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Debt Revenue and the Sustainability of Public Debt

Ricardo Reis

At the end of 2020, gross US government debt was 134 percent of GDP, the highest in US history, well above its previous record (121 percent just after World War II in 1946). The records for the size of public debt have likewise been broken for the groups of advanced economies and of emerging market economies (IMF 2021a). This was not solely the result of the pandemic, because debt had been growing since the 1980s and at a rising pace since the great financial crisis of 2008–2009 (Yared 2019). Is this level of debt sustainable, both for the US economy and for others around the world?

Governments have had centuries of experience actively using the public debt to prevent sharp changes in taxes or spending. Sometimes they just passively roll the debt over for many years, hoping for the best or falling for the seduction of reckless schemes. Economic theorists have analyzed how much and for how long debt can be sustained using impressive-sounding concepts like "bubbles," "Ponzi schemes," and "transversality conditions." Together, theory and experience have shown that ever-delaying the collection of taxes to pay for past debts is sometimes possible, but always eventually limited. Recently, a growing literature has found a third method by which to sustain public debt: to collect some new revenue every time that new public debt is issued. I call this the *debt revenue*. This essay describes where it comes from and its implications for whether the current level of public debt is sustainable.

■ *Ricardo Reis is Professor of Economics, London School of Economics, London, United Kingdom. His email address is r.a.reis@lse.ac.uk.*

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What is debt revenue? When the government tries to sell a public bond, it must compete with many other prospective borrowers, including foreign governments, firms, and even households, as a bank that lends more to the government may cut back on its personal credit. There is a market interest rate at which the borrowing by all equals the total amount lenders are willing to give. For some reason, the creditors give the government a discount, charging less on the public debt than that market rate. This discount times the amount of debt is the debt revenue. It saves the government the need to collect future taxes to repay a debt that grows at a lower rate than market returns.

Many governments in the past two decades received such a large discount that the real interest rate they paid was negative. In these cases, the revenue is visible: creditors give more today than what the government will pay them back in the future, so the government can set aside the repayment and spend the difference right away. But even if the real interest rate is positive, there is a debt revenue as long as there is a discount. The revenue may be realized, if the government borrows at the reduced rates and gives public loans at close-to-market rates, keeping the profits. Or, it may be implicit, by considering hypothetical counterfactuals: the government could borrow at its discounted rate, transfer that amount to households that were previously borrowing at market rates, and later tax those same households back by the original amount lent times the market rate. The household's resources have not changed at all, but the government is left with the debt revenue after it pays the original government debt. Another way to see the debt revenue is through the lens of the sustainability of public finances: for a given plan for spending and taxes, the public debt will grow at a slower rate as a result of the discount; without it, debt would explode faster and require that austerity arrives sooner.

Why has this debt revenue been negligible, and so typically ignored, in analyses of debt sustainability? What is special about government debt that gives rise to the discount in the returns that it pays its creditors in the first place? How large is the debt revenue, and how does it compare with the seignorage that central banks earn, a more familiar revenue from issuing a public liability? Does debt revenue come with different trade-offs facing policymakers when deciding how much to spend and tax? This article reviews the answers that a rapidly growing literature has given to these questions.[1]

Classic Analyses of Debt Sustainability[2]

The definition of debt sustainability has one equation at its foundation: the government budget constraint.

[1] Willems and Zettelmeyer (2022) provide a complementary review.

[2] Recent excellent examples of the classical analysis are in Gale (2019), Abbas, Pienkowski, and Rogoff (2020), and Eichengreen et al. (2022).

The Classic Version of the Government Budget Constraint

It is an accounting identity that, for a given year:

Increase in public debt = return to debtholders - primary balance.

The primary balance is the difference between tax revenues and government spending (on purchases and transfers). When it is positive, there is a surplus, and when it is negative, a deficit. The return to debtholders is the sum of: the promised interest rates on the debt, the repayment of the amount borrowed for debt that is coming due, and the change in the value of debts that will only come due in the future. The sum of balance and returns gives the left-hand side: the increase in the market value of the debt. As an identity, this equation always holds.

Starting from the market value of debt today, the equation tells us what debt will be next year. The same applies to the next year, the year after, and so on, linking today's market value of debt to what its value might be in a far-away future. However, the future balances are in the units of goods in the future, and the value of goods in the future is not the same as their value today. To add up these increments, one has to multiply the market values at future dates by their price in today's units. This can be expressed as the future increments to the debt being discounted at a rate d, as payments in the future are typically worth less than resources right away.

For decades, economists chose d to be the returns on government debt r. This seems like a natural discount rate for future deficits because it is the rate at which the government borrows to roll over pre-existing debt. This choice gives rise to the equation:

$$\frac{Debt}{GDP} = EPV_{r-g}\left(\frac{PrimaryBalance}{GDP}\right).$$

The notation $EPV_{r-g}(.)$ stands for the expected present value, using the returns on public debt r that are paid by government as the discount rate. Scaling by GDP is important because taxes and government spending can only be as large as the size of the economy. A positive debt has to be paid with positive surpluses at some point in the future, but these may be either a negligible or a significant share of the economy's income that year.

This equation is identical to the accounting identity as long as one important condition is met: that, on average and over the distant future, r is larger than the growth rate of the economy g. Otherwise, because the primary balances are growing with the economy, the future increments are growing faster than they are being discounted. The right-hand side would not be properly defined. If $r > g$ though, this is still just an accounting identity, even if now written in an intertemporal form (mathematically, it is the integral form of the differential equation).

Traditional Debt Sustainability

The equation relates the value of the public debt, on the left-hand side, to the expected present value of the balances that the government will use to pay it down, on the right-hand side. It is just like the relation between a stock price and expected present value of dividends. If the balances are too low, then the market value of the debt will be low, and the investors that held the debt from the past will be making losses on these holdings. If the expected present value of the balances is so low that it is below the payments on the debt that are due today, then the government has no choice but to default, paying back less than what was promised. More generally, the public debt is unsustainable if there needs to be either a default (so the left-hand side falls) or a reversal in public finances that generates a large increase in future primary balances (so the right-hand side rises) in order to bring the two sides in line.

Assessing the size of the right-hand side of the equation and comparing it with the size of the debt that is due or outstanding gives an assessment of debt sustainability. Different lenders may have different perspectives on what the future will be and may change their minds suddenly. When they do, the value of the debt can change suddenly, so the government wants to anticipate these changes with its own estimates. Fiscal councils (like the Congressional Budget Office in the United States) can perform a useful role in providing credible estimate of the right-hand side to inform and anchor the market expectations. If that estimate is well below the current market value of the debt, there are reasons to be concerned, as a sharp drop in government bond prices may be on the horizon.

Measuring public debt on the left-hand side of the equation may seem easy, but in practice a comprehensive measure can be tricky. First, it is important to add and subtract the debt issued and held by different branches of the state, including regional governments and social security trust funds. Second, and more difficult, one should subtract from the state's liabilities the assets that it will be willing to sell if needed to honor the public debt. Third, and very hard, the measurement has to depend on what will happen in the future since, in times of crisis, public debt can jump when certain contingencies are triggered as governments take on commitments (like insuring mortgages or business loans).

Measuring Future Primary Balances

A popular way to measure the right-hand side is to build forecasts of future primary balances. Experience has shown that the uncertainty around these forecasts is very large. For example, small differences in plausible assumptions about retirement age, the cost of health care, and what future governments will choose to tax during the next couple of decades can produce forecasts that differ by several multiples. With an $r - g$ that is around 0.01 or 0.02, budget forecasts that are as far away as 50 years from now will still loom quantitatively large in the present value calculations. A more fundamental challenge is that, since all countries have positive debt, sustainability suggests that these forecasts must include positive balances sometime in the future. However, for many countries, and the United States in particular,

the forecasts are for deficits for the foreseeable future. When the IMF conducts an analysis of debt sustainability as part of its surveillance of member countries, eventually, even if in a distant future, it always assumes that primary balances become positive.

These difficulties have led to a second approach to measure debt sustainability. It asks a slightly different question: whether, after a sudden shock to the public finances that raises the public debt, this new debt will be paid for by future balances. The answer turns out to be simple. As long as an increase in public debt leads eventually to an increase in the primary balance, even if only in the distant future, the debt is sustainable. Using past data to estimate how fiscal policy, through rules, common practices, or discretionary choices, changed primary balances in response to higher debt provides an indication of whether it will do so in the future. These responses of primary balances to past public debt are called "fiscal reaction functions." Estimates using data for advanced economies in the twentieth century have typically found a positive relation, leading to the conclusion that debt was always sustainable (Bohn 1998). At the same time, econometric identification of these rules is challenging, and the exercise makes the strong assumption that past patterns of fiscal policy reflect its future behavior.

A third approach to assess debt sustainability is to calculate the feasible maximum value of the right-hand side of the government budget constraint. Instead of trying to figure out what the government will do, it calculates what is the most that the goverment can feasibly do. If that is less than the outstanding debt, then the debt is unsustainable. To calculate the maximum requires models (D'Erasmo, Mendoza, and Zhang 2016). Most of them are versions of Laffer curves: relations between tax revenues and tax rates. Higher rates raise revenues at first, but eventually higher rates may discourage the desire to work, to invest, or to comply with the tax authorities, so that revenues actually fall. This peak of the curve gives the maximum revenue that the government can collect to pay for its public debt. An important limitation of these analyses is that there is no corresponding analysis of the feasibility of cutting government spending, so that at least half of the components of the balance is left out.

Classic Trade-Offs

Perhaps the most famous trade-off in debt sustainability analysis is the one surrounding austerity. Cuts in spending and rises in taxes raise the primary budget balance, but they may also lower the growth rate of the economy, therefore increasing the rate at which these balances are discounted. Austerity that causes a recession may then actually lower the right-hand side and make public finances less sustainable (Alesina, Favero, and Giavazzi 2019).

A related trade-off arises from structural reforms. On the one hand, they are meant to raise the growth rate of the economy, and a higher g would raise the present value of primary surpluses. On the other hand, such reforms may require deficits at first to make the needed investments. Whether the right-hand side rises or falls depends on the relative weights of the present versus the future and on the

success of the uncertain outcome of the reforms (Müller, Storesletten, and Zilibotti 2019).

Another prominent trade-off arises in discussions of whether to default on public debt. A default would lower the left-hand side automatically. If, however, the holders of government debt suspect that a default is likely, they will require a higher return r. This raises the discounting of future surpluses, and so lowers the right-hand side. In this framework, sovereign debt crises can arise suddenly and there may be multiple equilibria (Calvo 1988).

A final trade-off involves inflation, which affects debt sustainability through three channels. First, unexpected inflation lowers the value of public debt on the left-hand side. Second, fully expected inflation has no effect on either side, as it raises r and g by the same amount. Third, higher risk of inflation raises r because investors require higher expected returns to hold a bond that may be debased by inflation in the future, so it lowers the right-hand side. In practice, bouts of inflation have unexpected, expected, and risk elements. Complicating matters further, historically, inflation often comes with financial repression that keeps r low and increases primary balances. An extreme example of financial repression is for the debt to be paid back with reserves at the central bank that pay zero interest, yet must be held for a long period of time (Hilscher, Raviv, and Reis 2022).

These trade-offs are interrelated, and more could be added. Together with the measurement of sustainability, they have led to an enormous literature in economics that has sought to provide guidance to policymakers.

The Debt Revenue

A remarkable fact of the first two decades of the twenty-first century is the steady decline in the real return on public debt (r minus inflation). In the United States, for instance, on average between 2001 and 2020, that real return was 2.5 to 3.5 percent lower (depending on the measure used) than in the preceding 20 years. Even before, throughout the nineteenth and twentieth centuries, the United States had the enviable position of paying a return on its government debt that was on average lower than the growth rate of income. Over the last 20 years, this gap has become larger, but also more widely shared across countries (Blanchard 2019; Mehrotra and Sergeyev 2021). As a consequence, the equation on which the traditional analysis of debt sustainability was sustained is no longer valid. Setting the appropriate discount rate d equal to the return r is no longer tenable because the expected present value is not well defined, diverging to infinity.

However, there is a sensible alternative: the return on private investments, call it m. The private sector as a whole can hold as assets either the government debt or the economy's capital. The return on private investment (the marginal product of capital) is the opportunity cost of holding the debt. At the margin, for investors to hold government debt, they must calculate the expected present value of payoffs from government bonds using the return on holding the capital stock. Moreover,

even as r declined in the last 20 years, m did not, staying approximately constant and well above the growth rate of the economy g.

Using m as the discount rate changes the government budget constraint described earlier. The public debt must still be backed by the present value of primary balances; the only change to the first term on the right-hand side of the equation is that the present value is now discounted by $m - g$. The same measurement difficulties and associated policy trade-offs apply to this term as they did in the classic analysis. But now there is a new positive term relative to traditional analysis, the debt revenue term (Reis 2021; Cochrane 2021). This term takes the debt/GDP ratio every year moving forward, multiplies it by $m - r$, and then calculates the expected present value.

$$\frac{Debt}{GDP} = EPV_{m-g}\left(\frac{Primary\ Balance}{GDP}\right) + EPV_{m-g}\left(\frac{(m-r)Debt}{GDP}\right).$$

This new equation is well defined even as r is less than g, and classic analyses of debt sustainability apply all the same to the first term. Moreover, when the return on government bonds and the return on private capital are the same ($m = r$), then the two equations are the same: the debt revenue term is equal to zero, and there is a single return to discount the future. There is even an a priori argument for why it *should* be so. If the return on private capital was higher than the return on government bonds, then private investors should invest more in the capital stock and less in government bonds. In doing so, the forces of demand and supply should make m fall and r rise until they are the same. However, this is not so in the data. As a result, the government earns a debt revenue.

Why Is There a Debt Revenue?

Since, for some reason, people are willing to hold public debt in spite of it giving a lower return than the private market alternative, their opportunity cost of doing so is a form of revenue for the government. Supplying the public debt is providing some service to these investors. The government is rewarded for it by being allowed to borrow at a lower interest rate than it otherwise would. The gap $m - r$ measures the discount that the government receives on the terms of its borrowing in exchange for these services.

Multiplying the premium by the total debt supplied gives the debt revenue flow. In any given year, this may be positive or negative. After all, private capital sometimes gives unusually higher returns because the economy boomed, but other times markets crash and the return on private investment can fall below that on government debt. Likewise, public debt can sometimes give unusually low returns because the government defaulted or because unexpectedly high inflation subtracted from the low nominal interest rates at which the debt had been sold. It is important to take the expected present value of the debt revenue flow to get to the value of the debt revenue and adjust for the riskiness of the debt revenue flows.

Perhaps the last two decades of ultra-low real returns on government bonds were just a very unusual random draw. Recently, the runaway inflation in 2021 and 2022

in many advanced economies has led to record low returns on government bonds, as the nominal payments they make to the bondholders are worth less in units of goods. Maybe as lenders start expecting inflation, they will require higher returns to lend to the government, so that r is about to rise to become again close to or equal to m. In other words, the flow of debt revenues of the last 20 years may have been a fluke, so their expected present value looking forward may be close to zero.

To figure out if it is so requires understanding what creates the debt revenue in the first place. It can only sustain public debt systematically as long as, on average, the return on private assets is expected to be higher than the return on government debt. Economists sometimes call this expected gap a *premium*. Something must impede the market forces that drive the premium to zero. Or, equivalently, there must be something special about government debt, or some unique service that it provides, to those who are willing to hold it. The literature has provided several arguments for what this might be (Krishnamurthy and Vissing-Jorgensen 2012).

Where Does the Premium between Returns Come From?

First, public debt is useful as a store of value that fills some holes left by the limitations of private credit markets. A primary function of credit is to allow resources to flow from the many who have them to the few who right now have an entrepreneurial project or an investment idea. However, the inability to sort out good from bad projects, or for the borrower to commit to repay, may put limits on this flow, leaving too many savers unable to put their resources to good use. At the same time, prospective lenders may have their own investment opportunities in the future, so they would like to save for the future. Public debt becomes useful because it provides an alternative store of value to the private credit markets that absorbs this excess supply of savings. The $m - r$ premium emerges because even though savers would like to put their capital to use in firms to earn m, the limits to private credit hinder this action, thus creating a residual demand for public debt even if at a lower r. Closely related, when there no better ways to store value, there may be a bubble raising the price of government bonds because some investors buy them expecting the price to keep on rising and returns to be high.[3]

Second, public debt is a safe haven. Holding a government bond bears the risk of unexpected movements in inflation, but the return on private investment is affected not just by inflation but also by almost any other shock to sales, investment, labor costs, or productivity. Moreover, loans to private firms are more likely to be defaulted on than loans to the government. The investors who want a safe asset are willing to pay for it by requiring a lower return in their loans to the government. That individual investment projects come with risks that are specific to the project is also relevant. Because much of this risk cannot be diversified away, firms and households would like to hold some of their savings aside in a safe asset. Finally, when uncertainty rises, investors fly to the safety of government bond from all other

[3]For some models of this, see Reis (2021), Miao and Su (2021), Bayer, Born, and Luetticke (2020), Bonam (2021), and Gersbach, Rochet, and von Thadden (2022).

assets and markets. This makes the returns on government debt rise during crises, which in turn makes investors tolerant of its low returns most of the time.[4]

Third, the premium may reflect regulations and financial repression. Many financial institutions are required by regulations to hold government bonds as a share of their assets or as collateral in some transactions. Governments routinely restrict households and institutions from some private-sector investment choices and put limits on private credit. This reduces the demand for the capital stock and correspondingly raises the demand for government bonds as an alternative, thus contributing the premium between their returns. In this case, the premium is akin to a repression tax, and the debt revenue is a tax revenue charged on private agents who are forced to lend to the government at inferior returns. Even when the government is not involved, lenders often repress their willingness to lend by the collateral that they are willing to accept from borrowers in the event that they default on their obligation. An asset is good for collateral if it is itself unlikely to default, if it is liquid so the lender can sell it easily, and if it is insensitive to new information so the lender does not need to spend resources keeping track of its value. Public debt is a natural candidate, and government bonds are used as collateral throughout the financial system. The premium then reflects this demand for collateral from households and firms.[5]

Fourth, government bonds are traded in liquid markets. This makes them easy to sell for cash and goods when their holders want to quickly increase their spending in goods. Most private investments, instead, take time to unwind or are difficult to sell because buyers are suspicious that the motive behind the sale is there being something wrong with the project. The gap between returns is referred to as a liquidity premium.[6]

There are many models in the economic literature to justify stores of value, safety, repression, or liquidity. A catch-all term that is sometimes used for all of them is to say that government bonds provide a convenience premium. Public debt, somehow, provides a convenience service to its holders. This special service is reflected in the low return on government bonds, and its associated revenue is captured by its issuer, the government.

Different Types of Public Debt and Seignorage

Government debt takes different forms. Some of it is in bonds that pay their holders a set amount of currency; some has its payments automatically rise with inflation. Some debts make small payments every year for a fixed set of years, others repay the creditor once just three months after they were paid for. These features determine how safe or liquid they are, so the premium on their returns varies, as

[4]Models of this channel are in Bassetto and Cui (2018), Bassetto and Cui (2021), Reis (2021), Elenev et al. (2021), Brunnermeier, Merkel, and Sannikov (2022), and Jiang et al. (2022).

[5]For models of this channel, see Angeletos, Collard, and Dellas (2016), Miao and Su (2021), and Gorton and Ordoñez (2022).

[6]Models of this liquidity are, for instance, in Berentsen and Waller (2018), Sims (2020), and Schmid, Liu, and Yaron (2021).

does the debt revenue the government earns from issuing them. All countries have government debt offices that vary the composition of the public bonds that they issue in part to try to maximize the debt revenue that is earned.

Central banks earn a particular form of revenue that is familiar to economists—seignorage—and which is closely related to debt revenue. When the central bank issues currency (for example, in the form of banknotes), the bank can buy goods with it. Seignorage is the change in that currency divided by the price of the goods. The central bank could instead use the newly printed banknotes to buy government bonds, and in fact this is what is usually done. The returns paid on those bonds to the central bank are then sent back to the government, so this becomes a form of debt revenue that can be used for government purchases or transfers every year from then onwards. The once-off seignorage is equal to the expected present value of the debt revenue from currency.

Monetary theory has for decades developed justifications for why people hold currency when it gives an inferior return to government bonds. It uses arguments on storage of value, risk, liquidity, and repression that mirror the ones made for public bonds above. However, in almost all advanced economies, the stock of currency is typically between 5 percent and 15 percent of GDP, and nominal returns have been close to zero, so seignorage has been trivial. In the history of the United States, the seignorage generated by the Federal Reserve has only very rarely been above 1 percent of real GDP in any one year, playing no meaningful role in directly sustaining the public debt. As the next section will show, the debt revenue from US Treasuries is an order of magnitude larger than that from currency, as public debt exceeds 100 percent of GDP and the gap between returns on private investment and on government bonds is several percentage points. Seignorage is one particular component of debt revenue, but one that is not particularly large.

Why Rethink Debt Sustainability Now?

The combination in the past two decades of $r < g$ becoming a pervasive fact across most advanced economies and economists developing a variety or arguments for why the gap between m and r will persist has implications for many economic questions. It has contributed to a rethinking of how the evolution and dynamics of inequality over time, why financial markets misallocate capital, and how the search for safety can trigger economic crises.

For the study of debt sustainability, $r < g$ has meant that the conventional focus of calculating present values of future primary balances became futile: no matter what those balances are forecasted to be, how they respond to debt, or what their maximum is, still their present value is infinity. Fortunately, the classical insights can be rescued by discounting the relevant returns on private capital, as long as $g < m$.

In turn, $r < m$ has meant that flows of debt revenue appear. These revenues have been growing for the last two decades. Population aging has increased the demand for stores of value, the scars of the great financial crisis have increased the demand for safety, and growing financial regulations have increased financial repression while

reducing the offer of private forms of collateral or liquidity. Because these are all structural changes, this has emboldened economists to speculate that the premium on government bonds will persist on average, and so debt revenue can play a significant role in sustaining the public debt moving forward. Whether this is so depends on how large the debt revenue is.

Measurement of the Debt Revenue

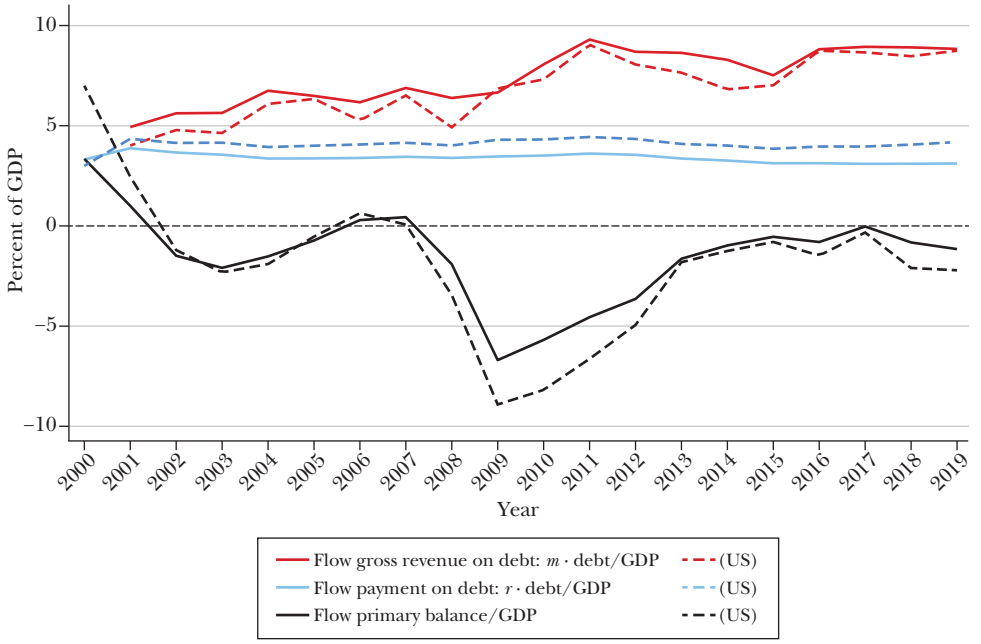
Measuring the debt revenue is hard because it involves measuring the difference between two returns for which there are no immediate counterparts in the data. There are many private investments with different returns, and many ways in which governments borrow (as well as invest). Moreover, it is total returns that matter for the debt revenue, so all of the different returns must be weighted, as opposed to picking just one that is more relevant at the margin.

Some basic calculations give a sense of the likely size of the debt revenue term. Figure 1 shows in one series (in blue) the total interest payments by the G-7 countries—that is, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States—summed using current exchange rates and divided by total GDP every year, over the last 20 years. Also in the figure, in dashed series, is the series for the United States. This is a direct measure of the return on bonds r multiplied by the debt/GDP ratio. The other series in the figure (in red) comes from multiplying the outstanding public debt over GDP by 0.06 plus average inflation. The choice of 6 percent for real m follows from an approximation that the growth rate of per capita real consumption should equal the difference between the marginal product of capital and the subjective discount rate times the intertemporal elasticity of substitution.[7] Given standard textbook parameter choices like a growth rate of 0.02, a discount rate of 0.02, and an intertemporal elasticity of substitution of 0.5, it follows that $m = 0.06$ plus inflation.

The gap between the two series—the red and the blue in Figure 1—gives the flow revenue on debt: *(m-r)Debt/GDP*. At the start of the twenty-first century, it was around 2 percent of GDP, but by the pre-pandemic years it had climbed above 6 percent, resulting in an average over the 20 years of 3.8 percent. In terms of present values, for $m - g = 0.04$, and ignoring risk or uncertainty in calculating the present value over a long time horizon, debt revenue can sustain 3.8/0.04 = 95 percent of GDP of public debt. For comparison, the 2020 value of debt/GDP for the group of G-7 countries was 140 percent. The debt revenue term over this time was approximately two-thirds of outstanding debt. For the United States during these 20 years, the debt revenue flow was on average 3 percent, for a present value of 75 percent of GDP to compare with the sum of market value of privately held Treasury debt in 2020 (86 percent) and deposits at the Federal

[7]Some readers will recognize this as an application of the Ramsey (1928) formula that specifies an optimal growth rate for consumption.

Figure 1
The Flow Budget Components as a Ratio of GDP for the G-7 Countries and the United States



Source: IMF (1972–2019a, b, 2021b).
Note: Interest payments as a ratio of GDP; public debt as a ratio of GDP times 0.06 plus inflation; primary balance as a ratio of GDP. Adding over all countries in the G-7.

Reserve plus currency in circulation (25 percent). These back-of-the-envelope figures suggest that a significant part of the public debt may be backed by debt revenues.

Another comparison is with the other term in the intertemporal budget constraint for sustainability of sovereign debt, the primary balance. The black series in Figure 1 shows it for the G-7 countries during the last 20 years, again summing across countries and dividing by their total GDP. On average, it has been negative, and smaller in absolute value than the debt revenue. As these rich countries have run large deficits, especially during the great financial crisis and the Covid recession, their outstanding public debt has greatly risen. However, it has risen by significantly less than it would have if the government had paid market interest rates on the new debt, and Figure 1 shows the difference was substantial.

Measuring Debt Revenue as a Residual

In a series of inspiring articles, Jiang et al. (2019; 2020; 2021) measured the expected present value of primary balances using the returns to private investment as the discount rate. They then compared this to the public debt outstanding for

the United States and for many countries in the eurozone. Because the difference between the two in the government budget constraint is the debt revenue term, this provides an approach to measure it as a residual.

To do so, one must have measures of expected future balances and measures of the returns to private investment. For the first, Jiang et al. (2019) use past behavior captured by a regression of US surpluses and other fiscal and macroeconomic variables on their past annual values between 1947 and 2019 as well as CBO estimates of what future deficits will be. For the second, they use an empirical asset-pricing model that can fit the observed returns on stocks and US Treasury bonds within this sample. Their results are puzzling: the debt revenue term is 246 percent of GDP on average, a very large number.

There are three reasons for these extreme estimates. First, since the US primary balance has been, on average, negative for the past seven decades, the present value of this average is negative. Second, this primary balance is strongly procyclical, as governments run deficits during recessions. This makes it a risky flow that is low when money is more valuable, which pushes down its present value when adjusting for risk. Third, because government spending and revenues in the long run move closely with GDP, they carry the long-run risk that seems to drive much of the riskiness in stocks and which leads to their high average returns. This large risk in money terms implies a large negative present value.

One can argue with the precise estimates, and the financial valuation of distant payoffs is as much art as it is science. Moreover, this calculation assumes that debt was sustainable: it takes as given that its market value is high and will remain so and uses this to infer what must be the present value of debt revenue that makes it so. Looking forward, perhaps the United States will suddenly start running large primary surpluses, and maybe these will be higher in future recessions (a terrible idea as procyclical deficits would likely exacerbate the amplitude of business cycles). But unlike what happened after the World Wars, there are no reasonable projections that there will be surpluses even in the distant future. Given the large stock of outstanding debt, this inescapably implies that the debt revenue term must be large.

Looking at other countries, Olijslagers, Van Wijnbergen, and de Vette (2020) focus on the Netherlands, which has often had primary surpluses that are less aggressively procyclical. They find that 53 percent of the outstanding public debt in 2018 is accounted for by the debt revenue term. For the countries in the eurozone, Jiang et al. (2021) find that the variation in the relative convenience yields explains most of the variation in sovereign yields across different countries. They estimate conservatively that since the start of the euro two decades ago, Spain and Italy have earned between 5 percent and 8 percent of GDP less than Germany in debt revenue.

Measuring Debt Revenue by Measuring the Premium

An alternative, more direct approach to measure debt revenue is to measure the premium $m - r$ and multiply it by debt/GDP. The difficulty with doing so concerns how to measure the returns on private capital. There are thousands of alternative investment projects and financial assets in an economy.

One approach provides some sensible estimates. From a macroeconomic perspective, it focuses on the average returns on the aggregate capital stock. From a financial perspective, it follows the teachings of the justly celebrated Modiglian-Miller theorem, looking at the income the project generates while ignoring the way this is carved up across the different financial instruments that funded the projects. Combining the two perspectives suggests dividing the total income that goes to the owners of the capital and firms by the total capital stock in the economy (Reis 2022b).

Table 1 shows a baseline estimate of m for the United States of 8.2 percent. This is close to the 6 percent real return assumed at the start of this section, since inflation has averaged 2.1 percent during these two decades. At the same time, reasonable changes in the assumptions used to measure both the numerator and the denominator can affect these estimates. For instance, in the denominator, the measure of the capital stock used was the standard one produced by the Bureau of Economic Analysis, but this may well be an underestimate of m due to undercounting investment in intangibles during this period. In the numerator, the baseline apportions two-thirds of the income of the self-employed to labor, and one-third to capital. Instead counting all of it as capital income, as the national accounts usually do, raises the estimate of m.

Table 1 shows a few more reasonable alternatives starting from the baseline. Subtracting the corporate taxes that firms pay is straightforward. A more controversial adjustment is whether to subtract rent payments, because land is fixed and is not a capital that the economy can accumulate. At the same time, if these are subtracted, then the increase in the price of the capital stock should perhaps be included as this is a gain to its holder. Across the alternatives, an m between 6.2 percent and 10.5 percent is reasonable, with the baseline estimate roughly in the middle.

The next panel in Table 1 turns to financial markets as a source of data on returns instead. A broad index of stocks is captured is captured by the Wilshire 5000 index, which has between 4000 and 5000 publicly traded firms depending on the year. Over these two decades, US firms increasingly turned to corporate bonds with an expansion of credit flowing through bonds that were rated as being especially risky in terms of default (a credit rating of BBB). These two measures suggest a return between 6.7 percent and 7 percent. However, this is likely an underestimate of m as many firms do not publicly trade stocks or do not issue corporate bonds. In the other direction, focusing on a narrower set of firms that sell shares (those in the S&P 500 index) or on bonds that are less likely to default (those with a AAA credit rating), the estimates are smaller. Most households do not directly hold stocks (although they may hold stocks indirectly via pension, life insurance, or retirement accounts), but many invest in housing, so the table also reports returns on housing that include both the service (or rent) flows from homeownership as well as capital gains and losses. In the other direction, banks actively buy and sell government bonds looking at the alterative returns they would get by lending to other banks at the interbank rate.

Even measuring r is not as easy as it may seem. At the margin, if the US government wants to borrow an extra dollar for one year, then the cost is given

Table 1

Average Nominal Annual Returns (2000–20) in the United States for Measures of *m* and *r*

Measure		%
Return on private investment/Marginal Product of Capital (*m*)		
Income Measure		
(i)	Ratio of Payments to Capital and the Capital Stock	8.2
	(i–a) with adjustment for intangible capital formation	8.0
	(i–b) including proprietors' labor income	10.5
(ii)	(i) minus corporate taxes	7.4
(iii)	(ii) minus rent payments	6.2
(iv)	(iii) plus capital gains	7.1
Financial Measure		
(v)	Wilshire 5000 stock market index	7.0
	(v–a) S&P 500 stock market index	6.6
(vi)	BBB-rated bonds	6.7
	(vi–a) AAA-rated bonds	5.9
(v)	Housing	8.2
(vi)	Interbank rate	2.2
Return on government bonds (r)		
(i)	Return on Treasuries of average maturity	4.1
(ii)	Yield on 1-year Treasuries	1.6

Source: Bureau of Economic Analysis (1901–2020, 1925–2020a, b, c, d, 1929–2020a, b); Global Financial Data (1871–2020); FRED (1960–2020a, b, 1962–2020a, b, 1970–2020, 1986–2020); Jorda et. al (2019).
Note: For detailed description of the series and data sources, see Reis (2022a).

by the interest rate on one-year Treasury bonds. However, the average maturity of government bonds during this period was closer to five years. These bonds gave a significantly higher return on average every year to their holders.

Looking at the whole table, one could make a case for a premium that lies anywhere between 0 and 8.9 percent. More research is needed to pin this down more precisely. The initial estimate at the start of this section set a real *m* of 6 percent and used interest payments, which when divided by the stock of debt for the G-7, leads to an estimate of 1.8 percent for the average real *r*. With a premium of 4.2 percent, and the International Monetary Fund forecasting a net US public debt/GDP ratio between 2021 and 2025 of 103 percent (IMF 2021a), then debt revenue seems likely to play a major role in the sustainability of this debt.

Policy Tradeoffs and Principles of Fiscal Policy

Each of the four sources of the premium on returns that gives rise to debt revenue—store of value, safety, repression, and liquidity—leads to new policy

tradeoffs. Moreover, because some of these policies also affect primary balances, they have the potential to reinforce some of the principles of fiscal management that grew out of the traditional approach, while upending some others.

More Public Debt Is Even Less Sustainable Debt

If there is demand for public debt as a provider of store of value, safety, collateral or liquidity, then increasing its supply should reduce the premium on returns. That premium arises because public debt was scarce. More public debt makes it less special, so it comes with an increase in the returns on public debt and a smaller gap between private investment and public debt. The debt revenue shrinks. Therefore, if the government runs a primary deficit, this not only reduces the classic term of debt sustainability, but also the second term on debt revenue.

Less Austerity: Deficits Can Stimulate the Private Economy

Spending more or cutting taxes during a recession will lower primary balances. However, in classical analyses, this may also stimulate economic activity, which will raise tax revenues and offset some of the decline in the primary balance. With a debt revenue, the temporary increase in the public debt that results will provide the economy with more stores of value, collateral, liquidity, or safety. If these are useful for economic activity or for investment, then this may provide a further stimulus to output. Related to this, public investment may increase the profitability of existing private capital stock, infrastructure being a case in point. Then, the deficits to pay for this investment may raise the returns on private capital, increase the premium, and so partly pay for themselves through debt revenue.

More Austerity: Extraordinary Debts Should Be Paid down Faster

Classic analyses of primary surpluses prescribe that a sudden unexpected increase in public spending, like what happened in 2020 in response to the pandemic, should come with only slightly higher tax revenues. This is because tax rates should be smooth over time in order to minimize their distortions. Primary balances should therefore fall when the spending rises, and then be slightly higher than before in the years that follow to slowly pay down the debt that resulted. From the perspective of debt revenue though, the increase in public debt makes the specialness of public debt less scarce. Weighing this effect, the fiscal authorities may want to raise taxes more aggressively in the short run in order to repay the debt faster. This way, they can enjoy more debt revenue in the future and deliver lower taxes in the long run.

Similarly, beyond stimulating output, there is a case for primary balances to fall during a recession because tax rates are kept unchanged so tax revenue falls. However, the debt revenue may move in the same or opposite direction, depending on whether the shocks that caused it raise or lower the demand for collateral and liquidity. Tax cuts and government spending may satisfy this demand in different directions.

Public Debt Crowds Out and In Private Debt

Savings equal investment. Therefore, for a fixed stock of private savings, if the government saves less by having a deficit, then private investment must fall. Public debt crowds out private investment from the perspective of classical analyses. From the perspective of the specialness of public debt, there are other forms of crowding out and crowding in. For instance, if public debt increases the supply of collateral, it may allow for private savings to rise, increasing investment. Still from the perspective of collateral, private assets that can serve as collateral must sometimes be produced by the private sector. If the supply of public debt crowds out this production, then this serves as a countervailing force on investment.

More subtle, if the government adopts austerity policies, and there are fewer public bonds as a result, then investors will look for which private assets are safe enough to serve as collateral. This makes these private assets more sensitive to information and so less suitable as a whole to serve as collateral. This multiplies the initial effect of austerity in making collateral scarcer in the economy and increasing the premium on returns. It may also trigger a financial crisis due to the absence of collateral.

Debt Management Creates Risks

Traditional debt sustainability analyses emphasize how the response of primary balances to public debt affects the present value of primary balances. However, their responsiveness to debt, output, inflation, or other variables also affects the riskiness of government debt. Therefore, the fiscal response functions also determine the specialness of debt in providing safety, and so the size of debt revenue.

Moreover, say that the government reduces financial repression that made public bonds special, and so lowers debt revenue. To keep public debt sustainable, it offsets this by increasing taxes and so the present value of primary balances. Repression through the efficiency costs of taxation is higher. In addition, with a higher average tax level, future changes in government spending and revenues that cause changes in tax rates may create more uncertainty in returns in the economy and lower investment and economic activity.

Price Stability Keeps Debt Sustainable

Public debt carries a risk of inflation because it promises a fixed nominal payment. Many private investments instead have returns that rise in nominal terms with inflation. Therefore, more inflation risk reduces the premium and the debt revenue. When the public debt is high, it may be more tempting to let inflation rise, temporarily giving debtholders negative returns, as happened in 2022. But it is the trust by investors that monetary policy will do its best to prevent this from happening that allows for the debt revenue term to remain large. Independent inflation-targeting central banks may be especially in the interest of the fiscal authority because price stability—as opposed to attempts to inflate the debt—maximize debt revenue and may keep debt sustainable.

Richer Monetary-Fiscal Interactions

Quantitative easing policies consist of paying for government bonds in exchange for deposits at the central bank. These have different premia, so they come with different debt revenues, which are now partly earned by the central bank and then rebated to the government. This adds a fiscal dimension to monetary policy.

An important difference is that the liabilities of the central bank are the unit of account in the economy—"money," for short. Treasury bonds instead have a price that is set at auction when they are sold and that fluctuates in markets. Therefore, while the market value of debt can quickly adjust to shocks to primary surpluses or to debt revenue, the real value of money only adjusts slowly with changes in the prices of goods. Debt sustainability is tied to price stability (Calvo and Velasco 2022).

Finally, imagine that monetary policy keeps nominal interest rates fixed. This could be by choice, or it could be because the central bank would like to lower nominal interest rates but they have reached an effective lower bound. If inflation is sticky, then traditional analyses note that more government spending can stimulate output and so increase primary balances. Because issuing more debt now has no impact on the real return r, it also raises debt revenues (Mian, Straub, and Sufi 2022).

Spillovers across Borders

The debt of the US government is seen as a safe haven by international investors, and this is a significant part of the debt revenue that it collects. Other countries never have debt revenue that is too large and, worse, any existing debt revenue in those countries can dissipate quickly during a financial crisis when investors rush out of all domestic assets. At all times, this means that the fiscal (and monetary policy) of the United States will spill over to the returns premium of countries around the world and affect their debt revenue and debt sustainability (Jiang, Krishnamurthy, and Lustig 2020).

Debt Revenue and Ricardian Equivalence

Imagine that the government provides a transfer to a household, funds it by selling a bond to that household, and later on pays for that bond by taxing the same household again. The principle of Ricardian equivalence states that the household will save the whole of the initial transfer in order to pay for the future taxes and change no other of its choices. With a premium on government debt, the household may be willing to collect a low return on the public bond issued by the government to finance the transfer. This is an opportunity cost for the household that could be collecting higher returns on private investment. This cost is just offset by the debt revenue and by lower taxes in the future to pay for the debt. Therefore, the household still realizes its net wealth has not changed and changes none of its other actions (Barro 2020).

What Is Good for the Public Purse May Not Be Good for Welfare

Any improvement in how the private credit market works or in social programs that reduce the supply of savings will reduce the demand for the safety or store of

value that is offered by public debt. Therefore, it lowers debt revenues. Policies that promote financial development, provide social insurance, or lower inequality may be good for economic growth and social welfare, but they also reduce debt revenue and hence shrink the fiscal resources available for other government programs. When considering public policies, governments may want to take into account not only their direct impact on the primary balance, but also how much they will affect the usefulness and demand for public debt

Moreover, just because there are debt revenues does not mean that society would be better off if there was more public debt. After all, if the government can just increase the supply of public debt at no cost, it might want to do so until the demand for the specialness of this debt is fully satiated. At that point, both the return premium and the debt revenue are zero.[8] At the same time, having positive debt revenues can lower the need to use distortionary taxes to collect revenues in response to shocks and be used to stimulate aggregate demand out of deep recessions. More generally, the different policy trade-offs described so far combine to imply an optimal amount of debt.

Conclusion

The traditional literature on debt sustainability has focused on measuring the expected present value of primary balances and on studying how different policies may increase or lower it, depending on the relative strength of different trade-offs. This literature has its challenges, and there are still many open questions both in theory and in measurement, but it has been useful to fiscal authorities all over the world when considering how much spending and how much borrowing a government can do. However, the steady downward trend in the return on government bonds, which for years leading up to the pandemic was decidedly below the growth rate of the economy, has made the framework hard to apply because the present value of future primary surpluses is not mathematically well defined.

At the same time, the returns to private investment in the data have stayed comfortably above the growth rate of the economy, and there has been a wealth of theories to explain why there is an increasing discount in government bond returns relative to private investment. Taking into account this premium on government bond returns reveals a new fiscal revenue that comes from the act of issuing public debt to satisfy the demand for its store of value, safety, collateral, or liquidity. Simple calculations suggest that this debt revenue term is large and may be sustaining most of the public debt outstanding in developed economies. Perhaps this accounts for the lack of a debt crisis in the United States and most other advanced economies in spite of debt/GDP ratios that are broaching record highs.

[8]This argument is an extended version of the famous Friedman (1969) rule for the supply of currency, which held that the optimal quantity of money should be so that the level of price deflation in the economy would cause the nominal interest rate to be zero and the seignorage to be nil.

Economists around the world are debating the path of deficits and debt. For example, US economists are discussing how quickly to pay for the pandemic debt; European Union economists are considering what rules might be useful for restricting national government deficits and debt; and economists who study emerging and low-income economies are debating whether a sovereign debt crisis is on the horizon. For all of these debates, and many others, considering the debt revenue term promises to be useful.

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References

Abbas, S. Ali, Alex Pienkowski, and Kenneth Rogoff. 2020. *Sovereign Debt: A Guide for Economists and Practitioners*. Oxford: Oxford University Press.

Alesina, Alberto, Carlo Favero, and Francesco Giavazzi. 2019. *Austerity: When it Works and When it Doesn't*. Princeton, NJ: Princeton University Press.

Angeletos, George-Marios, Fabrice Collard, and Harris Dellas. 2016. "Public Debt as Private Liquidity: Optimal Policy." CEPR Working Paper 15488.

Barro, Robert J. 2020. "R minus G." NBER Working Paper 28002.

Bassetto, Marco, and Wei Cui. 2018. "The Fiscal Theory of the Price Level in a World of Low Interest Rates." *Journal of Economic Dynamics and Control* 89: 5–22.

Bassetto, Marco, and Wei Cui. 2021. "A Ramsey Theory of Financial Distortions." IFS Working Paper W21/05.

Bayer, Christian, Benjamin Born, and Ralph Luetticke. 2020. "The Liquidity Channel of Fiscal Policy." CEPR Discussion Paper 14883.

Berentsen, Aleksander, and Christopher Waller. 2018. "Liquidity Premiums on Government Debt and the Fiscal Theory of the Price Level." *Journal of Economic Dynamics and Control* 89 (C): 173–82.

Blanchard, Olivier. 2019. "Public Debt and Low Interest Rates." *American Economic Review* 109 (4): 1197–1229.

Bohn, Henning. 1998. "The Behavior of US Public Debt and Deficits." *Quarterly Journal of Economics* 113 (3): 949–63.

Bonam, Dennis. 2021. "A Convenient Truth: The Convenience Yield, Low Interest Rates and Implications for Fiscal Policy." De Nederlandsche Bank Working Paper 700.

Brunnermeier, Markus K., Sebastian A. Merkel, and Yuliy Sannikov. 2022. "Debt as a Safe Asset." NBER Working Paper 29626.

Bureau of Economic Analysis. 1901–2020. "Table 2.7. Investment in Private Fixed Assets, Equipment, Structures, and Intellectual Property Products by Type." United States Department of Commerce. https://apps.bea.gov/iTable/iTable.cfm?reqid=10&step=3&isuri=1&table_list=51&series=q&first_year=2013&allyears=1&tabledisplay=&scale=-99&last_year=2020 (accessed September 6, 2022).

Bureau of Economic Analysis. 1901–2020. "Table 2.7. Investment in Private Fixed Assets, Equipment, Structures, and Intellectual Property Products by Type." United States Department of Commerce. https://apps.bea.gov/iTable/iTable.cfm?reqid=10&step=3&isuri=1&table_list=51&series=q&first_year=2013&allyears=1&tabledisplay=&scale=-99&last_year=2020 (accessed September 6, 2022).

Bureau of Economic Analysis. 1925-2020a. "Table 6.1. Current-Cost Net Stock of Private Fixed Assets by Industry Group and Legal Form of Organization." United States Department of Commerce. https://apps.bea.gov/iTable/iTable.cfm?reqid=10&step=3&isuri=1&table_list=41&series=q&first_year=2013&allyears=1&tabledisplay=&scale=-99&last_year=2020 (accessed September 6, 2022).

Bureau of Economic Analysis. 1925–2020b. "Table 6.2. Chain-type Quantity Indexes for Net Stock of Private Fixed Assets by Industry Group and Legal Form of Organization." United States Department of Commerce. https://apps.bea.gov/iTable/iTable.cfm?reqid=10&step=3&isuri=1&table_list=48&series=q&first_year=2013&allyears=1&tabledisplay=&scale=-99&last_year=2020 (accessed September 6, 2022).

Bureau of Economic Analysis. 1925–2020c. "Table 1.1. Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods." United States Department of Commerce. https://apps.bea.gov/iTable/iTable.cfm?reqid=10&step=3&isuri=1&table_list=16&series=q&first_year=2013&allyears=1&tabledisplay=&scale=-99&last_year=2020 (accessed May 31, 2022).

Bureau of Economic Analysis. 1925–2020d. "Table 1.3. Current-Cost Depreciation of Fixed Assets and Consumer Durable Goods." United States Department of Commerce. https://apps.bea.gov/iTable/iTable.cfm?reqid=10&step=3&isuri=1&table_list=86&series=q&first_year=2013&allyears=1&tabledisplay=&scale=-99&last_year=2020 (accessed June 15, 2022).

Bureau of Economic Analysis. 1929–2020a. "Table 1.10. Gross Domestic Income by Type of Income." United States Department of Commerce. https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=3&isuri=1&select_all_years=1&nipa_table_list=51&series=a&first_year=2020&last_year=2021&scale=-9&categories=survey&thetable= (accessed September 6, 2022).

Bureau of Economic Analysis. 1929–2020b. "Table 1.1.4. Price Indexes for Gross Domestic Product." United States Department of Commerce. https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=3&isuri=1&select_all_years=1&nipa_table_list=4&series=a&first_year=2020&last_year=2021&scale=-99&categories=survey&thetable= (accessed September 6, 2022).

Calvo, Guillermo A. 1988. "Servicing the Public Debt: The Role of Expectations." *American Economic Review* 78 (4): 647–61.

Calvo, Guillermo A., and Andrés Velasco. 2022. "Joined at the Hip: Monetary and Fiscal Policy in a Liquidity-Dependent World." NBER Working Paper 29865.

Cochrane, John H. 2021. "r<g." Unpublished.

Corrado, Carol, Jonathan Haskel, Cecilia Jona-Lasinio, Massimiliano Iommi. 2016. "Intangible Investment in the EU and US before and since the Great Recession and Its Contribution to Productivity Growth" In Investment and Investment Finance in Europe, 73–102. Luxembourg: European Investment Bank.

D'Erasmo, Pablo, Enrique Mendoza, and Jiang Zhang. 2016. "What is a Sustainable Public Debt?" In *Handbook of Macroeconomics*, Vol. 2, edited by J. B. Taylor and Harald Uhlig, 2493–2597. Amsterdam: Elsevier.

Eichengreen, Barry, Asmaa El-Ganainy, Rui Esteves, and Kris J. Mitchener. 2021. *In Defense of Public Debt*, Oxford: Oxford University Press.

Elenev, Vadim, Tim Landvoigt, Patrick J. Schultz, and Stijn Van Nieuwerburgh. 2021. "Can Monetary Policy Create Fiscal Capacity?" NBER Working Paper 29129.

FRED. 1960–2020a. "ICE Data Indices: Bank of America Merrill Lynch US Corp BBB Total Return Index." Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/BAMLCC0A4BBBTRIV (accessed September 7, 2022).

FRED. 1960–2020b. "ICE Data Indices: Bank of America Merrill Lynch US Corp AAA Total Return Index." Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/BAMLCC0A1AAATRIV (accessed September 7, 2022).

FRED. 1962–2020a. "Market Yield on U.S. Treasury Securities at 1-Year Constant Maturity, Quoted on an Investment Basis (DGS1)." St. Louis: Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/DGS1 (accessed December 13, 2021).

FRED. 1962–2020b. "Market Yield on U.S. Treasury Securities at 5-Year Constant Maturity, Quoted on an Investment Basis (DGS5)." Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/DGS5 (accessed December 13, 2021).

FRED. 1970–2020. "Wilshire 5000 Total Market Full Cap Index (WILL5000INDFC)." Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/WILL5000INDFC (accessed September 9, 2022).

FRED. 1986–2020. "ICE Benchmark Administration: 12-Month London Interbank Offered Rate." Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/USD12MD156N (accessed December 13, 2021).

Friedman, Milton. 1969. *The Optimal Quantity of Money and Other Essays.* New York, NY" Routledge.

Gale, William G. 2019. "Fiscal Policy with High Debt and Low Interest Rates." In *Maintaining the Strength of American Capitalism*, edited by Melissa S. Kearney and Amy Ganz, 78–115. Washington, DC: Aspen Institute Economic Strategy Group.

Gersbach, Hans, Jean-Charles Rochet, and Ernst-Ludwig von Thadden. 2022. "Public Debt and the Balance Sheet of the Private Sector." CEPR Discussion Paper 17529.

Global Financial Data. 1871–2020. "S&P 500 Total Return Index." S&P Dow Jones Indices. (accessed September 7, 2022)

Gorton, Gary, and Guillermo Ordoñez. 2022. "The Supply and Demand for Safe Assets." *Journal of Monetary Economics* 125: 132–47.

Hilscher, Jens, Alon Raviv, and Ricardo Reis. 2022. "Inflating Away the Public Debt? An Empirical Assessment." *Review of Financial Studies* 35 (3): 1553–95.

IMF. 2021a. *Fiscal Monitor: October 2021.* Washington, DC*:* International Monetary Fund.

IMF. 2021b. "World Economic Outlook Database: October 2021." World Economic and Financial Surveys. https://www.imf.org/en/Publications/WEO/weo-database/2021/October/download-entire-database (accessed December 13, 2021).

INTAN-Invest. 1977–2017. "Unpublished Update to Corrado and Hulten (2010) for INTAN-Invest and the SPINTAN project." http://www.intaninvest.net/charts-and-tables/ (accessed June 16, 2022).

Jiang, Zhengyang, Arvind Krishnamurthy, and Hanno Lustig. 2020. "Dollar Safety and the Global Financial Cycle." NBER Working Paper 27682.

Jiang, Zhengyang, Hanno Lustig, Stijn Van Nieuwerburgh, and Mindy Z. Xiaolan. 2019. "The US Public Debt Valuation Puzzle." CEPR Discussion Paper 16082.

Jiang, Zhengyang, Hanno Lustig, Stijn Van Nieuwerburgh, and Mindy Z. Xiaolan. 2020. "Manufacturing Risk-Free Government Debt." CEPR Discussion Paper 16304.

Jiang, Zhengyang, Hanno Lustig, Stijn Van Nieuwerburgh, and Mindy Z. Xiaolan. 2021. "Bond Convenience Yields in the Eurozone Currency Union." Unpublished.

Jiang, Wei, Thomas J. Sargent, Neng Wang, and Jinqiang Yang. 2022. "A p Theory of Government Debt and Taxes." NBER Working Paper 29931.

Jorda, Oscar, Katharina Knoll, Dmitry Kuvshinov, Moritz Schularick, Alan M. Taylor. 2019. "Replication Data for: The Rate of Return on Everything, 1870–2015." Harvard Dataverse. https://doi.org/10.7910/DVN/GGDQGJ.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen. 2012. "The Aggregate Demand for Treasury Debt" *Journal of Political Economy* 120 (2): 233–67.

Mehrotra, Neil R., and Dmitriy Sergeyev. 2021. "Debt Sustainability in a Low Interest Rate World." *Journal of Monetary Economics* 124: S1–18.

Mian, Atif, Ludwig Straub, and Amir Sufi. 2022. "A Goldilocks Theory of Fiscal Policy." NBER Working Paper 29707.

Miao, Jianjun, and Dongling Su. 2021. "Fiscal and Monetary Policy Interactions in a Model with Low Interest Rates." Unpublished.

Müller, Andreas, Kjetil Storesletten, and Fabrizio Zilibotti. 2019. "Sovereign Debt and Structural Reforms." *American Economic Review* 109 (12): 4220–59.

Olijslagers, Stan, Sweder Van Wijnbergen, and Nander de Vette. 2020. "Debt Sustainability when $r - g < 0$: no Free Lunch After All." CEPR Discussion Paper 15478.

Ramsey, Frank. 1928. "A Mathematical Theory of Saving." *The Economic Journal* 38 (152): 543–59.

Reis, Ricardo. 2021. "The Constraint on Public Debt when $r < g$ but $g < m$." CEPR Discussion Paper 15950.

Reis, Ricardo. 2022a. "Replication data for: Debt Revenue and the Sustainability of Public Debt." American Economic Association [publisher], Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/E180241V1.

Reis, Ricardo. 2022b. "Which r-star, Government Bonds or Private Investment? Measurement and Policy Implications." Unpublished.

Schmid, Lukas, Yang Liu, and Amir Yaron. 2021. "The Risks of Safe Assets." CEPR Discussion Paper 16407.

Sims, Christopher. 2020. "Optimal Fiscal and Monetary Policy with Distorting Taxes." Unpublished.

Willems, Tim, and Jeromin Zettelmeyer. 2022. "Sovereign Debt Sustainability and Central Bank Credibility." *Annual Review of Financial Economics* 14.

Yared, Pierre. 2019. "Rising Government Debt: Causes and Solutions for a Decades-Old Trend." *Journal of Economic Perspectives* 33 (2): 115–40.