge. While this may be good for investors, this spells high borrowing costs for the federal government. The United States was able to borrow cheaply during the pandemic because there were historically low interest rates; but now that interest rates are at a relatively historical high, it is questionable if federal debt is solvent. As the national debt rises, so will the interest as the American government borrows more and more. In June of 2023, the Congressional Budget Office (CBO) estimated that annual net interest costs would sum around $663 billion in 2023 and double in just a decade, given current inflation and interest rate measures (CBO, 2023). That means that within a decade, roughly 35% of government spending will go towards paying back interest on debt, rather than going towards other important sectors such as Social Security, Medicare, Defense Discretionary, Non-defense Discretionary, CHIP (& marketplace subsidies), and other important categories (Peter G. Peterson Foundation, The National Debt).

The question now lies within where the limit of increasing interest rates resides. Currently, the interest rate stands around 5.25% - 5.50%, which is a significant difference from the previous decade which stood at a low 1-2%. While inflation has decreased a bit, the job sector and consumer spending are still doing fairly well. The public worries that the Fed will continue to raise interest rates until they see decreased consumer spending and employment take a hit. While the Fed has stopped hiking interest rates for now, it is possible another fiscal shock such as the pandemic could happen again. As such, this proposed research will explore at what potential level of interest rate will likely cause severe consequences to the economy and financial markets by projecting how further interest rate hikes. More specifically, a projection of how different interest rates would affect the market under the high debt environment based on CBO data and historical data will be completed. Overall, by reviewing the historical government debt-interest rate relationship, analyzing government spending, and projecting different interest rates on the economy, I plan to find the theoretical limit of rising interest rates under a high debt environment.

Chapter 5

Methodology & Results

Assumptions

In order to assess the limit of interest rates under a high debt environment, the federal debt and average interest rate held on that debt were assessed. This was done by analyzing the Congressional Budget Office's data; the CBO is a nonpartisan federal agency within the legislative branch of the United States government that provides budget and economic information to Congress. For this specific research, data from the CBO's Budget and Economic Outlook: 2024 to 2034 published in February of 2024 were utilized. As such, all conclusions found in this research are based on the projections made in the CBO's report. By analyzing the CBOs budget data, an understanding of government spending and debt can be established.

In order to calculate the limit of the federal funds rate, an assessment of government spending was completed. Tax revenues were first assessed because taxes are the main source of revenue for the government. Mandatory and Discretionary spending categories were then looked at because the government must pay dues every day to keep them functional and solvent. Given the severe situation of the government's current and accumulated debt, this paper will stress test what will happen given the CBO's current projections of debt. More specifically, it will be assumed in this paper that the projected debt subject to limit by the CBO is the actual debt ceiling and further borrowing past that limit is not allowed. By assuming no further borrowing is allowed, the pressure that is put on the government's current spending categories can be understood. Thus, in this paper, we will assume that given a limited amount of spending, which is the Debt Subject to Limit that the CBO has projected for each year, Net Interest costs may not exceed a certain amount less the government is not able to meet its mandatory and discretionary spending requirements. It will also be assumed that a percentage point increase in the federal funds rate will lead to a percentage point increase in the average interest rate for debt held by the public. Hence, the theoretical limit rate for interest rates can be found.

The sample limit for this research will span over the decade of 2024-2034, same as the CBO's baseline projection term. The CBO completes a ten-year baseline forecast every year due to the Congressional Budget Act of 1974 (CBO, 2023a). This act, commonly referred to as the Budget Act, enforces the House and Senate Committees on the Budget to set broad federal tax and spending policies and simultaneously identify priorities for allocating budgetary resources. In order to help the committees fulfill their duties, the CBO produces an annual report on federal spending, revenues, and deficits or surpluses. This annual report also includes the ten-year baseline projection because it supplies Congress with information about the budgetary outlook over the coming decade under current laws and spending. With this outlook, Congress can use it as a benchmark to determine whether proposed legislation is subject to various budget enforcement procedures (CBO, 2023a). Consequently, this paper will also utilize a ten year sample limit to achieve the same effect.

In order to project net interest costs, the Congressional Budget Office first uses a model that incorporates each outstanding Treasury security, including its principal amount, time to maturity, and the interest rate that applies to it. The model then incorporates projections of future deficits and other financing obligations, the CBO's forecast for interest rates, and estimations about the type of securities that the Treasury will issue to meet borrowing needs. The estimate for net interest costs mostly relies on two critical factors however - federal debt and interest rates. Generally, for debt, the CBO looks at the federal debt at the beginning of a projection period and then the additional debt generated during the projection period; more to the point, this is the amount by which annual government spending exceeds annual revenues. This is what really helps them determine the amount of annual borrowing. As for the interest rates, these projections will mostly determine what the Treasury would pay on outstanding debt. It is notable that interest costs are also sensitive to the mix of securities that are issued by the Treasury. Because the CBO already does a thorough analysis of the economy in their projections, this paper will make projections following the same assumptions and understandings of the CBO in their Budget and Economic Outlook of 2024-2034.

Methodology

This study seeks to determine the limit of interest rates based on the government's high debt accumulation. To accomplish this, I run 5 different interest rate scenarios and observe its effects on the projected net interest cost and projected debt held by the public. All data and assumptions are based on the CBO's assumptions and current legislation presented in their Budget and Economic Outlook of 2024-2034.

The scenario starts with actual data from 2023 and then ascends to projected data for each year after from 2024-2034. The baseline data that I am working with comes from the CBO's Baseline Projections of Federal Debt (refer to Appendix A). I first find the total debt held by the public projected for each year by summing the following.

$$\mathit{Total\ Debt\ Held\ by\ the\ Public} =$$

$$(\mathit{Debt\ held\ by\ the\ public\ at\ the\ beginning\ of\ the\ year})$$

$$+$$

$$(\mathit{Changes\ in\ debt\ held\ by\ the\ public\ resulting\ from\ other\ means\ of\ financing})$$

I include changes in debt held by the public resulting from other means of financing because it includes factors not included in budget totals that affect the government's need to borrow from the public (CBO, 2024). This total debt held by the public is the base value that I will apply the interest rate to in order to find the net interest cost. The interest that I will be using is the average interest rate on debt held by the public that is given by the CBO in their baseline projections of federal debt. To find the net interest cost, take the product of

$$\mathit{Net\ Interest} = (\mathit{Projected\ total\ debt\ held\ by\ the\ public}) * (\mathit{Average}$$

$$\mathit{interest\ rate\ on\ debt\ held\ by\ the\ public})$$

However, because I am testing the effect of increasing interest rates on the debt, I add a variable to the equation. The main independent variable that I am testing for is the interest rate increase. This variable will be called (interest_change), and each scenario will have a variable with a different number to match the test. For example, scenario 1 will include (interest_change_1), and the same will apply for each test following. Note that this variable is not the actual interest rate, but rather, how much the interest rate will increase by. For example, in the first scenario, (interest_change_1 = 0.01); this means the average interest rate on debt held by the public, as projected by the CBO, will increase by 0.01. Thus, the equation for finding the new net interest cost with an increase in the average interest rate on debt held by the public by (interest_change_X) is found by

$$New\ Net\ Interest = (Projected\ total\ debt\ held\ by\ the\ public) * (Average\ interest\ rate\ on\ debt\ held\ by\ the\ public + Interest\_Change\_X)$$

Where "X" stands for the specific increase in interest rate in the specific scenario case. To understand the effect of this new interest cost, I then subtract the original net interest cost projected by the CBO utilizing the following equation

$$Extra\ Projected\ Deficit = (New\ Net\ Interest) - (Original\ Net\ Interest)$$

Note that the Original Net Interest equals the Net Interest cost that the CBO originally projected in their Budget and Economic Outlook of 2024-2034. The New Net interest cost is simply that original net interest cost plus the added effects of increasing the rate by (interest_change_X). Extra Projected Deficit is simply the difference between the two. However, this Extra Projected Deficit will be added to the following year's total debt held by the public because the government does not pay that actual debt but instead rolls over the debt under the next year's interest rate. The government only pays the net interest cost that is associated with rolling over this debt. Thus, for the total debt held by the public for every year following 2023, the value can be found by

$$New\ Total\ Debt\ Held\ by\ the\ Public = (Debt\ held\ by\ the\ Public) + (Changes\ in\ debt\ held\ by\ the\ public\ resulting\ from\ other\ means\ of\ financing) + (Extra\ Projected\ Deficit)$$

Based on the New Total Debt Held by the Public and the Extra Projected Deficit, the effect of increasing interest rates can be assessed. The interest rate will increase by a percentage point for each scenario and will stop once the increase has reached 5 percentage points. This is done to mimic the actual amount the Fed hiked interest rates over 2022-2023 as mentioned in The Interest Rate. By mimicking actual actions by the Fed, this paper seeks to find the most realistic limit of interest rates under a high debt environment.

The Data

The goal of this analysis is to determine the limit of interest rates based on the government's high debt accumulation. The results of the different scenario analyses are shown below.

Scenario 1	**Interest_change_1**				**= 0.01**	
In billions of dollars	**Actual, 2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Average interest rate on debt held by the public	0.0269	0.0331	0.0338	0.0336	0.0332	0.0331
Avg interest rate + interest_change_1	0.0369	0.0431	0.0438	0.0436	0.0432	0.0431
New total debt held by the public	24,544	26,636	28,256	30,110	31,900	33,625
New net interest 1	905.69	1148.02	1237.60	1312.78	1378.08	1449.25
CBO's projected net interest	659	870	951	1,005	1,049	1,105
Extra projected deficit	247	278	287	308	329	344
In billions of dollars	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Average interest rate on debt held by the public	0.0332	0.0334	0.0339	0.0345	0.0349	0.0351
Avg interest rate + interest_change_1	0.0432	0.0434	0.0439	0.0445	0.0449	0.0451
New total debt held by the public	35,537	37,317	39,269	41,359	43,593	46,151
New net interest 1	1535.19	1619.54	1723.92	1840.46	1957.33	2081.41
CBO's projected net interest	1,170	1,241	1,328	1,430	1,527	1,628
Extra projected deficit	365	379	396	410	430	453

Table 2. Projected Debt Effects Given a 1 Percentage Point Increase

Scenario 2	Interest_change_2				= 0.02	
In billions of dollars	**Actual, 2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Average interest rate on debt held by the public	0.0269	0.0331	0.0338	0.0336	0.0332	0.0331
Avg interest rate + interest_change_2	0.0469	0.0531	0.0538	0.0536	0.0532	0.0531
New total debt held by the public	24,544	26,882	28,535	30,407	32,217	33,961
New net interest 2	1,151.13	1,427.42	1,535.19	1,629.83	1,713.95	1,803.34
CBO's projected net interest	659	870	951	1,005	1,049	1,105
Extra projected deficit	492	557	584	625	665	698
In billions of dollars	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Average interest rate on debt held by the public	0.0332	0.0334	0.0339	0.0345	0.0349	0.0351
Avg interest rate + interest_change_2	0.0532	0.0534	0.0539	0.0545	0.0549	0.0551
New total debt held by the public	35,891	37,691	39,662	41,773	44,029	46,611
New net interest 2	1,909.39	2,012.69	2,137.80	2,276.60	2,417.21	2,568.26
CBO's projected net interest	1,170	1,241	1,328	1,430	1,527	1,628
Extra projected deficit	739	772	810	847	890	940

Table 3. Projected Debt Effects Given a 2 Percentage Point Increase

Scenario 3	Interest_change_3				= 0.03	
In billions of dollars	**Actual, 2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Average interest rate on debt held by the public	0.0269	0.0331	0.0338	0.0336	0.0332	0.0331
Avg interest rate + interest_change_3	0.0569	0.0631	0.0638	0.0636	0.0632	0.0631
New total debt held by the public	24,544	27,127	28,819	30,711	32,541	34,304
New net interest 3	1396.57	1711.72	1838.68	1953.20	2056.56	2164.57
CBO's projected net interest	659	870	951	1,005	1,049	1,105
Extra projected deficit	738	842	888	948	1,008	1,060
In billions of dollars	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Average interest rate on debt held by the public	0.0332	0.0334	0.0339	0.0345	0.0349	0.0351
Avg interest rate + interest_change_3	0.0632	0.0634	0.0639	0.0645	0.0649	0.0651
New total debt held by the public	36,252	38,073	40,063	42,195	44,474	47,080
New net interest 3	2291.13	2413.80	2560.05	2721.57	2886.38	3064.91
CBO's projected net interest	1,170	1,241	1,328	1,430	1,527	1,628
Extra projected deficit	1,121	1,173	1,232	1,292	1,359	1,437

Table 4. Projected Debt Effects Given a 3 Percentage Point Increase

Scenario 4	Interest_change_4				= 0.04	
In billions of dollars	**Actual, 2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Average interest rate on debt held by the public	0.0269	0.0331	0.0338	0.0336	0.0332	0.0331
Avg interest rate + interest_change_4	0.0669	0.0731	0.0738	0.0736	0.0732	0.0731
New total debt held by the public	24,544	27,373	29,109	31,020	32,870	34,653
New net interest 4	1642.02	2000.94	2148.21	2283.09	2406.11	2533.16
CBO's projected net interest	659	870	951	1,005	1,049	1,105
Extra projected deficit	983	1,131	1,197	1,278	1,357	1,428
In billions of dollars	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Average interest rate on debt held by the public	0.0332	0.0334	0.0339	0.0345	0.0349	0.0351
Avg interest rate + interest_change_4	0.0732	0.0734	0.0739	0.0745	0.0749	0.0751
New total debt held by the public	36,621	38,462	40,473	42,626	44,928	47,559
New net interest 4	2680.63	2823.11	2990.93	3175.61	3365.13	3571.67
CBO's projected net interest	1,170	1,241	1,328	1,430	1,527	1,628
Extra projected deficit	1,511	1,582	1,663	1,746	1,838	1,944

Table 5. Projected Debt Effects Given a 4 Percentage Point Increase

Scenario 5	Interest_change_5				= 0.05	
In billions of dollars	**Actual, 2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Average interest rate on debt held by the public	0.0269	0.0331	0.0338	0.0336	0.0332	0.0331
Avg interest rate + interest_change_5	0.0769	0.0831	0.0838	0.0836	0.0832	0.0831
New total debt held by the public	24,544	27,618	29,403	31,336	33,207	35,010
New net interest 5	1887.46	2295.06	2463.95	2619.68	2762.82	2909.33
CBO's projected net interest	659	870	951	1,005	1,049	1,105
Extra projected deficit	1,228	1,425	1,513	1,615	1,714	1,804
In billions of dollars	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Average interest rate on debt held by the public	0.0332	0.0334	0.0339	0.0345	0.0349	0.0351
Avg interest rate + interest_change_5	0.0832	0.0834	0.0839	0.0845	0.0849	0.0851
New total debt held by the public	36,997	38,860	40,890	43,065	45,392	48,047
New net interest 5	3078.14	3240.88	3430.71	3639.03	3853.75	4088.84
CBO's projected net interest	1,170	1,241	1,328	1,430	1,527	1,628
Extra projected deficit	1,908	2,000	2,103	2,209	2,327	2,461

Table 6. Projected Debt Effects Given a 5 Percentage Point Increase

Starting with a general outlook, for each scenario, the extra projected deficit increase by more than double fold over the course of 2023-2034. It is scary to see how quickly the net interest goes up with the simple addition of one percentage point to the average interest rate on debt held by the public. In Scenario 1, where the interest rate increase by one percentage point, the new net interest increased by an average of 352 billion dollars in comparison to the net interest cost projected by the CBO. For Scenario 2 it increased by an average of 776 billion dollars, for Scenario 3 it increased by an average of 1,091 billion dollars, for Scenario 4 it increased by an average of 1,471 billion dollars, and for Scenario 5 it increased by an average of 1,859 billion dollars. This means the deficit is not increasing linearly, but exponentially. However, the average new net interest increase seems to increase by an average of 400 billion dollars for each scenario. For example, if we look at the table below, we see that the average extra projected deficit seems to grow by 400 billion dollars from each scenario to the next.

Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**
352	776	1,091	1,471	1,859

This suggests that for every percentage point increase on the average interest rate on debt held by the public over the projected decade, the average extra projected deficit will grow by an estimate of around 400 billion dollars. Given that the United State government is already projected to be in a deficit for every single year in the next decade, this means that any additional interest rate increase will only lead to further pressure on current spending categories. To understand how these additional debts compare to GDP refer to Table 7 below, which depicts the scenario-projected total debt held by the public as a percentage of GDP. In the table, GDP as projected by the CBO is shown in the first line to depict what GDP the new total debt held by the public as a percentage of GDP is based off. The second line, which is highlighted blue, depicts the original debt held by the public as projected by the CBO in their Budget and Economic Outlook of 2024 - 2034 (for more details, refer to Appendix B). Each row after those projects what the total debt held by the public would be if the interest change in the specified scenarios were incorporated as a percentage of GDP.

New Total Debt Held by Public as a % of GDP for Each Scenario Analysis						
Year	**Actual, 2023**	**2024**	**2025**	**2026**	**2027**	**2028**
GDP, in billions of dollars (projected by CBO)	26,974	28,177	29,256	30,504	31,756	33,043
CBO's Projection	97.28	99	101.7	103.3	104.7	106.3
Scenario 1	97.28	99.88	102.64	104.25	105.62	107.34
Scenario 2	97.28	100.75	103.59	105.23	106.62	108.36
Scenario 3	97.28	101.63	104.56	106.23	107.64	109.40
Scenario 4	97.28	102.50	105.55	107.24	108.68	110.46
Scenario 5	97.28	103.37	106.56	108.28	109.74	111.53
Year	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
GDP, in billions of dollars (projected by CBO)	34,375	35,746	37,157	38,609	40,106	41,646
CBO's Projection	107.4	108.7	110.2	111.9	114	116
Scenario 1	108.39	109.76	111.21	112.92	115.07	117.01
Scenario 2	109.42	110.80	112.27	113.99	116.15	118.12
Scenario 3	110.48	111.87	113.35	115.08	117.26	119.24
Scenario 4	111.55	112.96	114.45	116.20	118.40	120.39
Scenario 5	112.64	114.07	115.58	117.34	119.55	121.57

Table 7. Projected Total Debt Held by Pubic as a % of GDP based on Scenario

Note that the value for 2023 is the same for every scenario including the one given by the CBO; this is because the value used were from the actual year of 2023, and so that value is the real value of 2023. However, every value after 2023 is projected because those years have not been completed yet.

The most important takeaway from this table is the percentage amounts. Even before adding the scenarios, total debt held by the public as a percentage of GDP surpasses 100% in 2025. This means not only is the growth of debt higher than the growth of GDP, but the growth of debt has surpassed the actual amount of GDP that is brought into the United States each year. This is the worst possible situation given the United States preference of rolling over debt, and seriously highlights the importance of addressing the issue of rising debt. Given the scenarios however, the theoretical limit of interest rates most likely stands around an addition of 5 percentage points. If you observe the table below, it juxtaposes the different scenario net interest costs (highlighted yellow) against the CBO's projected outlays (highlighted blue) as a percentage of GDP.

Outlays, as a % of GDP	2023	2024	2025	2026	2027	2028
Mandatory	13.9	13.9	13.9	13.9	14.0	14.0
Discretionary	6.4	6.2	6.0	5.9	5.7	5.6
Net interest	2.4	3.1	3.2	3.3	3.3	3.3
Scenario 1 Net Interest	3.36	4.07	4.23	4.30	4.34	4.39
Scenario 2 Net Interest	4.27	5.07	5.25	5.34	5.40	5.46
Scenario 3 Net Interest	5.18	6.07	6.28	6.40	6.48	6.55
Scenario 4 Net Interest	6.09	7.10	7.34	7.48	7.58	7.67
Scenario 5 Net Interest	7.00	8.15	8.42	8.59	8.70	8.80
Outlays, as a % of GDP	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Mandatory	14.3	14.4	14.6	14.7	14.9	15.1
Discretionary	5.5	5.4	5.3	5.2	5.1	5.1
Net interest	3.4	3.5	3.6	3.7	3.8	3.9
Scenario 1 Net Interest	4.47	4.53	4.64	4.77	4.88	5.00
Scenario 2 Net Interest	5.55	5.63	5.75	5.90	6.03	6.17
Scenario 3 Net Interest	6.67	6.75	6.89	7.05	7.20	7.36
Scenario 4 Net Interest	7.80	7.90	8.05	8.22	8.39	8.58
Scenario 5 Net Interest	8.95	9.07	9.23	9.43	9.61	9.82

Table 8. Projected Scenario Net Interest Costs Compared to CBO Projections

Already in Scenario 1, net interest costs will surpass defense spending as it takes up roughly a little more than half of discretionary spending. With each interest rate increase, the mounting net interest cost only puts more pressure on mandatory and discretionary spending categories, in addition to the deficit that is already present due to the lack of revenues in comparison to spending. If the interest rate were to increase by 5 more percentage points, the net interest costs will put serious enough pressure on the United States government to either default, raise taxes, or increase the debt ceiling, yet again. Regardless of the government’s response, if the interest rate were to increase by 5 percentage points, the government will have to make some sort of response in order to handle excessive costs. As such, this paper proposes the limit of interest rates at a 5 percentage point increase.

Conclusion

By running different interest rate scenarios on the CBO's projection of the government's financial situation, the theoretical limit of interest rates was found. Based on the results, this paper suggests that a 5 percentage point increase in the federal funds rate will put a severe enough pressure on government spending categories that will cause them to cut spending. Hence, the proposed limit of the interest rate is an increase of 5 percentage points to the current federal funds rate. It is important to recall that this conclusion is based on the ten-year projections made by the Congressional Budget Office, and estimations of this magnitude are variable.

Regardless, the importance of this research is that the government's mounting federal debt is not a conundrum that can be continuously ignored. Even before calculating interest rate limits, the severe debt situation of the United States government was already alarming. While much literature has described the "infinite" rolling over of government debt, the cost of servicing this debt has grown greatly; and more importantly, it is outpacing the growth of GDP. This means not only is current government spending being taxed by extraneous net interest, but rolling debt is also no longer sustainable. Of course, these dire circumstances are given under current laws and legislation. If action is taken by policymakers, this severe debt situation can be corrected; but the actions necessary will be painful for the economy. Nevertheless, action is necessary, and although it will be uneasy, it must be taken for there to be a strong economic future of the United States.

APPENDIX A

Table 1-3.

CBO's Baseline Projections of Federal Debt

Billions of dollars

	Actual, 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Debt held by the public at the beginning of the year	24,252	26,240	27,897	29,749	31,515	33,233	35,141	36,916	38,868	40,945	43,201	45,739
Changes in debt held by the public												
Resulting from the deficit	1,695	1,507	1,772	1,692	1,640	1,844	1,723	1,917	2,054	2,238	2,556	2,579
Resulting from other means of financing[a]	292	150	81	74	78	64	52	35	23	18	-18	-18
Total	**1,987**	**1,657**	**1,852**	**1,766**	**1,718**	**1,908**	**1,775**	**1,952**	**2,077**	**2,256**	**2,538**	**2,561**
Debt held by the public at the end of the year												
In billions of dollars	**26,240**	**27,897**	**29,749**	**31,515**	**33,233**	**35,141**	**36,916**	**38,868**	**40,945**	**43,201**	**45,739**	**48,300**
As a percentage of GDP	**97.3**	**99.0**	**101.7**	**103.3**	**104.7**	**106.3**	**107.4**	**108.7**	**110.2**	**111.9**	**114.0**	**116.0**
Addendum:												
Federal financial assets[b]	2,203	2,353	2,433	2,507	2,585	2,648	2,700	2,736	2,758	2,776	2,758	2,740
Debt minus financial assets												
In billions of dollars	24,037	25,544	27,316	29,008	30,648	32,492	34,216	36,132	38,187	40,425	42,981	45,560
As a percentage of GDP	89.1	90.7	93.4	95.1	96.5	98.3	99.5	101.1	102.8	104.7	107.2	109.4
Federal Reserve's holdings of debt held by the public	4,958	4,381	4,414	4,969	5,577	6,187	6,718	7,227	7,741	8,264	8,781	9,304
Debt minus financial assets and the Federal Reserve's holdings												
In billions of dollars	19,079	21,163	22,902	24,038	25,071	26,305	27,498	28,905	30,446	32,161	34,200	36,256
As a percentage of GDP	70.7	75.1	78.3	78.8	78.9	79.6	80.0	80.9	81.9	83.3	85.3	87.1
Gross federal debt[c]	32,988	34,825	36,775	38,624	40,243	42,021	43,702	45,460	47,294	49,255	51,718	54,386
Debt subject to limit[d]	33,070	34,906	36,853	38,701	40,319	42,098	43,778	45,535	47,369	49,330	51,791	54,459
Average interest rate on debt held by the public (percent)	2.7	3.3	3.4	3.4	3.3	3.3	3.3	3.3	3.4	3.5	3.5	3.5

Data sources: Congressional Budget Office; Department of the Treasury. See www.cbo.gov/publication/59710#data.

GDP = gross domestic product.

a. Factors not included in budget totals that affect the government's need to borrow from the public. Those factors include changes in the government's cash balances and cash flows associated with federal credit programs, such as those related to student loans. (The subsidy costs of those programs are reflected in the budget deficit.)

b. The value of outstanding student loans and other credit transactions, cash balances, and various financial instruments.

c. Federal debt held by the public plus Treasury securities held by federal trust funds and other government accounts.

d. The amount of federal debt that is subject to the overall limit set in law. That measure of debt excludes debt issued by the Federal Financing Bank and reflects certain other adjustments that are excluded from gross federal debt. Currently, the statutory limit on the issuance of new federal debt is suspended through January 1, 2025. In the absence of any legislative action on the debt limit before the suspension ends, the amount of borrowing accumulated during the suspension will be added to the previous debt limit of $31.4 trillion. The Deficit Control Act requires CBO to project spending, revenues, and deficits independently of the debt limit. For more details, see Congressional Budget Office, *Federal Debt and the Statutory Limit, February 2023* (February 2023), www.cbo.gov/publication/58906.

(CBO, 2024).

APPENDIX B

Table 1-1.

CBO's Baseline Budget Projections, by Category

													Total	
	Actual, 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2025–2029	2025–2034
							In billions of dollars							
Revenues														
Individual income taxes	2,176	2,469	2,520	2,789	3,031	3,124	3,251	3,381	3,511	3,634	3,793	3,973	14,715	33,007
Payroll taxes	1,614	1,663	1,734	1,812	1,884	1,960	2,039	2,121	2,205	2,291	2,379	2,466	9,430	20,892
Corporate income taxes	420	569	494	491	484	491	501	511	519	519	533	551	2,461	5,094
Other[a]	229	234	247	259	283	296	355	402	421	445	464	485	1,439	3,656
Total	**4,439**	**4,935**	**4,996**	**5,351**	**5,683**	**5,870**	**6,147**	**6,414**	**6,656**	**6,890**	**7,168**	**7,474**	**28,046**	**62,649**
On-budget	3,246	3,706	3,711	4,013	4,295	4,430	4,650	4,860	5,041	5,213	5,429	5,672	21,100	47,313
Off-budget[b]	1,194	1,229	1,285	1,337	1,387	1,440	1,496	1,554	1,615	1,677	1,740	1,803	6,946	15,336
Outlays														
Mandatory	3,753	3,838	4,061	4,246	4,448	4,743	4,807	5,153	5,407	5,682	6,131	6,320	22,306	50,999
Discretionary	1,722	1,734	1,756	1,791	1,825	1,866	1,893	1,937	1,975	2,016	2,066	2,106	9,131	19,231
Net interest	659	870	951	1,005	1,049	1,105	1,170	1,241	1,328	1,430	1,527	1,628	5,280	12,435
Total	**6,135**	**6,442**	**6,768**	**7,042**	**7,323**	**7,715**	**7,870**	**8,331**	**8,710**	**9,128**	**9,724**	**10,054**	**36,718**	**82,665**
On-budget	4,915	5,121	5,354	5,541	5,736	6,032	6,090	6,448	6,721	7,026	7,516	7,738	28,753	64,201
Off-budget[b]	1,220	1,322	1,414	1,501	1,587	1,683	1,781	1,883	1,989	2,102	2,209	2,316	7,965	18,464
Total deficit (-)[c]	**-1,695**	**-1,507**	**-1,772**	**-1,692**	**-1,640**	**-1,844**	**-1,723**	**-1,917**	**-2,054**	**-2,238**	**-2,556**	**-2,579**	**-8,672**	**-20,016**
On-budget	-1,669	-1,414	-1,643	-1,528	-1,441	-1,602	-1,439	-1,588	-1,680	-1,813	-2,087	-2,066	-7,653	-16,888
Off-budget[b]	-26	-93	-129	-164	-200	-242	-284	-328	-374	-425	-469	-513	-1,019	-3,128
Primary deficit (-)[c,d]	-1,036	-637	-821	-687	-591	-739	-554	-676	-726	-808	-1,029	-951	-3,392	-7,581
Debt held by the public	26,240	27,897	29,749	31,515	33,233	35,141	36,916	38,868	40,945	43,201	45,739	48,300	n.a.	n.a.
Addendum:														
GDP	26,974	28,177	29,256	30,504	31,756	33,043	34,375	35,746	37,157	38,609	40,106	41,646	158,933	352,197
							As a percentage of GDP							
Revenues														
Individual income taxes	8.1	8.8	8.6	9.1	9.5	9.5	9.5	9.5	9.5	9.4	9.5	9.5	9.3	9.4
Payroll taxes	6.0	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Corporate income taxes	1.6	2.0	1.7	1.6	1.5	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.5	1.4
Other[a]	0.8	0.8	0.8	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.2	0.9	1.0
Total	**16.5**	**17.5**	**17.1**	**17.5**	**17.9**	**17.8**	**17.9**	**17.9**	**17.9**	**17.8**	**17.9**	**17.9**	**17.6**	**17.8**
On-budget	12.0	13.2	12.7	13.2	13.5	13.4	13.5	13.6	13.6	13.5	13.5	13.6	13.3	13.4
Off-budget[b]	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.4	4.4
Outlays														
Mandatory	13.9	13.6	13.9	13.9	14.0	14.4	14.0	14.4	14.6	14.7	15.3	15.2	14.0	14.5
Discretionary	6.4	6.2	6.0	5.9	5.7	5.6	5.5	5.4	5.3	5.2	5.2	5.1	5.7	5.5
Net interest	2.4	3.1	3.2	3.3	3.3	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.3	3.5
Total	**22.7**	**22.9**	**23.1**	**23.1**	**23.1**	**23.3**	**22.9**	**23.3**	**23.4**	**23.6**	**24.2**	**24.1**	**23.1**	**23.5**
On-budget	18.2	18.2	18.3	18.2	18.1	18.3	17.7	18.0	18.1	18.2	18.7	18.6	18.1	18.2
Off-budget[b]	4.5	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.4	5.5	5.6	5.0	5.2
Total deficit (-)[c]	**-6.3**	**-5.3**	**-6.1**	**-5.5**	**-5.2**	**-5.6**	**-5.0**	**-5.4**	**-5.5**	**-5.8**	**-6.4**	**-6.2**	**-5.5**	**-5.7**
On-budget	-6.2	-5.0	-5.6	-5.0	-4.5	-4.8	-4.2	-4.4	-4.5	-4.7	-5.2	-5.0	-4.8	-4.8
Off-budget[b]	-0.1	-0.3	-0.4	-0.5	-0.6	-0.7	-0.8	-0.9	-1.0	-1.1	-1.2	-1.2	-0.6	-0.9
Primary deficit (-)[c,d]	-3.8	-2.3	-2.8	-2.3	-1.9	-2.2	-1.6	-1.9	-2.0	-2.1	-2.6	-2.3	-2.1	-2.2
Debt held by the public	97.3	99.0	101.7	103.3	104.7	106.3	107.4	108.7	110.2	111.9	114.0	116.0	n.a.	n.a.

Data source: Congressional Budget Office. See www.cbo.gov/publication/59710#data.

GDP = gross domestic product; n.a. = not applicable.

a. Consists of excise taxes, remittances from the Federal Reserve System, customs duties, estate and gift taxes, and miscellaneous fees and fines.

b. The revenues and outlays of the Social Security trust funds and the net cash flow of the Postal Service are classified as off-budget.

c. When outlays exceed revenues, the result is a deficit. Values in this row were calculated by subtracting outlays from revenues; thus, negative values indicate deficits.

d. Primary deficits exclude net outlays for interest.

(CBO, 2024).

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