Exorbitant Privilege Gained and Lost: Fiscal Implications*

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Abstract

We study three centuries of U.K., U.S. and Dutch fiscal history. When a country is the dominant safe asset supplier, it can issue more debt than what is justified by its future primary surpluses, even after accounting for seigniorage revenue from convenience yields on the debt. This pattern holds for the Dutch Republic in the 17th and 18th, the U.K. in the 18th and 19th, and the U.S. in the 20th and 21st centuries. When the Dutch Republic's and the U.K.'s fiscal fundamentals deteriorated, they lost their dominant position as the safe asset supplier. After losing their exorbitant privilege, their debt was fully backed by primary surpluses. We conclude that exorbitant privilege derives from the ability to issue overpriced government debt in the early stage, followed by bondholder losses and financial repression in the later stage.

Key words: bond pricing, fiscal policy, term structure, convenience yield, exorbitant privilege

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1 Introduction

The international monetary system has been characterized by a hegemon configuration in which a single dominant country issues most of the world's safe assets. These safe assets, mostly government debt, tend to be more expensive than the debt issued by other countries, reflecting a high demand from domestic and international investors alike. The U.S. has been in this position since World War II. French finance minister Valéry Giscard d'Estaing labeled this position an *exorbitant privilege*. In this paper, we broaden the perspective by studying the world's safe asset suppliers over the past three centuries. Before the U.S., the U.K. was the safe asset issuer in part of 18th and the 19th centuries, and before that, the Dutch Republic in the 17th and part of the 18th century. By comparing the market valuation of government debt to the fiscal backing of the global hegemon, we obtain a new measure of the exorbitant privilege and document how it evolves over time. Our main finding is that the world's safe asset provider borrows more than justified by its fiscal backing. In contrast, the historical evidence shows that before or after a country occupies that privileged position, its debt remains below the fiscal backing; the country must live within its means. When the country loses its privilege, bondholders suffer large losses and governments resort to financial repression.

We start our analysis in the 18th and the 19th century. London was the world's financial center and U.K. government debt played a central role in securities markets. Around 1815, the U.K.'s national debt accounted for more than half of the world's traded securities (Odlyzko, 2016). Prior to WW-I, the U.K. also found itself at the center of the global trade network, and the pound was the world's reserve currency. The U.K. government had a monopoly as the world's safe asset supplier. Its government debt/GDP ratio approached 175% in the first half of the 19th century.

Was all of the U.K. government debt backed by future fiscal resources, i.e., primary surpluses? To answer this question, we measure the fiscal backing as the present discounted value of future primary surpluses using the approach developed by Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2024a), henceforth JLVX (2024a). This approach measures the expected present value of primary surpluses using a VAR system with macroeconomic and financial state variables and uses the returns to private investment as the discount rate. To accommodate potential regime shifts in the data generating processes when countries gained and lost their exorbitant privilege, we estimate fiscal backing separately in the pre- and post-war subsamples. Our estimate suggests that only about three-quarters of U.K. government debt was backed by future primary surpluses in the two centuries before WW-I.

Safe asset demand typically lowers the equilibrium yields on reserve assets below yields on otherwise comparable bonds (Krishnamurthy and Vissing-Jorgensen, 2012). Indeed, U.K. government debt traded at yields below those of other countries also on the gold standard. The U.K.

earned a "convenience yield" of around 1% per year on its government debt prior to WW-I. We augment our measure of the U.K.'s fiscal backing to account for the seigniorage revenue earned from this convenience yield. We find that the revenue boost is not large enough to close the gap between the market value of government debt and its fiscal backing. Our conclusion that excess fiscal capacity is allocated to the global hegemon remains unchanged.

The late 18th and 19th century fiscal experience of the U.S. was quite different. The first Secretary of the U.S. Treasury, Alexander Hamilton, was frustrated by the U.K.'s ability to tap the bond markets at lower interest rates (Hall, Payne, Sargent, and Szőke, 2022). Throughout the 19th century, U.S. yields were higher than in the U.K., even though the U.K. had issued more debt relative to its output than the U.S.[1] The yields converged only towards the end of the 19th century. Consistent with the U.S.' peripheral position in the international monetary system back then, our estimates show that the U.S. government borrowing did not exceed its fiscal backing before WW-II. The U.S. was borrowing well within its means.

We next shift our attention to the 20th and 21st century. The U.K. abandoned the gold standard at the start of WW-I, then briefly returned to it in 1925, only to permanently abandon it in 1931. Between the end of WW-I and the end of WW-II, the dollar became the new global reserve currency in the Bretton-Woods international financial architecture.[2] The U.S. took over the baton from the U.K. as the hegemon in the international financial system.

Reflecting the reversal of fortunes, we find that the U.S. government debt consistently exceeded its fiscal backing after WW-II when the U.S. became the global safe asset supplier. In fact, the gap between the market value of debt and fiscal backing is much larger for post-war U.S. than for pre-war U.K. According to our estimates, less than one-third of post-WW-II U.S. government debt was backed by future surpluses, with much of this gap attributable to the sharp rise in its government debt over the past two decades. In sharp contrast, after the U.K. lost its position at the center of global finance, the U.K.'s debt has been more than fully backed by our estimate of fiscal surpluses, even though the U.K. stopped earning convenience yields. Bond market investors returned to relying on fiscal fundamentals when assessing the U.K.'s fiscal capacity after WW-II.

Finally, we go further back in history to the 17th and the early 18th century when the Dutch Republic was the most financially advanced nation. The Dutch florin was the dominant currency (Quinn and Roberds, 2014). Its provincial governments were borrowing at lower rates than the Spanish, French and English crowns (Schultz and Weingast, 2003), because they had a monopoly as the safe asset supplier to the emerging upper class of wealthy Dutch investors. We find that the

[1] To address this issue, Hamilton set out to buy back U.S. foreign debt owed to France, Spain, and Holland, in order to build a reputation for debt repayment.

[2] Eichengreen and Flandreau (2009) and Chitu, Eichengreen, and Mehl (2014) discuss the exact timing of when the dollar took over the sterling as the leading reserve currency.

Dutch 17th and 18th century experience mirrors that of the U.K. in the 19th century. The province of Holland was able to borrow more than 200% of GDP in the 18th century, which is significantly higher than our measure of its fiscal backing. After 1814, when the U.K. took over as the dominant player in the international monetary system, the Dutch lost their exorbitant privilege. In this new regime, the market value of Dutch debt became fully backed by its future surpluses.[3]

This historical evidence might prove relevant for the U.S. in the 21st century. Being the world's safe asset supplier allows countries to increase debt issuance beyond what their fiscal capacity would allow, as investors are less concerned about rollover risk. However, this privileged position does not last forever and may be at risk when fiscal fundamentals deteriorate. After the U.K. pushed its debt/GDP ratio above 130% at the end of WW-II,[4] and the province of Holland's debt exceeded 200% of GDP at the end of the 18th century, they lost their status as the hegemon at the center of the international monetary system. These shifts were accompanied by very low realized returns for their bondholders. Dutch bondholders suffered large losses in the early 19th century. During and after WW-I, the U.K.'s bondholders suffered a decline in the real value of their government bonds of 61% between 1913 and 1920. This experience raises the possibility that the U.S. might cede its current hegemony in the international financial system at some point, especially if its debt continues to rise as it has in the last twenty years.[5] The CBO currently projects an increase in U.S. debt held by the public from 97% of GDP in 2023 to 166% of GDP by 2054. By then, China may stand ready to take over the baton (Clayton, Dos Santos, Maggiori, and Schreger, 2022; Coppola, Krishnamurthy, and Xu, 2023).

Based on the empirical evidence, we conclude that the debt issued by the world's safe asset supplier may be persistently overpriced relative to its fiscal backing, even after accounting for the seigniorage revenue the safe asset supplier earns from convenience yields. Thus, part of the exorbitant privilege may reside in the ability to issue overpriced securities, until the markets tap a new global safe asset supplier. When that happens, bondholders lose and governments typically resort to financial repression.

We start by considering a model without mis-pricing. If the government's inter-temporal budget constraint holds and the dynamics of the economy and asset prices are specified correctly, then the wedge between the market value of debt and the fiscal backing reflects a violation of the

[3] The Dutch provinces were arguably the only suppliers of safe assets in the 17th and the early part of the 18th century. The Dutch case differs from the U.K. and U.S. cases in that Dutch government bonds were mostly held domestically, but bond ownership was dispersed across a large swath of the Dutch population (C't Hart, 1993). Other nations were borrowing mostly from bankers at the time. In the early 18th century, Dutch investors started to invest in English government bonds, a practice that gained importance in the second half of the 18th century (see de Vries and van der Woude, 1997b, pp.141-142.).

[4] This number is 250% of GDP when non-marketable debt is included.

[5] Atkeson, Heathcote, and Perri (2022) raise the possibility that the U.S. may have already exhausted its exorbitant privilege based on the deterioration in the U.S. net foreign asset position between 2007 and 2022.

transversality condition (JLVX (2024a), Collin-Dufresne, Hugonnier, and Perazzi (2023)). Models that allow government debt to serve as a device for sharing idiosyncratic risk can generate a bubble component in the value of debt, resulting in a present value of surpluses that is below the market value of debt (Bassetto and Cui, 2018; Chien and Wen, 2019; Angeletos, Collard, and Dellas, 2023; Brunnermeier, Merkel, and Sannikov, 2024; Reis, 2021). A few observations give us pause about the TVC violation explanation.

First, the key finding of our paper is that only countries with exorbitant privilege experience this violation of the intertemporal government budget constraint, while the constraint is satisfied for non-hegemonic countries in the data. A violation of TVC suggests that bondholders are content to hold a portion of the government bond that is never backed because they assume that the government will always be able to issue new debt to sustain this unbacked portion. This requires that bondholders believe the government will perpetually retain its exorbitant privilege. However, neither the Dutch Republic nor the U.K. managed to maintain this status indefinitely. The holders of their debt were forced to bear large losses when the privilege was lost. It may prove difficult to write down a model that generates violations of the TVC in which investors rationally anticipate large losses when the exorbitant privilege regime ends.

Second, in the theories that generate TVC violations by appealing to the role of government debt as a risk-sharing device, seigniorage revenue would be larger in less financially developed countries with fewer insurance opportunities. However, in the data, it is typically the most financially developed economy that is awarded the hegemon status.

Third, in standard asset pricing models with long-lived investors, long-lived assets and realistic equity risk premium pricing implications, the TVC holds for a claim to GDP. If debt is cointegrated with GDP, the TVC also holds for debt (Jiang, Lustig, Van Nieuwerburgh, and Xiaolan, 2020).

Absent a TVC violation, the findings leave open two alternative interpretations. The first one is model misspecification. We estimate an upper bound on the present value of future surpluses whose measurement is less prone to misspecification concerns. Our VAR specification for the economy's dynamics delivers reasonably small forecast errors, and the VAR is robust to alternative specifications. Most importantly, our upper bound estimate of fiscal capacity is above the observed debt value when a country does benefit from exorbitant privilege, suggesting that our model works well in normal times for countries without exorbitant privilege. We also develop a steady-state measure of fiscal backing that does not depend on the VAR dynamics. That said, we cannot definitively rule out model misspecification.

The second possibility is that investors overprice the debt issued by the hegemon, and this is our preferred interpretation. Bond investors, who normally would lower their valuation of the government's debt when its fiscal fundamentals deteriorate, subjectively perceive the debt of the hegemon to be invariably safe, resulting in debt overvaluation. Empirical evidence for the overvaluation explanation comes from poor ex-post returns following an exogenous shock that leads investors to question their belief in the exorbitant privilege status. An example of one such shock is WW-I which results in a large increase in the U.K.'s primary deficits, and signaled the beginning of the end of its exorbitant privilege. During and in the aftermath of WW-I, the realized return on marketable U.K. government debt was -61% in real terms.[6] Explaining such a large negative return in a standard Full Information Rational Expectations model would require wars to be designated as low marginal utility growth (good) states of the world. More plausibly, government debt is risky in that it suffers from low returns in high marginal utility growth states such as wars. In a rational model, this implies a positive risk premium, raising the cost of government debt. The absence of such a risk premium for the global hegemon is a signature of mispricing. Similarly, we find that investors in Dutch bonds suffered even larger real losses at the end of the 18th and the start of the 19th century.

U.S. Treasurys are expensive relative to other assets post WW-II. Prior work has pointed out that Treasurys often are overpriced relative to Agency bonds (Longstaff, 2004), corporate bonds (Bai and Collin-Dufresne, 2019), TIPS (Fleckenstein, Longstaff, and Lustig, 2014), and other sovereign bonds (Du, Im, and Schreger, 2018; Jiang, Krishnamurthy, and Lustig, 2021). Hall, Payne, Sargent, and Szőke (2022) show that 19th century U.K. consols were expensive relative to similar U.S. instruments. We also find evidence that U.K. yields were persistently lower than foreign yields during the gold standard regime before the start of WW-I. Our contribution is to compare the valuation of Dutch, U.K., and U.S. government bonds, not to other bonds and securities, but to the underlying collateral, the stream of primary surpluses. We find that U.K. (Dutch) debt was expensive relative to the underlying collateral in the 19th (18th) century, even after accounting for convenience yields. The same is true to an even greater extent for U.S. debt after WW-II. Put differently, U.K. (Dutch) bond yields were too low before WW-I (the late 18th century), and U.S. yields were too low after WW-II.

Our findings shed light on the wide gap between the market value of debt and fiscal capacity that has been documented for the U.S. in recent decades by JLVX (2024a). Reis (2022) calls this wedge the debt revenue term; we call it excess fiscal capacity. The measurement in JLVX (2024a) is focused on the post-war US. Our paper compares the historical experience of the Dutch Republic, the U.K. and the U.S. The historical evidence helps to discriminate between different models of fiscal capacity. Candidate models must explain why investors coordinate on a single global safe asset provider, why that borrower enjoys excess fiscal capacity, and why that excess capacity

[6] In addition, the U.K. defaulted on intergovernmental loans from the U.S. and it restructured a war bond, all examples of financial repression.

disappears once the country loses is status as the global hegemon. Theories of safe asset determination (Gorton and Ordoñez, 2022; He, Krishnamurthy, and Milbradt, 2019), whose driving force is investor demand for informationally-insensitive assets, point to the role of relative macro fundamentals. In coordinating on a single safe asset, there is strategic complementarity for investors' payoffs. The investment of an additional investor reduces rollover risk (Cole and Kehoe, 2000), and renders the debt safer for all other investors. If the relative fundamentals improve, that may increase the country's ability to borrow at low rates, because of this coordination aspect, even if the absolute fiscal fundamentals measured by the PDV of surpluses do not warrant this. The imputed seigniorage revenue computed from the convenience yield, as traditionally measured, may not fully capture this safe asset effect. Consistent with these theories, our findings provide evidence that the valuation of the debt issued by the safe supplier is not sufficiently sensitive to information about its own absolute macro-fundamentals. These theories point to changes in relative fiscal fundamentals, maybe driven by fiscal crises or wars, as the causes of a switch in the identity of the safe asset provider. They show an intricate feedback mechanism between relative fiscal fundamentals and the presence or loss of exorbitant privilege.

In recent work, Halac and Yared (2024) provide a political-economy theory of deficit-biased governments and privately-observed fiscal shocks to generate endogenous cycles of fiscal rectitude followed by fiscal irresponsibility. Such regime switches are triggered by a large fiscal shock. Pflueger and Yared (2024) build on this theory to explain switches in exorbitant privilege.

Our work contributes to the literature on the role of the dollar as the global reserve currency (Gourinchas and Rey, 2007; Caballero, Farhi, and Gourinchas, 2008; Caballero and Krishnamurthy, 2009; Maggiori, 2017; He, Krishnamurthy, and Milbradt, 2019; Gopinath and Stein, 2020; Krishnamurthy and Lustig, 2019; Coppola, Krishnamurthy, and Xu, 2023, among others) by exploring the fiscal implications of safe asset supplier status.

If the hegemon is indeed able to temporarily issue overpriced securities, then unfunded spending increases may not lead to higher inflation, even in a regime of fiscal dominance (Leeper, 1991; Jacobson, Leeper, and Preston, 2023). The extra source of government revenue may change the nature of the interaction between monetary and fiscal authorities.

Finally, we connect to a large literature in financial history. The nature of institutions played a key role in allowing the Dutch Republic and the British Crown to out-borrow rival powers and establish military dominance (North and Weingast, 1989; Sargent and Velde, 1995; Schultz and Weingast, 2003): the decentralized nature of fiscal decision making in the Dutch Republic and the constitutional limits on the power of the monarch in the U.K. as well as Parliament's authority over the budget. The French and Spanish monarchies had fewer of these limits and their credit history was marred by defaults (Drelichman and Voth, 2016). Our evidence suggests that these institutions may even have allowed the Dutch Republic and the U.K. to overborrow in their role as safe asset suppliers. Our quantitative findings are consistent with the accounts of economic historians (see van Riel, 2021, for an analysis of the 19th-century Dutch fiscal experience). Our paper is closely related to work on the U.K.'s exorbitant privilege by Meissner and Taylor (2006); van Hombeeck (2020) who also study the 1870–1914 period. We are focused on the fiscal implications of the exorbitant privilege. Golez and Koudijs (2018) also study four centuries of financial market data in the Netherlands, U.K., and U.S. but they focus on stock return predictability.

The paper is organized as follows. We start by discussing the data for the U.K. and the U.S. in section 2. Then, we discuss how we measure the fiscal backing in section 3. We report our steady-state fiscal backing results for the U.S. and the U.K. in section 4. These headline results do not depend on a model for the joint dynamics of the state variables. Then, we report our VAR-based, dynamic fiscal backing results for the U.S. and the U.K. in section 5. Finally, section 6 applies the same approach to analyze the case of Holland and the Netherlands.

2 The Historical Cash Flow Dynamics: Stylized Facts

2.1 Data and Fiscal Cash Flows

For the U.K., we use annual data from 1729 to 2020. The main U.K. dataset we used is *A Millennium of Macroeconomics Data* published by the Bank of England, which contains a broad set of historical macroeconomic and financial market data. Our historical (1793–1929) U.S. government finance data were taken from Hall and Sargent (2021), which contain detailed historical government finance information. We use other datasets to complement the main dataset, as detailed in Appendix A.

Over the course of three centuries, the U.K. has been running positive primary surpluses of 1.41% of the GDP. Table 1 reports summary statistics for the U.K. and U.S. central government's government spending excluding debt service, tax revenues, and the primary surplus, all expressed as fractions of GDP. In the pre-WW-I sample, reported in the top panel, the average U.K. primary surplus is 2.4% of GDP. Throughout the 19th century, the U.K. government was much larger than the U.S. government, as measured by spending and taxation as a percent of GDP that are about three times higher in the U.K. The U.S. surpluses are much smaller than the U.K.'s. Before WW-I, the U.S. realized a small primary surplus of 0.5%. The moments for the pre-WW-II period are reported in the middle panel of Table 1. In this sample, the average primary surplus of the U.K. government is 1.3% of GDP while that of the U.S. government is -0.1% of GDP. After WW-II, the U.K. continues to run large primary surpluses of 1.8% of GDP, while the U.S. runs even smaller primary surpluses of 0.1% of GDP (bottom panel).

Table 1: Summary Statistics of Government Finance

	mean	std	min	25%	50%	75%	max
			Pre 1914 Sample				
			Panel A: U.K.				
τ	9.0	2.7	5.8	7.0	7.9	9.9	17.6
g	6.6	3.3	3.0	4.3	5.3	7.8	18.3
$\tau - g$	2.4	3.0	-9.3	1.1	2.5	4.0	8.7
			Panel B: U.S.				
τ	2.4	1.0	0.5	1.7	2.2	2.8	6.1
g	2.0	1.5	0.6	1.4	1.7	2.1	12.2
$\tau - g$	0.5	1.7	-8.9	0.1	0.5	1.4	3.3
			Pre 1946 Sample				
			Panel A: U.K.				
τ	10.8	5.5	5.8	7.1	8.5	12.7	35.2
g	9.5	10.5	3.0	4.5	5.8	10.5	57.3
$\tau - g$	1.3	7.6	-41.8	0.7	2.7	4.9	9.7
			Panel B: U.S.				
τ	3.4	3.0	0.5	1.9	2.5	3.5	19.0
g	3.4	4.9	0.6	1.5	1.9	2.4	30.5
$\tau - g$	-0.1	2.8	-16.1	-0.2	0.4	1.4	3.3
			1947 – 2020 Sample				
			Panel A: U.K.				
τ	32.3	2.0	28.2	30.8	32.7	33.7	36.4
g	30.6	4.6	23.7	26.9	30.3	34.0	46.3
$\tau - g$	1.8	3.9	-10.6	-0.4	1.8	4.7	10.4
			Panel B: U.S.				
τ	17.6	1.1	13.9	16.9	17.6	18.4	20.2
g	17.5	2.4	13.0	15.9	17.4	18.4	30.1
$\tau - g$	0.1	2.6	-12.4	-1.0	0.3	1.4	4.8

Note: The table reports summary statistics for the ratio of government spending to GDP (g) and the ratio of tax revenue to GDP (τ) for the U.K. central government and the U.S. federal government. The spending (g) is before interest payments. The surplus is the primary surplus ($\tau - g$). For the U.S., the full sample is from 1793 to 2020. For the U.K., the full sample is from 1729 to 2020. All values are in percentage points.

Panel A of Figure 1 plots the ratios of government spending, tax revenues, and the primary surplus to GDP over time. The shaded areas indicate wars and large macroeconomic crises. The U.K. runs primary surpluses throughout the 19th century except during wars. Tax revenue increases in wars, but not as much as spending. Hall and Sargent (2022) refer to this as Gallatin-Barro tax smoothing, consistent with normative analysis in Barro (1979); Aiyagari, Marcet, Sargent, and Seppälä (2002).[7] The two largest primary deficits occurred during WW-I (average of -33.7% of GDP from 1914 to 1918) and WW-II (average of -21.9% of GDP from 1939 to 1945) as a direct result of the U.K. entering these wars on the European continent. Appendix Figure E.1 plots the same data against recession episodes, showing that spending/GDP, tax/GDP and surplus/GDP ratios are largely acyclical before WW-I.

We obtain the market value of the U.K. public debt data using the data constructed by Ellison and Scott (2020), which contains the quantity and market price of every individual bond issued by the U.K. government starting in 1694. We compute the market value by matching each bond's ID for market price and quantity data, and summing across all individual bonds. The Ellison-Scott dataset includes only marketable debt, which is the concept we focus on. We also obtain the market value of the public debt (marketable plus non-marketable) from the *A Millennium of Macroeconomics Data*. Figure 2 plots the evolution of the market value of the public debt scaled by the U.K. GDP over time. Between 1914 and 1980, the gap between the marketable debt and the total public debt portfolio consists of the sizable international government loans initiated during WW-I and WW-II, mainly loans extended by the U.S. to the U.K. The market value of debt/GDP peaks at the end of WW-II. The figure also shows a large increase in the outstanding debt starting in 2008. The debt/GDP ratio exceeds 100% at the end of 2020. Below, in our main analysis, we will only use marketable debt.

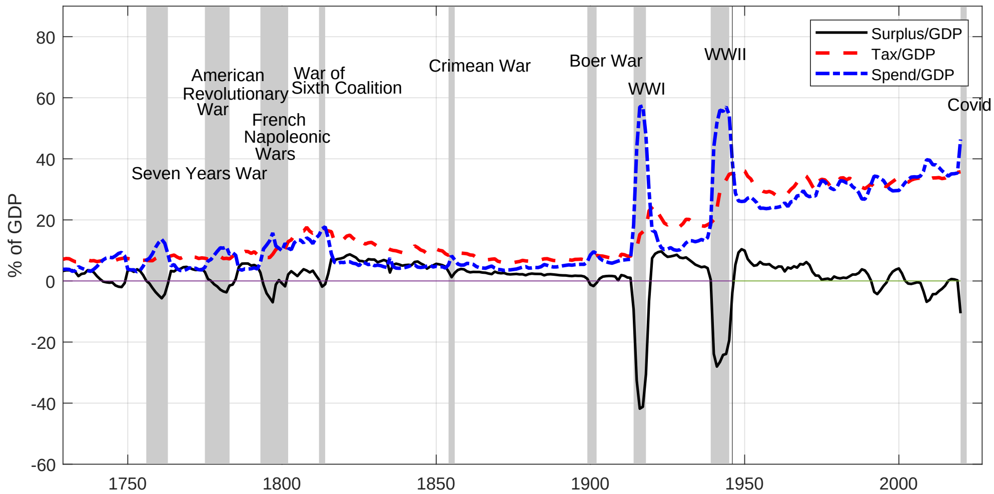
During the interbellum, late-stage exorbitant privilege, the U.K. government resorted to financial repression. The U.K. restructured the 5% War Loan (The Third Great War Loan) in 1932. The U.K. abandoned the gold standard at the start WW-I, then briefly returned to it in 1925, only to permanently abandon it in 1931. The U.K. notified the U.S. in 1934 that it would defer payments on all of its WW-I loans from the U.S. (Ellison, Sargent, and Scott, 2019).

The real returns on U.K. government debt were exceptionally low during and after the world wars. If an investor had invested one pound at the end of 1913 in the portfolio of Gilts, they would have ended up with 0.39 pounds in real terms in 1920, because of inflation and rising yields. Similarly, if an investor had invested one pound in at the end of 1939, they would have

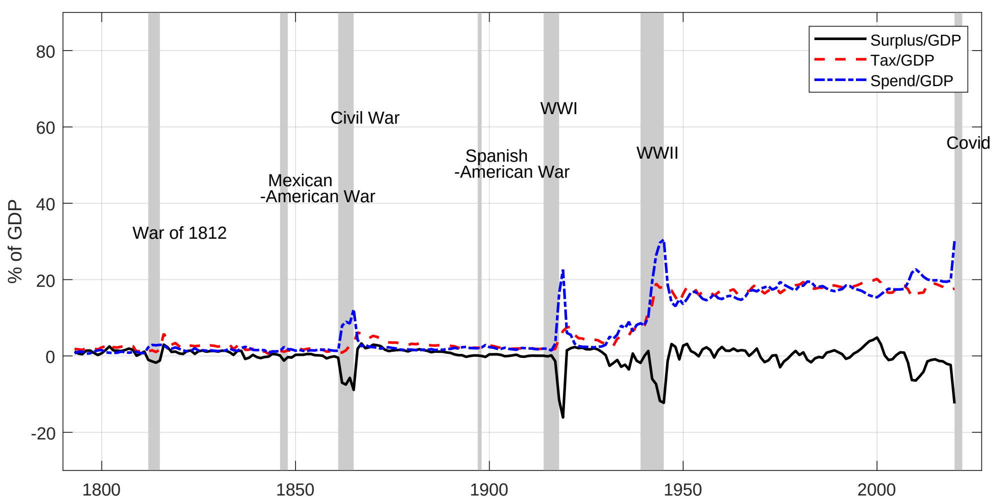
[7] Albert Gallatin's (1807) Annual Report recommended that during a war, tax rates should be set to "provide a revenue at least equal to the annual expenses on a peace establishment, the interest on the existing debt, and the interest on the loans which may be raised... losses and privations caused by war should not be aggravated by taxes beyond what is strictly necessary."

Figure 1: Fiscal Cash Flows over Time

Panel A: United Kingdom 1729 – 2020



Panel B: United States 1793 – 2020



The figure shows the ratio of government spending, tax revenues, and primary surpluses to GDP for the United Kingdom from 1729 to 2020 (Panel A) and the United States from 1973 to 2020 (Panel B). The primary surpluses are the government revenue minus government spending before interest payments. The shaded areas are major wars and macro-economic crises. For the U.K., those are the Seven Years' war in 1756–1763, the American Revolutionary War 1775–1783, the French Napoleonic Wars in 1793–1802, the War of the Sixth Coalition 1812–1814, the Crimean War in 1853–1856, the Boer War in 1899–1092, World War I in 1914–1918, World War II in 1939–1945, the U.K. Pound Sterling crisis in 1992, and the Covid-19 Pandemic in 2020. For the U.S., those are the War of 1812, the Mexican-American War, the Civil War, the Spanish-American War, World War I, World War II, and the Covid-19 Pandemic.

had 0.27 pounds in 1979 in real terms (Appendix E.3).

Our paper is focused on the U.K. central government's balance sheet. There might be untapped fiscal capacity in the dominions and colonies. The dominions, mainly Australia and New Zealand, had high debt/GDP ratios in the run-up to WW-I. When we consolidate the balance sheets of the U.K. with those of its dominions and colonies, the ratio of marketable debt/GDP for the Commonwealth looks similar to that of the U.K. We return to this discussion in Section 5.8 with details in Appendix F.

2.2 Convenience Yields

The U.K. was the world's safe asset supplier in the 19th century, allowing it to harvest seigniorage revenue on the sales of its bonds. We infer U.K. convenience yields from violations of covered interest rate parity (CIP) in sovereign bond markets driven by safe asset demand, following Du, Im, and Schreger (2018); Jiang, Krishnamurthy, and Lustig (2021). During the era of the gold standard, violations of CIP can be measured as government bond yield differentials, provided that the commitment to the gold standard is perceived to be credible and that there is no default risk.[8]

We measure the government bond yield difference between the U.K. and a set of 15 advanced economies on the gold standard: the U.S., Austria, Belgium, France, Germany, Netherlands, Japan, Italy, Denmark, Finland, Norway, Portugal, Spain, Sweden, Switzerland. We use a short-term and a long-term interest rate series from J̀ordà-Schularick-Taylor Macrohistory database (Jordà, Knoll, Kuvshinov, Schularick, and Taylor, 2019). The short rates are measured as T-bill rates or equivalent money-market rates. We use bonds with a maturity of 10 years to measure the long rates. In each year, we keep the countries in the comparison set only if they are on the gold standard. For the period from 1873 until 1914 and from 1925 until 1931, the gold standard was the basis for the international monetary system. In 1914 the U.K. abandoned the gold standard until 1925, so we do not use interest rates for this period.

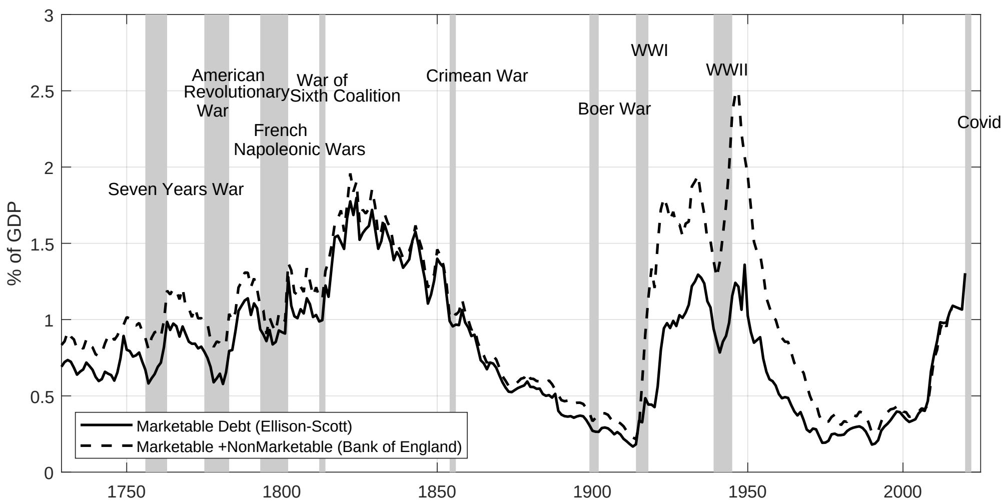
Figure 3 plots the interest rate differentials with the U.K. Using long bonds, the average convenience yield for the 1873–1914 period is 1.10%. Using short-term bonds, it is 1.46%. During 1925–1931, the sample average is 0.55% for the long-term and 0.70% for the short-term measure. After 1950, the average yield difference between the other advanced economies and the U.K. is -0.68% for the long-term and -0.49% for the short-term measure. Hence, there is no longer any evidence of the U.K. earning convenience yields after WW-II.

Our calculations reveal only approximate CIP violations because the bonds in various coun-

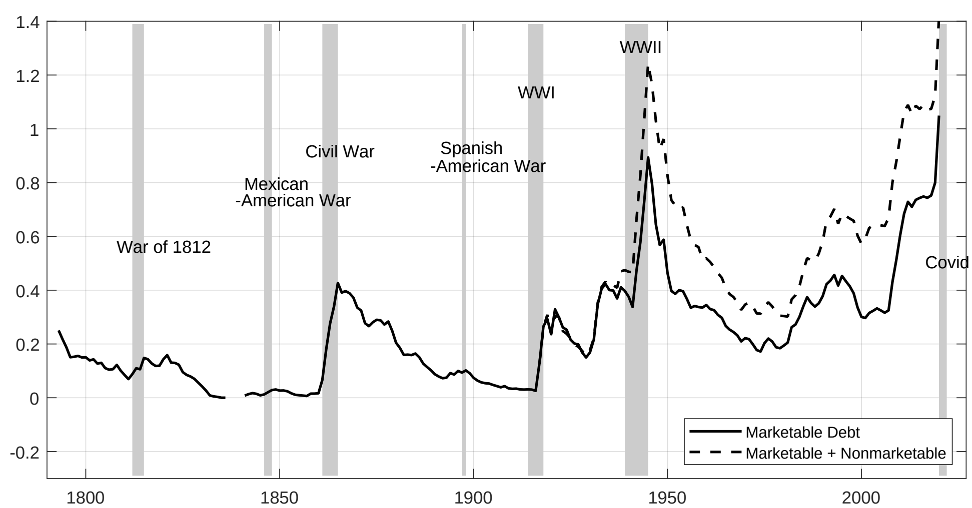
[8] Du, Tepper, and Verdelhan (2018) document that these CIP deviations are more persistent than CIP deviations measured in money markets, and that they predate the Global Financial Crisis.

Figure 2: The Market Value of Outstanding Debt to GDP

Panel A: U.K.



Panel B: U.S.



Panel A plots the ratio of the nominal market value of outstanding government debt divided by nominal GDP for the U.K. The UK GDP data is from *A Millennium of Macroeconomics Data* published by the Bank of England. We used two sources for the UK gilt data. The solid line is from the micro data constructed by Ellison and Scott (2020), for which we aggregate each gilt's market value computed by multiplying market price and quantity. The dashed line is from the series reported by *A Millennium of Macroeconomics Data*. Panel B plots the ratio of the nominal market value of outstanding government debt divided by nominal GDP for the U.S. We obtain the marketable and nonmarketable debt data from Hall, Payne, and Sargent (2018). The nominal GDP data is from Global Financial Database.

tries are not exactly maturity-matched. Hall, Payne, Sargent, and Szőke (2022) carefully compare the yields on U.S. and U.K. consols during the 19th century. They find even larger interest rate differentials, but they attribute part of these to larger perceived default risk on U.S. bonds. Our measures of CIP deviations are larger at the short end of the maturity spectrum. This maturity structure is less consistent with default risk, and more consistent with convenience yields as the main driver of these persistent interest rate differences. If non-U.K. default risk was driving these differences, we would expect to see an upward sloping term structure of the CIP deviations. To be clear, we cannot definitively rule out residual currency risk that differs across countries nor can we definitively rule out default risk. There were no derivatives traded in that era, and, hence, we cannot hedge out these risks. But, overall, the evidence is most consistent with convenience yields.

Figure 3: U.K. Long-term and Short-term Convenience Yields

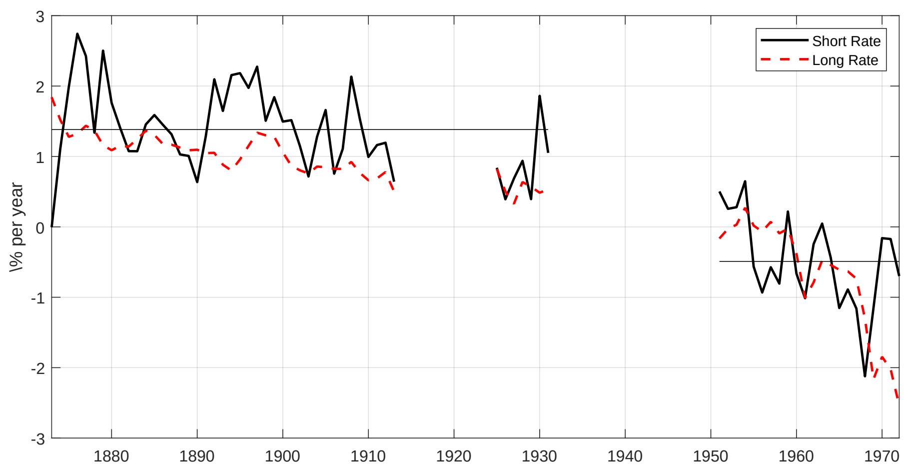


Figure plots interest rate differences with the U.K. constructed using the long rates and the short rates. We obtain the rate differences between U.K. and a set of advanced economies on the gold standard: the U.S., Austria, Belgium, France, Germany, the Netherlands, Japan, Italy, Denmark, Finland, Norway, Portugal, Spain, Sweden, Switzerland. For a given year, we keep the countries in the comparison set only if they are on the gold standard. The convenience yield is the cross-sectional average of the rate differences. Data Source: Jordà-Schularick-Taylor Macrohistory database.

In the pre-WW-II sample, the U.K. government bond portfolio consists of mostly long-term bonds (with an average maturity of 94 years), indicating the government bond portfolio carries long-term convenience yields. Based on the above calculations for 1873–1914 and 1925–1931, the sample average of long-term convenience yields for the U.K. is 99 basis points per annum.

We then compute seigniorage revenue as a share of GDP as the product of the convenience yield and the debt-to-GDP ratio. From 1873 to 1914, the average seigniorage revenue in the data is

0.45% of GDP. We assume that the average seigniorage/GDP ratio for the period 1795–1872 is the same as the 1873–1914 average. From 1925 to 1931, the average seigniorage revenue in the data is 0.56% of GDP. We assume that the average seigniorage/GDP ratio for the periods 1914–1924 and 1932–1946 are the same as the 1925–1931 average. For the earliest period from 1729 until 1794, we assign zero seigniorage revenue to U.K. government bonds since for the much of 18th century, the Dutch Republic was the strongest economy and was able to borrow at lower rates than the U.K. government.[9] Under these assumptions, the sample average seigniorage revenue earned by the U.K. government is 0.33% of U.K. GDP over 1729 to 1946. This is the number we use below in our computations of U.K. fiscal backing before WW-II.

Figure 4 plots the convenience yields for the United States post-WW-II. Given the switch to floating exchange rates after the demise of Bretton-Woods, we cannot simply use interest rate differences to measure convenience yields.[10] To proxy for the U.S. convenience yield, we follow the approach in JLVX (2024a). We first construct the interest rate spread between a risk-free benchmark, which is the 3-month CD rate from 1964 and the 3-month banker's acceptance rate before 1964, and the 3-month U.S. Treasury yield. Figure 4 plots this spread. The average convenience yield is 0.36% per year over the period 1947—2020.

3 Measuring Fiscal Backing

Armed with these estimates of the seigniorage revenue, we evaluate the fiscal backing of the U.K. and the U.S. governments. We follow the approach developed by JLVX (2024a) in evaluating the U.K.'s intertemporal government budget constraint.

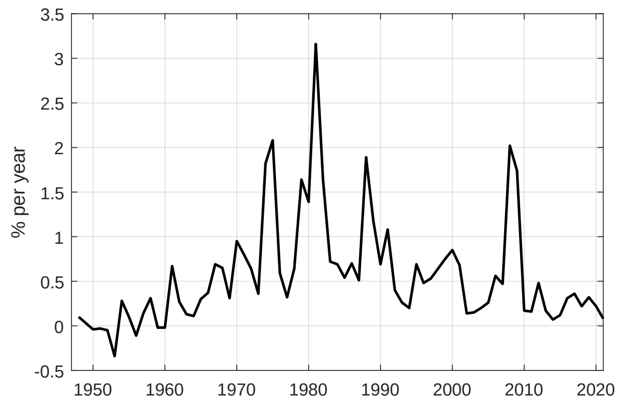
3.1 Fiscal Backing Without Convenience Yields

Let G_t denote nominal government spending before interest expenses on the debt, T_t denote nominal government tax revenue, and $S_t = T_t - G_t$ denote the nominal primary surplus. Let $P_t^{\$}(h)$ denote the price at time t of a nominal zero-coupon bond that pays \$1 at time $t+h$, where h is the maturity. There exists a multi-period stochastic discount factor (SDF) $M_{t,t+h}^{\$} = \prod_{k=0}^{h} M_{t+k}^{\$}$ is the product of the adjacent one-period SDFs, $M_{t+k}^{\$}$. By no arbitrage, bond prices satisfy $P_t^{\$}(h) = \mathbb{E}_t\left[M_{t,t+h}^{\$}\right] = \mathbb{E}_t\left[M_{t+1}^{\$} P_{t+1}^{\$}(h-1)\right]$. By convention $P_t^{\$}(0) = M_{t,t}^{\$} = M_t^{\$} = 1$ and $M_{t,t+1}^{\$} = M_{t+1}^{\$}$. The government bond portfolio is stripped into zero-coupon bond positions $Q_{t,h}^{\$}$, where $Q_{t,h}^{\$}$ denotes the outstanding face value at time t of the government bond payments due at time $t+h$.

[9]For a detailed discussion, see Section 6 below. Our results are robust to assigning a non-zero seigniorage revenue to the U.K. for the sample from 1729 to 1794.

[10]The average interest rate differential between the U.S. and other major economies under the gold standard (from 1945 to 1971) is 58 bps per annum for the short-term interest rate. This is slightly higher than the average 36 basis points per annum convenience yield computed using our main proxy (1947–2020).

Figure 4: U.S. Convenience Yields



This figure plots the convenience yields for the U.S.from 1947 to 2020. To estimate the convenience yields, we first construct the spread cy_t between the 3-month Treasury yield and a risk-free benchmark, which is the 3-month CD rate from 1964 and the 3-month banker's acceptance rate before 1964. We assume that bills earns 100% of cy_t, 1-year bonds earn 90% of cy_t, and 10-year bonds earn 50% of cy_t and 10-yr beyond earns zero cy_t. The following plot reports the overall convenience yields weighted by maturity structure of the bond portfolio. The maturity structure is estimated from the CRSP monthly Treasury database.

$Q^{\$}_{t-1,1}$ is the total amount of debt payments that is due today. The outstanding debt reflects all past bond issuance decisions, i.e., all past primary deficits. Let D_t denote the market value of the outstanding government debt portfolio. As shown in JLVX (2024a), the market value of the outstanding government bond portfolio equals the present risk-adjusted discounted value of current and future primary surpluses:

$$D_t \equiv \sum_{h=0}^{H} P_t^{\$}(h) Q^{\$}_{t-1,h+1} = \mathbb{E}_t \left[\sum_{j=0}^{\infty} M^{\$}_{t,t+j} (T_{t+j} - G_{t+j}) \right] \equiv P_t^T - P_t^G, \tag{1}$$

where the cum-dividend value of the tax claim and value of the spending claim are defined as:

$$P_t^T = \mathbb{E}_t \left[\sum_{j=0}^{\infty} M^{\$}_{t,t+j} T_{t+j} \right], \quad P_t^G = \mathbb{E}_t \left[\sum_{j=0}^{\infty} M^{\$}_{t,t+j} G_{t+j} \right].$$

Equation (1) defines fiscal backing for a country that does not earn convenience yields.

Equation (1) relies only on the existence of a SDF, i.e., the absence of arbitrage opportunities, not on the uniqueness of the SDF, i.e., complete markets. It imposes a transversality condition (TVC) that rules out a rational government debt bubble: $\mathbb{E}_t \left[M_{t,t+T} D_{t+T} \right] \to 0$ as $T \to \infty$. Most of the models generating violations of the TVC (i) abstract from aggregate risk premia which would be priced into the terminal value and are likely to enforce the TVC (Jiang, Lustig, Van

Nieuwerburgh, and Xiaolan (2020),Wijnbergen, Olijslagers, and Vette (2020); Barro (2023)), and (ii) rely on the absence of long-term investors when pricing long-lived assets.

3.2 Campbell-Shiller Decomposition for Tax and Spending Claims

Consider the holding period return on the tax claim T and the spending claim G:

$$\begin{aligned} R^T_{t+1} &= \frac{P^T_{t+1} + T_{t+1}}{P^T_t} = \frac{\frac{T_{t+1}}{T_t}(1 + PD^T_{t+1})}{PD^T_t}, \\ R^G_{t+1} &= \frac{P^G_{t+1} + G_{t+1}}{P^G_t} = \frac{\frac{G_{t+1}}{G_t}(1 + PD^G_{t+1})}{PD^G_t}. \end{aligned}$$

Let r^i_t denote the log holding period return $\log(R^i_t)$ and pd^i_t denotes the log price-dividend ratio for $i = \{T, G\}$, the tax claim and the spending claim, respectively:

$$pd^T_t = \log P^T_t - \log T_t = \log\left(\frac{P^T_t}{T_t}\right); \qquad pd^G_t = \log P^G_t - \log G_t = \log\left(\frac{P^G_t}{G_t}\right),$$

where the price is measured at the end of the period and the cash flow is over the same period. When we log-linearize the return equation around the mean log price/dividend ratio, iterate forward, take expectations, and impose a TVC, we obtain the following expressions for the log price/dividend ratios of the tax claim and the spending claim:

$$pd^T_t = \frac{\kappa^T_0}{1-\rho_T} + \mathbb{E}_t\left[\sum_{j=1}^{\infty} \rho_T^{j-1} \Delta \log T_{t+j}\right] - \mathbb{E}_t\left[\sum_{j=1}^{\infty} \rho_T^{j-1} r^T_{t+j}\right], \tag{2}$$

$$pd^G_t = \frac{\kappa^G_0}{1-\rho_G} + \mathbb{E}_t\left[\sum_{j=1}^{\infty} \rho_G^{j-1} \Delta \log G_{t+j}\right] - \mathbb{E}_t\left[\sum_{j=1}^{\infty} \rho_G^{j-1} r^G_{t+j}\right], \tag{3}$$

where the linearization coefficients depend on the mean of the log price/dividend ratio pd^i_0:

$$\rho_i = \frac{e^{pd^i_0}}{e^{pd^i_0}+1} < 1, \quad \kappa^i_0 = \log(1 + \exp(pd^i_0)) - \rho_i pd^i_0, \quad i = \{T, G\}. \tag{4}$$

Restating the fiscal backing equation (1), the discounted present value of primary surpluses PV^S_t scaled by GDP Y_t is given by a weighted average of the valuations ratios for the tax and spending claims:

$$\frac{D_t}{Y_t} = \frac{PV^S_t}{Y_t} = \frac{P^T_t}{Y_t} - \frac{P^G_t}{Y_t} = \tau_t \exp(pd^T_t) - g_t \exp(pd^G_t), \tag{5}$$

where $\tau_t = T_t/Y_t$ and $g_t = G_t/Y_t$ denote the tax/GDP and spending/GDP ratios. Below, we estimate the fiscal backing given in (5) using the expressions of the price/dividend ratios (2) and (3). This requires measuring expectations of both the cash flows $\{\Delta \log T_{t+j}, \Delta \log G_{t+j}\}$ and the returns $\left\{r^T_{t+j}, r^G_{t+j}\right\}$.

3.3 Fiscal Backing With Convenience Yields

As discussed above, U.K. government bonds carried convenience yields before the U.K. abandoned the gold standard. As a result, the U.K. government can sell its government bonds at a higher price than other issuers, and the convenience yield produces an additional source of seigniorage revenue. The convenience yield, $\lambda_t \geq 0$, is the expected return that investors are willing to forgo under the risk-neutral measure. Assuming a uniform convenience yield across the maturity spectrum, the Euler equation for a Treasury bond with maturity $h+1$ is:

$$\exp(-\lambda_t) = \mathbb{E}_t \left[M_{t+1} \frac{P^{\$}_{t+1}(h)}{P^{\$}_t(h+1)} \right].$$

If the TVC holds, the value of the government debt portfolio equals the value of future surpluses plus the value of future seigniorage revenue:

$$D_t = \mathbb{E}_t \left[\sum_{j=0}^{\infty} M^{\$}_{t,t+j} \left(T_{t+j} - G_{t+j} + (1 - e^{-\lambda_{t+j}}) \sum_{h=1}^{H} Q^{\$}_{t+j,h} P^{\$}_{t+j}(h) \right) \right], \tag{6}$$

where D_t on the left-hand side denotes the cum-dividend value of the government's debt portfolio at the start of period t, and $\sum_{h=1}^{H} Q^{\$}_{t+j,h} P^{\$}_{t+j}(h)$ on the right-hand side denotes the ex-dividend value of the government's debt portfolio at the end of period $t+j$. Equation (6) defines fiscal capacity in the presence of convenience yields. If the quantity of current and future outstanding government debt is positive, then a positive convenience yield acts as an additional source of revenue, akin to seigniorage revenue, and expands the government's fiscal capacity.

Let $K_{t+j} = (1 - e^{-\lambda_{t+j}}) \sum_{h=1}^{H} Q^{\$}_{t+j,h} P^{\$}_{t+j}(h)$ denote the seigniorage revenue in period $t+j$, and $k_t = K_t/Y_t$ denote the seigniorage/GDP ratio. Let pd^K_t denote the log price-dividend ratio on the claim to the seigniorage revenue. Then, fiscal capacity with convenience yields can be written with an additional term which reflects the value of the seigniorage revenue stream from convenience:

$$\frac{D_t}{Y_t} = \frac{P^T_t}{Y_t} + \frac{P^K_t}{Y_t} - \frac{P^G_t}{Y_t} = \tau_t \exp(pd^T_t) + k_t \exp(pd^K_t) - g_t \exp(pd^G_t). \tag{7}$$

3.4 Fiscal Backing With Mispricing

When assessing fiscal capacity, we will plug the seigniorage revenue computed from our empirical measure of the convenience yields (in section 2.2) into (6). However, in general, if one does not tie one's hands to measured convenience yields, the implied λ_t process that enforces the equality in equation (6) can be interpreted as a measure of overpricing of bonds issued by the government. We will argue that there is evidence of overpricing of bonds issued by the hegemon over and above what is predicted by conventional measures of the convenience yield. In that sense, our results will imply that λ's well in excess of the measured convenience yields are needed to rationalize the market value of debt.

4 Results: Steady-State Analysis of Fiscal Backing

Our first set of results derive and implement a steady-state measure of fiscal backing. This exercise only requires long-run averages without committing to a model for the dynamics. In the next section, we allow for richer assumptions on the dynamics of the economy to obtain a time-varying measure of fiscal capacity.

4.1 Discount Rates and Valuation Ratios

We use rp_0^i for $i = \{T, G, Y\}$ to denote the steady-state risk premium on the tax claim, spending claim, and GDP claim relative to a long-term bond yield:

$$\mathbb{E}[r_{t+1}^i] = y_0^\$(1) + yspr_0^\$ + rp_0^i.$$

The long-term bond yield is the sum of the short-term bond yield, $y_0^\$(1)$, and the yield spread, $yspr_0^\$$, which measures the difference between the 10- and 1-year government bond yield.

We can think of the GDP claim as an unlevered claim to the stock market:

$$rp_0^Y = \mathbb{E}[r_t^Y] - (yspr_0^\$ + y_0^\$(1)) \approx \frac{1}{1+\frac{D}{E}} rp_0^M,$$

where rp_0^M is the unconditional expected return on the stock market minus the long-term bond yield, and where D/E is the debt/equity ratio of the corporate sector.

The average log price/dividend ratio on the GDP claim satisfies:

$$pd_0^Y(1-\rho_Y) - \kappa_0^Y = x_0 + \pi_0 - y_0^\$(1) - yspr_0^\$ - rp_0^Y$$

where x_0 is the unconditional mean of real GDP growth, π_0 is the unconditional mean inflation rate, and with linearization constants:

$$\rho_Y = \frac{e^{pd_0^Y}}{e^{pd_0^Y}+1}, \quad \kappa_0^Y = \log(1+\exp(pd_0^Y)) - \rho_Y pd_0^Y.$$

4.2 Steady-State Fiscal Backing Without Convenience Yields

To obtain our measure of *steady-state* fiscal capacity without convenience yields, we evaluate the expression for D_t in (1) at the unconditional mean of all variables:

$$\frac{D_0}{Y_0} = \tau_0 \exp(pd_0^T) - g_0 \exp(pd_0^G).$$

A country can run deficits in the steady-state ($\tau_0 < g_0$) and maintain non-negative debt capacity ($D_0 \geq 0$) only if $\exp(pd_0^T) > \exp(pd_0^G)$. This requires that the tax process is less risky than the spending process: $rp_0^T < rp_0^G$. JLVX (2024a) shows that this constellation of risk premia is inconsistent with the U.S. tax and spending data after WW-II. We return to this discussion in detail below.

4.3 Risk Premia on Tax and Spending Claims

To compute the steady-state fiscal capacity, we need a value for the risk premium on the tax and spending claims: rp_0^T and rp_0^G. We assume that these risk premia are equal to the GDP risk premium: $rp_0^T = rp_0^Y = rp_0^G$. This assumption implies that expected returns are equal:

$$\mathbb{E}[r_{t+1}^G] = \mathbb{E}[r_{t+1}^T] = \mathbb{E}[r_{t+1}^Y] = y_0^{\$}(1) + yspr_0^{\$} + rp_0^Y.$$

Since the unconditional growth rates of tax revenues and government spending must equal GDP growth by cointegration, it follows that $pd_0^T = pd_0^G = pd_0^Y$ and $\rho_T = \rho_G = \rho_Y$.

Why is the GDP risk premium a plausible imputation for the risk premia on tax revenue and spending claims? First, in the long run, the tax claim and spending claim are exposed to the same long-run risk as the output claim, because of co-integration with output. Hence, they should carry the same long-run risk premia. Second, in the short-run, the tax claim and spending claim are exposed to business cycle risk. We distinguish between two regimes.

The short-run consumption growth beta for government spending from 1830 to 1914 is highly negative, and much lower than tax revenue beta (as shown in Appendix B). The large negative consumption growth betas in this period are driven by the wars. Consistent with the Barro-Galatin prescription, the U.K. governments ramp up spending more than revenue when they go to war and consumption growth is low. This pattern persists in the pre-WW-II regime. In the post-WW-II regime, the tax claim is again riskier than the spending claim. In a regression of tax revenue growth on consumption growth, the slope is slightly positive (see Appendix B). In contrast, spending growth has a negative consumption growth beta due to the counter-cyclicality of government spending.

In both subsamples, given the same long-run risk but higher short-run risk for tax than for spending claims, we obtain the inequality: $rp_0^T \geq rp_0^Y \geq rp_0^G$. Assuming that $rp_0^T = rp_0^Y = rp_0^G$ results in an *upper bound* on fiscal capacity. This is because this assumption increases the value of the tax claim (by discounting it at a rate that is too low) and reduces the value of the spending claim (by discounting it at a rate that is too high), thereby increasing the value of their difference. Put differently, this is a generous bound for the underlying amount of fiscal backing.

Countries with higher GDP growth x_0 and lower real rates $y_0^{\$}(1) - \pi_0$ have higher valuation ratios pd_0^Y, i.e., higher fiscal backing per 1% point of surplus/GDP, as emphasized recently by Blanchard (2019); Furman and Summers (2020); Mehrotra and Sergeyev (2021). However, a higher term spread $yspr_0^{\$}$ and GDP risk premium lower the valuation ratio pd_0^Y, thus lowering fiscal backing. A realistic GDP risk premium affects fiscal backing in quantitatively important ways.

4.4 Quantifying the GDP Risk Premium

In financial economics, the claim to GDP is referred to as the total wealth or market portfolio (Jensen, 1972; Roll, 1977; Stambaugh, 1982; Lustig, Van Nieuwerburgh, and Verdelhan, 2013). The return on the total wealth portfolio plays a central role in the canonical asset pricing models, ranging from the Sharpe-Lintner CAPM to the version of the Breeden-Lucas-Rubenstein Consumption-CAPM with long-run risks developed by Bansal and Yaron (2004). The total wealth return is commonly proxied in the asset pricing literature by the unlevered return on the stock market. A portfolio of all publicly-listed companies broadly reflects the evolution of the overall economy. We will adopt this approach, recognizing that the stock market is a levered claim to corporate cash flows.[11] This leads us to un-lever the equity return to arrive at the total wealth return, the return on a claim to future GDP. We discuss the implementation below.

Using equity and government bond returns from Jordà-Schularick-Taylor Macrohistory database and corporate bond yields from Global Financial Data, we compute an equity premium of 5.92%, a credit risk premium of 1.74%, and a term premium of 1.24%, all three measured relative to the short-term bond yield, for the U.K. The ratio of corporate debt to equity plus corporate debt

[11] In the pre-WW-II U.S. sample, the real GDP growth volatility is 0.067 per year, which is 59% of the real corporate earnings volatility of publicly-traded firms, 0.11 per year. In the post-WW-II U.S. sample, the unlevered corporate earnings volatility is 0.028, which is close to volatility of real GDP growth of 0.026. The real corporate earnings volatility is estimated using the stock market database from Robert Shiller's website. In other words, the unlevered corporate earnings volatility is smaller (similar) than the real GDP volatility in the pre-WW-II (post-WW-II) sample, and we under-estimate (correctly assess) the risk of the GDP claim when proxying it by the unlevered equity claim.

is 0.47. As a result, the unlevered equity risk premium relative to the long-term bond yield is $2.73\% = 0.47 \times 1.74\% + (1 - 0.47) \times 5.92\% - 1.24\%$ in the 1870–2020 sample, as shown in the last column of Table 2. In the shorter post-war sample, we obtain an unlevered equity premium of 3.88% for the U.K.

The bottom panel reports the same calculation for the U.S. The leverage ratio is 0.57 in the long sample. The estimated risk premia are remarkably similar. Over the long sample, we obtain an unlevered equity premium of 2.82%. Over the short sample, our U.S. estimate is 3.04%.

Based on this evidence, and for ease of comparison across samples and between the U.K. and the U.S., we assume a 3% GDP risk premium in all subsamples. At various points, we do robustness with respect to this important parameter.

Table 2: GDP Risk Premium

	(1) Equity RP vs TBill	(2) Corporate bond RP vs TBill	(3) LT govt. bond vs TBill	(4) Unlevered equity RP vs TBill	(5) Unlevered equity RP vs LT bond
			United Kingdom		
1870–2020	5.92%	1.74%	1.24%	3.97%	2.73%
1946–2020	7.89%	2.27%	1.53%	5.42%	3.88%
			United States		
1870–2020	6.33%	1.35%	0.69%	3.51%	2.82%
1946–2020	7.56%	1.79%	1.45%	4.49%	3.04%

Table reports the equity premium relative to the Treasury Bill rate in (1), the average corporate bond yield relative to the Treasury Bill rate in (2), the term spread between the long-term and the short-term government bond yields in (3), the un-levered equity premium relative to the Treasury Bill rate in (4), and the un-levered equity premium relative to the long bond yield in (5). The equity premium and term premium are from Jordà-Schularick-Taylor's Macrohistory database. The data sources are described in section A.1.3 and A.2.3 of the separate appendix. The U.K. leverage ratio, measured as debt/(debt+equity), is 0.47 in 1870–2020 and 0.44 in 1946–2020. The U.S. leverage ratio is 0.57 in 1870–2020 and 0.53 in 1946–2020.

4.5 Steady-State Fiscal Backing With Convenience

As discussed above, U.K. bonds earned an average convenience yield λ_0 of about 1% per year pre-WW-II. We interpret this as a *narrow* convenience yield, i.e., it affects only government bonds but not other risky assets such as a claim to GDP. Hence, when we allow for a narrow convenience yield λ_0, we assume that this convenience yield raises the true risk-free rate (without convenience) by λ_0 and lowers the true risk premium on the GDP claim by the same λ_0.[12] As a result, the expected return on GDP claim is unchanged, and so is the discount rate for the revenue and spending claims.

[12] Concretely, this implies that if the expected return on the GDP claim is 3% above the government bond yield, and the government bond yield contains a 1% convenience yield, then the true GDP risk premium is 2% rather than 3%.

Seigniorage revenues are equal to the product of the convenience yield and the debt/GDP ratio. Given the average debt/GDP ratio in this period, the 0.99% convenience yield results in an average seigniorage revenue of $k_0 = 0.33\%$ of U.K. GDP. This convenience yield revenue is discounted at the same rate as tax revenue and government spending, namely by the expected return on the GDP claim. Each percentage point of additional seigniorage revenue/GDP yields an additional $\exp(pd_0^Y)$ in fiscal backing.

4.6 Results for Steady-State Fiscal Backing Before WW-II

U.K. The left panel of Table 3 reports the U.K. steady-state analysis of the fiscal backing for different samples. We start with the pre-WW-I sample in the first column. In the two centuries preceding WW-I, the average primary surplus was 2.39% of GDP. The U.K. ran large primary surpluses. The expected real return on the GDP claim is $y_0^\$(1) + yspr_0^\$ - \pi_0 + rp_0^Y = 6.31\%$. The average price/dividend ratio for the GDP claim is $\exp(pd_0^Y) = 20.78$ with a convenience yield of 0.69%. Per 1% of primary surplus, the U.K. government can borrow an extra 20.78% of GDP. The U.K.'s steady-state fiscal backing with convenience yields is given by:

$$(\tau_0 + k_0 - g_0)\exp(pd_0^Y) = (8.96 + 0.29 - 6.57)\% \times 20.78 = 55.67\%$$

The U.K.'s fiscal backing, based on the present value of future surpluses, is well below the observed debt/GDP ratio of 86.45% pre-WW-I. We focus on the market value of marketable debt issued by the U.K., excluding non-marketable debt such as intergovernmental loans. Given that marketable debt alone already exceeds fiscal capacity, our analysis is conservative.

How much additional fiscal backing does the U.K. government receive as a result of its convenience yield in the pre-WW-I sample? The fiscal backing with convenience yields of 55.67% of GDP is only modesty above that without convenience yields of 49.45% of GDP, and remains well below the average debt/GDP ratio of 86.45%.

Next, we turn to the pre-1946 sample, which includes the interbellum, reported in the second column of Table 3. The average surplus is heavily influenced by the inclusion of WW-I and WW-II. The pre-1946 sample surplus is only $10.77 - 9.49 = 1.28\%$ of GDP. After accounting for seigniorage revenue of 0.33% of U.K. GDP, the pre-WW-II steady-state fiscal backing estimate is $(10.77 - 9.49 + 0.33)\% \times 22.40 = 36.09\%$. Again, our fiscal backing estimate is well below the observed debt/GDP ratio of 87.06%.[13]

Our conclusion that the U.K. debt was not fully backed in the pre-war era is robust. The two

[13]The fiscal backing for the period that includes the 1915–1945 period is much lower that for the period that ends in 1914. Consistent with our estimate of a reduced fiscal capacity, the U.K. government restructured one of its long-term war loans in 1932, modifying the interest rate from 5% to 3.5% in order to reduce its debt service burden.

Table 3: Steady-state Analysis of Fiscal Backing

	U.K.			U.S.		
	1729 – 1914	1729 – 1946	1947 – 2020	1793 – 1914	1793 – 1946	1947 – 2020
x_0	1.58	1.52	2.26	3.93	3.88	2.95
$yspr_0$	-0.21	-0.01	0.80	-0.12	0.07	0.89
π_0	0.16	0.60	4.78	0.56	0.90	3.16
$y_0^{\$}$	3.67	3.52	5.64	4.50	4.06	4.26
κ_0^Y	0.19	0.18	0.11	0.13	0.11	0.10
ρ_Y	0.95	0.96	0.98	0.97	0.98	0.98
$\exp(pd_0^Y)$	20.78	22.40	41.21	34.18	42.03	48.99
τ_0	8.96	10.77	32.34	2.42	3.35	17.60
g_0	6.57	9.49	30.56	1.97	3.41	17.55
s_0	2.39	1.28	1.77	0.46	-0.06	0.05
λ_0	0.69	0.99	0.00	0.00	0.00	0.56
Seign.$/Y$	0.29	0.33	0.00	0.00	0.00	0.11
	Steady-state at $z = 0$					
$PV(S)/Y$	49.45	28.59	73.13	15.56	-2.42	2.66
$PV(S+CY)/Y$	55.67	36.09	73.13	15.56	-2.42	8.03
$PV(S+CY)/D$	64.40	41.45	136.58	130.64	-14.72	20.03
	Sample Averages					
D/Y	86.45	87.06	53.55	11.91	16.48	40.09
$PV(S)/Y$	55.70	58.34	85.46	17.78	21.08	7.67
$PV(S+CY)/Y$	61.32	64.93	85.46	17.78	21.08	12.80
$PV(S+CY)/D$	70.93	74.58	159.60	149.28	127.96	31.93
$\rho(PV(S+CY)/Y, D/Y)$	0.71	0.62	0.79	0.16	0.65	0.05

The top panel reports the moments of the data that are inputs into the stead-state fiscal backing estimation. The bottom two panels report estimates of fiscal backing for the U.K. and the U.S. All values are in percentage points, except for the *pd* ratio $\exp(pd_0^Y)$ and κ_0^Y. We use an unlevered equity or output risk premium rp_0^Y of 3% in all subsamples. In case of convenience yields, we use narrow convenience yields, which raise the actual risk-free rate by λ_0 and lower the output risk premium by λ_0, leaving the discount rate unchanged. D denotes the market value of marketable debt. $\exp(pd_0^Y)$ is calculated with convenience yield whenever applicable.

parameters that are hardest to pin down are the GDP risk premium rp_0^Y and the average seigniorage revenue/GDP ratio k_0. We need to decrease the GDP risk premium by half, from 3% to 1.5% per year, thereby boosting $\exp(pd_0^Y)$ to 34.39, to ensure that the average debt is fully backed by the steady-state surpluses inclusive of seigniorage revenue in the pre-WW-I period. Given a narrow convenience yield λ_0 of 0.99%, this would mean that the effective GDP risk premium (without convenience) would only be 0.51% per annum, which seems implausibly low. Alternatively, we would have to multiply the convenience yield by more than a factor of four (resulting in seigniorage revenue of 1.30% of GDP) to ensure that the debt is fully backed by surpluses.

U.S. The pre-WW-II results for the U.S. stand in sharp contrast to those for the U.K. The right panel of Table 3 reports the same analysis for the U.S. The U.S. has much lower fiscal backing than the U.K. in the first part of the sample for two reasons. First, the U.S. generates much smaller surpluses: 0.46% of GDP before WW-I and -0.06% including the interbellum. Second, the U.S. does not earn convenience yields pre-WW-II.

The U.S.' average fiscal backing estimate is 15.56% of GDP before WW-I. But because the U.S. government did not borrow much, our low estimate of the U.S. fiscal backing still exceeds the observed average debt/GDP ratio of 11.91% of GDP. In contrast to the U.K., U.S. debt is fully backed by future surpluses, i.e., by fiscal fundamentals. The pre-WW-II steady-state estimate of fiscal backing is even lower at -2.42% of GDP, due to the negative average primary surplus for the period that includes the interbellum. As we will see below, our dynamic upper bound on fiscal capacity generates a higher mean estimate for the pre-WW-II fiscal backing than the steady-state estimate. The former still exceeds the debt/GDP ratio, confirming that the U.S. was borrowing within its fiscal means before 1946.

As an aside, because the U.S. was growing at a much faster rate (real GDP growth of 3.88%) than the U.K. (1.52%), the U.S. could have boosted its fiscal backing by 42.03% per % of GDP in surpluses, compared to only 22.40% in the case of the U.K. However, the U.S. seemed unable or unwilling to generate larger average surpluses in the 19th century, despite its high growth rate.

4.7 Results for Steady-State Fiscal Backing After WW-II

U.K. The U.K. steady-state analysis for the Post-WW-II sample is shown in the third column of Table 3. We recall that the U.K. loses its convenience yield in this period.

One key difference between the pre- and the post-WW-II sample is that the expected real return on the GDP claim is 4.66%, 1.25% points lower than the 5.91% in the pre-WW-II sample. Also, the growth rate of GDP is higher for the U.K. after 1946 than before 1946. With a lower discount rate and a higher growth rate, the steady-state valuation ratio of the output claim for the post-WW-II sample increases to 41.21. A higher $\exp(pd_0^Y)$ raises the U.K.'s fiscal backing for each percentage point of surpluses/GDP. As a result, the U.K.'s fiscal backing is higher in the post-WW-II era compared to the pre-WW-II era despite lower average surpluses than in the pre-WW-I era and despite the absence of convenience yields:

$$(\tau_0 - g_0)\exp(pd_0^Y) = (32.34 - 30.56)\% \times 41.21 = 73.13\%$$

The steady state fiscal backing of 73.13% exceeds the post-war debt/GDP ratio of 53.55%. The U.K. debt is more than fully backed by the surpluses in the post-WW-II period.

U.S. Once more, the results for the U.S. stand in sharp contrast to those for the U.K. Steady-state fiscal backing with convenience yields is 8.03% of GDP. The measure without convenience yields is only 2.66% of GDP due to the minimal surpluses of 0.05% of GDP in post-WW-II U.S. data. Even the most comprehensive number with convenience yields is far below the observed average debt/GDP ratio of 40.09%. Less than 1/4 of the market value of debt is backed by future surpluses inclusive of seigniorage revenue from convenience yields.

The conclusion about the lack of fiscal backing in post-WW-II U.S. is robust. Even if we lowered the GDP risk premium from 3% to 2% (which amounts to an effective output risk premium of 1.43% once the convenience yield is accounted for), thereby increasing $\exp(pd_0^Y)$ to 95, the implied steady-state fiscal backing would still only be 15% of GDP. The conclusion of low fiscal backing is hard to avoid given that the U.S. is generating minimal surpluses after WW-II.

4.8 Riskiness of Tax and Spending Claims

By assuming that the riskiness of tax revenue and government spending claims are the same as those of the GDP claim when in fact revenues are riskier and spending safer, we obtain an upper bound on fiscal backing.[14] One proxy for the riskiness of the tax (spending) claim is the beta of tax revenue (spending) growth with respect to consumption growth. The difference between the beta of the tax and the beta of the spending process is a measure of the riskiness of the primary surplus. In Appendix B, we estimate for the U.K. that $\beta^T - \beta^G = 2.31$ in the period 1830–1946 and $\beta^T - \beta^G = 0.88$ in 1947–2020. We find the opposite pattern in the U.S., where $\beta^T - \beta^G = 0.56$ in the period 1871–1946 and $\beta^T - \beta^G = 2.78$ in 1947–2020. In other words, the riskiness of the surplus process is higher during the period of global hegemony in both the U.K. (before WW-II) and the U.S. (after WW-II). Not only can the hegemon run smaller primary surpluses on average, it can also have riskier surpluses. Since a riskier surplus process reduces our measure of fiscal backing,

[14]When the tax revenue process is risky, we have $rp_0^T > rp_0^Y$ and $pd_0^T < pd_0^Y$, so that the actual measure of fiscal backing is below the upper bound measure.

this cash-flow risk effect strengthens our main finding of excess debt capacity during the period of hegemony, obtained from working with the upper bound on fiscal backing.

5 Dynamic Analysis of Fiscal Backing

In this section, we extend the prior analysis to allow for dynamics in (i) expected tax revenue and spending growth rates, and (ii) in the expected return on the GDP claim. We continue to make our baseline assumption that the risk premia on T and G claims are constant and equal to the GDP risk premium.

5.1 VAR Model of Cash Flow Dynamics

We propose a vector auto-regression (VAR) model to capture the dynamics in expected cash flows and discount rates in the economy.

We assume that the $N \times 1$ vector of state variables $\boldsymbol{z}$ follows a Gaussian first-order VAR:

$$\boldsymbol{z}_t = \boldsymbol{\Psi} \boldsymbol{z}_{t-1} + \boldsymbol{u}_t = \Psi \boldsymbol{z}_{t-1} + \boldsymbol{\Sigma}^{\frac{1}{2}} \boldsymbol{\varepsilon}_t, \tag{8}$$

with $N \times N$ companion matrix Ψ and homoscedastic innovations $\boldsymbol{u}_t \sim i.i.d. \mathcal{N}(0, \Sigma)$. The Cholesky decomposition of the covariance matrix, $\boldsymbol{\Sigma} = \Sigma^{\frac{1}{2}} \left(\Sigma^{\frac{1}{2}}\right)'$, has non-zero elements on and below the diagonal. In this way, the shock u_t to each state variable is a linear combination of its own structural shock $\boldsymbol{\varepsilon}_t$, and the structural shocks to the state variables that precede it in the VAR, with $\boldsymbol{\varepsilon}_t \sim i.i.d. \mathcal{N}(0, I)$. Table 4 summarizes the variables we include in the state vector, in order of appearance of the VAR. The vector $\boldsymbol{z}$ contains the state variables demeaned by their respective sample averages.

Table 4: State Variables

Position	Variable	Mean	Description
1	π_t	π_0	Log Inflation
2	$y_t^{\$}(1)$	$y_0^{\$}(1)$	Log 1-Year Nominal Yield
3	$yspr_t^{\$}$	$yspr_0^{\$}$	Log 10-Year Minus Log 1-Year Nominal Yield Spread
4	x_t	x_0	Log Real GDP Growth
5	$\Delta \log d_t$	μ_d	Log Real Stock Dividend Growth
6	pd_t^m	pd_0^m	Log Stock Price-to-Dividend Ratio
7	$\Delta \log \tau_t$	μ_τ	Log Tax Revenue-to-GDP Growth
8	$\log \tau_t$	$\log \tau_0$	Log Tax Revenue-to-GDP Level
9	$\Delta \log g_t$	μ_g	Log Spending-to-GDP Growth
10	$\log g_t$	$\log g_0$	Log Spending-to-GDP Level

To capture the government's cash flows, the VAR includes $\Delta \log \tau_t$ and $\Delta \log g_t$, the log change in tax revenue-to-GDP and the log change in government spending-to-GDP in its seventh and ninth rows. It also includes the log level of revenue-to-GDP, τ_t, and spending-to-GDP, g_t, in its eighth and tenth rows. First, this fiscal cash flow structure allows spending and revenue growth to depend not only on the own lag, but also on a rich set of macroeconomic and financial variables. Lagged inflation, GDP growth, interest rates, the slope of the term structure, the stock price-dividend ratio, and the dividend growth rate all predict future revenue and spending growth. Innovations in the fiscal variables are correlated with innovations in these macro-finance variables.

Second, it is crucial to include the level variables τ_t and g_t. When there is a positive shock to spending, spending tends to revert back to its long-run trend with GDP. Similarly, after a negative shock to tax revenue, future revenues tend to increase back to their long-run level relative to GDP. This mean reversion captures the presence of automatic stabilizers and of corrective fiscal action, as pointed out by Bohn (1998). Put differently, without inclusion of τ_t and g_t, all shocks to spending and tax revenues are permanent rather than mean-reverting.[15] As a result, in the long run, claims to taxes, spending and GDP all earn the same risk premium because they are exposed to the same long-run risk.

In the baseline specification, we do not include the log debt/GDP ratio in the state vector. Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2024b) show that the U.S. debt/GDP ratio has no predictive ability for surpluses or debt returns. We include the debt/GDP ratio for the U.K. in a robustness exercise discussed in Section 5.7.

5.2 Tax and Spending Growth Forecasts

In Appendix C.1, we evaluate the forecasting performance of the VAR model. Overall, predictive accuracy of the VAR is similar to that of the best linear forecast at the five- and ten-year horizons. This evidence leads us to conclude that the VAR implies reasonable behavior of long-run fiscal cash flows.

[15] Formally, the inclusion of the levels of spending and tax revenue relative to GDP in the VAR is motivated by a cointegration analysis; the system becomes a vector error correction model. We perform Johansen cointegration tests, and both the trace test and the max eigenvalue test support two cointegration relationships, one between log tax revenue and log GDP and one between log spending and log GDP. The coefficient estimates of the cointegration relationships tend to vary across sample periods. As a result, we take an a priori stance that the tax-to-GDP ratio $\log \tau$ and the spending-to-GDP ratio $\log g$ are stationary. That is, we assume cointegration coefficients of $(1, -1)$ for both relationships.

5.3 Discount Rates and Valuation Ratios

Given the VAR dynamics and our assumption that the GDP risk premium is constant, the expected return on the tax and spending claim at a future date $t+j$ is given by:

$$\mathbb{E}_t[r^i_{t+j+1}] = y^{\$}_0(1) + yspr^{\$}_0 + rp^i_0 + (\boldsymbol{e}_y + \boldsymbol{e}_{yspr})'\boldsymbol{\Psi}^j \boldsymbol{z}_t, \quad i \in \{T, G\},$$

where $\boldsymbol{e}_k$ to denote a column vector of zero with a 1 as the k-th element. The dynamics in the expected nominal return on the tax and spending claims are driven by the dynamics in the nominal short rate and in the slope of the term structure.

The discount rate (DR) terms in equations (2) and (3) for the valuation ratios of the tax and spending claims are defined by:

$$DR^i_t = \mathbb{E}_t\left[\sum_{j=1}^{\infty} \rho_i^{j-1} r^i_{t+j}\right] = \frac{y^{\$}_0(1) + yspr^{\$}_0 + rp^i_0}{1-\rho_i} + (\boldsymbol{e}_y + \boldsymbol{e}_{yspr})'(I - \rho_i \boldsymbol{\Psi})^{-1}\boldsymbol{z}_t, \quad i \in \{T, G\}$$

The cash flow (CF) terms in equations (2) and (3) are easily computed from the VAR:

$$CF^i_t = \mathbb{E}_t\left[\sum_{j=1}^{\infty} \rho_i^{j-1} \Delta \log CF^i_{t+j}\right] = \frac{x_0 + \pi_0}{1-\rho_i} + (\boldsymbol{e}_\pi + \boldsymbol{e}_x + \boldsymbol{e}_i)'\boldsymbol{\Psi}(I - \rho_i \boldsymbol{\Psi})^{-1}\boldsymbol{z}_t, \quad i \in \{T, G\}$$

We use $\widetilde{CF}^i_t$ and $\widetilde{DR}^i_t$ to denote the time-varying components of the cash-flow and discount rate expressions CF^i_t and DR^i_t above. With discount rates and valuation ratios from the VAR in hand, and our assumption $rp^T_0 = rp^G_0 = rp^Y_0$, we can compute the valuation ratios in equations (2) and (3). See Appendix D for the derivation.

5.4 Dynamic Measure of Fiscal Backing

Fiscal capacity without convenience yields in equation (1) as:

$$PV^S_t = \tau_t \exp(pd^T_0 + \widetilde{CF}^T_t - \widetilde{DR}^T_t) - g_t \exp(pd^G_0 + \widetilde{CF}^G_t - \widetilde{DR}^G_t), \tag{9}$$

where the mean log price dividend ratios $pd^T_0 = pd^G_0 = pd^Y_0$ as before. The fiscal backing measure with convenience yields adds the present value of seigniorage revenues. We continue to measure seigniorage revenues based on the product between the debt quantity and the convenience yield level according to equation (6), and now discount the revenue stream using the time-varying expected return on the GDP claim.

5.5 Results for Dynamic Fiscal Backing Before WW-II

U.K. Panel A of Figure 5 plots the dynamic fiscal capacity estimate for the U.K. in the pre-1946 era in red. This estimate includes the seigniorage revenue from convenience yields. This dynamic fiscal capacity reflects the time-varying expected tax revenue and government spending growth rates as well as time-varying discount rates arising from long-term interest rate dynamics. The grey shaded areas indicate one- (dark) and two-standard error (light) bands obtained by bootstrap.

Whenever the U.K. goes to war, the fiscal capacity estimate actually increases because the VAR correctly forecasts larger surpluses following a period of war deficits. Our fiscal capacity estimates correctly see through these short-lived deficits. So do bond market investors. The correlation between our measure of fiscal capacity and the debt/GDP ratio is 0.62 before 1946. This high correlation is not a mechanical result since the debt/GDP ratio is not in the VAR.

Between 1730 and 1830, our dynamic estimate of fiscal capacity gradually increases from 50 to 80% of U.K. GDP. Until 1870, the observed market value of debt-to-GDP ratio (blue line) exceeds the fiscal capacity estimate. The debt is not fully backed by our estimate of future surpluses and seigniorage revenue. The wedge between the debt and our fiscal backing estimate increases to 50% of GDP after the Napoleonic wars. However, starting in 1870, fiscal capacity tracks the actual U.K. debt/GDP ratio more closely.

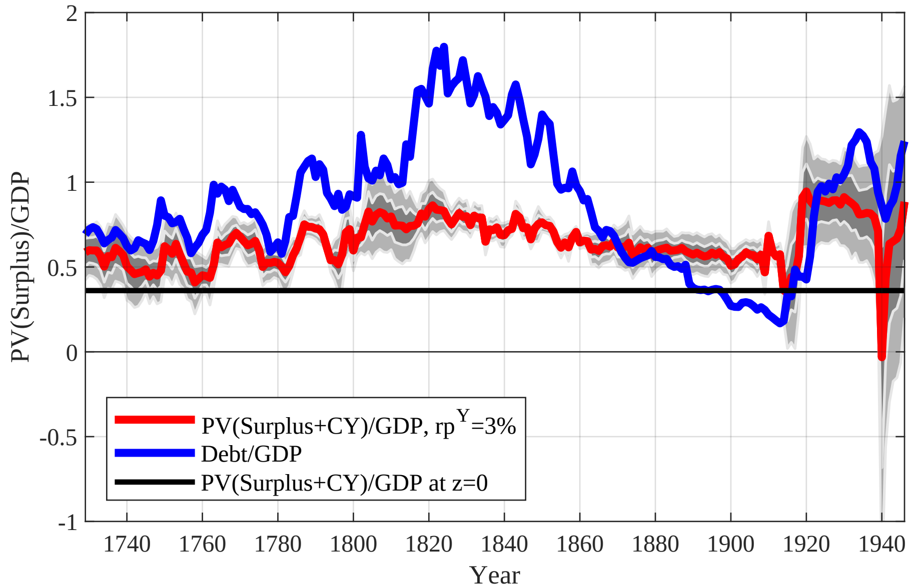
As shown in the bottom panel of Table 3, the average fiscal capacity including seigniorage in the pre-1914 period is 61.32%. This number is close to the steady-state fiscal capacity estimate from the previous section and well below the observed debt/GDP ratio. On average, only 70.93% of U.K. debt was backed by future surpluses and convenience yields before WW-I, according to our dynamic estimates. For the pre-1946 sample, the average dynamic fiscal capacity is 64.93%. This estimate is quite a bit higher than the corresponding steady-steady fiscal capacity estimate of 36.09%. This large difference arises because the dynamic estimate from the VAR reflects the mean reversion in surpluses after the wartime deficits, while the steady-state measure does not. However, the fiscal backing estimate remains well below the observed debt/GDP ratio for this sample as well.[16]

U.S. The dynamic fiscal capacity estimates confirm that the U.S. experience was quite different from the U.K.'s before WW-II. Panel B of Figure 5 plots the dynamics of the fiscal capacity for the U.S. in red with standard error bands. In the pre-1946 sample, the correlation between our measure of fiscal capacity and the U.S. debt/GDP ratio is 0.65. Before 1930, the fiscal capacity stays

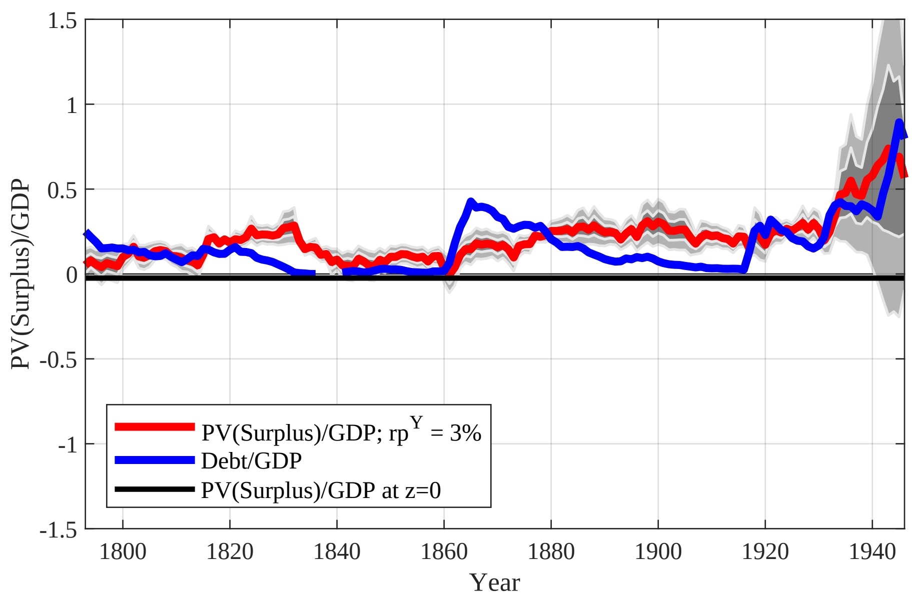
[16] As a robustness check, we also estimate the fiscal capacity for the sample that starts after the Industrial Revolution. The latter began in U.K. around 1760 and greatly improved productivity. Higher economic growth leads to a larger fiscal backing, all else equal. Our estimates for this sample show that the fiscal backing is on average 70.50% of GDP (Appendix E.5). Since fiscal backing remains below the average outstanding debt of 89.76% of GDP for this period, our conclusion is robust.

Figure 5: Fiscal Capacity: Pre-WW-II

Panel A: U.K. 1729 – 1946



Panel B: U.S. 1793 – 1946



The top panel plots the dynamic measure of fiscal capacity for the U.K. government over the sample period from 1729 to 1946 (red line), the steady-state fiscal capacity measure (horizontal black line), and the actual debt/GDP ratio (blue line), based on the market value of marketable debt. The fiscal capacity measure for the U.K. assumes a GDP risk premium of 3% and includes the seigniorage revenue from convenience yields. The two-standard-error confidence interval around the dynamic fiscal capacity estimate is generated by bootstrapping 10,000 samples. The bottom panel plots the dynamic fiscal capacity for the U.S. government over the sample period from 1793 to 1946; it too assumes a GDP risk premium of 3%.

below 50% of GDP. Unlike for the U.K., the U.S. fiscal capacity estimate remains above the actual debt/GDP ratio throughout the pre-1946 sample, except for three brief periods at the inception of the U.S., around the Civil War, and just before WW-II. When the U.S. goes to war, the estimates of fiscal capacity increase as the VAR forecasts larger surpluses in the near future. But both during the Civil War and WW-II, the build-up in debt outpaced the increase in fiscal backing.[17] The bottom panel of Table 3 confirms that surpluses fully back the value of the debt. The average ratio of U.S. fiscal capacity to debt is 149.28% before WW-I and 127.96% for the full period before 1946.

5.6 Results for Dynamic Fiscal Backing After WW-II

U.K. Next, we turn to the post-war sample. The top panel of Figure 6 plots the dynamic fiscal capacity estimate after WW-II. As shown in Panel A of Figure 6, the U.K.'s dynamic fiscal capacity stays above the market value of debt-to-GDP ratio over the entire period from 1947 to 2020. The correlation between fiscal capacity and debt/GDP is still quite high (0.79).

U.S. Panel B of Figure 6 plots the dynamic fiscal backing estimate for the U.S. after WW-II.[18] The contrast with the U.K. could not be clearer. Except for a short period around the year 2000, the U.S. dynamic fiscal capacity measure inclusive of seigniorage revenue is below the market value of debt. Future surpluses and convenience yields cover only 31.93% of outstanding U.S. debt after WW-II. The gap has grown much wider after 2007.

Despite its privileged position as the world's safe asset provider post-WW-II, U.S. debt is substantially less well-backed than U.K. debt was during its period as the global hegemon pre-WW-I. Interestingly, and in contrast with the U.K. during its period of financial hegemony, the correlation between fiscal backing and the debt/GDP ratio is close to zero (0.05). This indicates that fiscal fundamentals play no discernible role in the valuation of U.S. debt.

5.7 Robustness

We consider three robustness checks and show that our results remain largely unchanged.

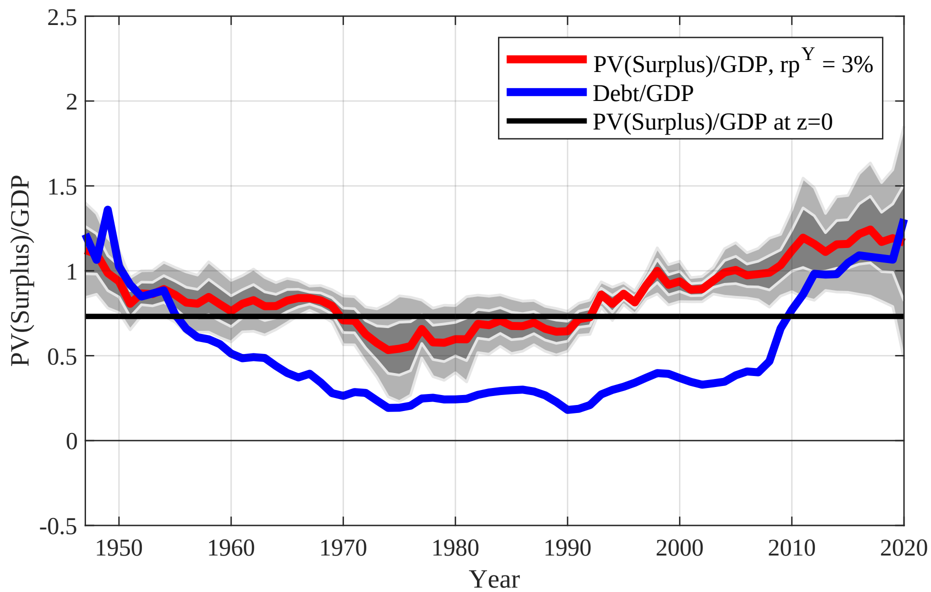
In our benchmark results, we use the actual convenience yield multiplied by the contemporaneous debt/GDP ratio to proxy seigniorage revenue. In a first robustness check, we study how

[17] Before the Civil War, the U.S. federal government relied on customs duties and land sales as the main source of revenue. During the Civil War, the federal government implemented a host of new taxes, permanently increasing its tax base. As a robustness check, we have estimated a version of the model with an additional structural break in 1860. The results are presented in Appendix E.6, and are similar to the results from the main model.

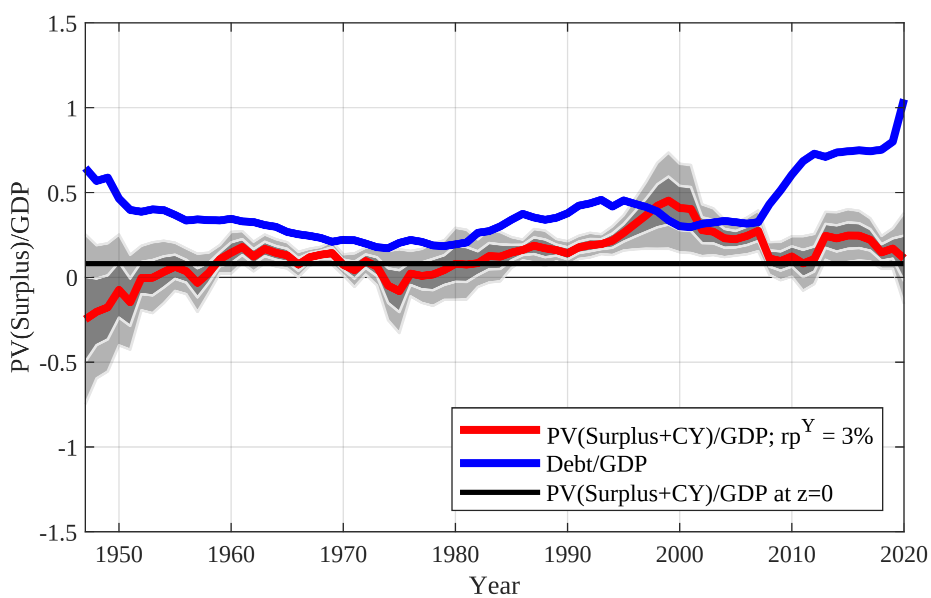
[18] Since the fiscal backing estimate for 1946 comes from the pre-WW-II regime and the estimate for 1947 from the post-WW-II regime, and these regimes differ in terms of both the mean values and the dynamics of the state variables, there is no guarantee of continuity between the regimes.

Figure 6: Fiscal Capacity: Post-WW-II.

Panel A: U.K. 1947 – 2020



Panel B: U.S. 1947 – 2020



The top (bottom) panel plots U.K. (U.S.) fiscal backing post-WW-II. In the post-WW-II U.S. period, the benchmark case includes the seigniorage revenue from convenience yields. 2-standard-error confidence intervals generated by bootstrapping 10,000 samples. We also report the steady-state upper bound evaluated at $z = 0$, and the actual debt/GDP ratio, based on the market value of marketable debt. We report the benchmark case with a GDP risk premium of 3%.

sensitive results are to an alternative measure of convenience yield that holds seigniorage revenue from convenience fixed at 0.33% of GDP for the U.K. in the pre-WW-II period.

The yellow line in Panel A of Figure 7 presents the estimated dynamic fiscal capacity. The last two columns of Table E.1 report the averages of the fiscal capacity for both the pre-WW-II and post-WW-II samples. The steady-state fiscal capacity for the pre-WW-II period is 35.96%, very similar to the benchmark value of 36.09%. The sample average of the dynamic fiscal capacity estimate (yellow line) for the pre-WWII period is 64.87%, compared to 64.93% in the benchmark case (red line). This alternative approach to measuring convenience yields does not change our conclusions.

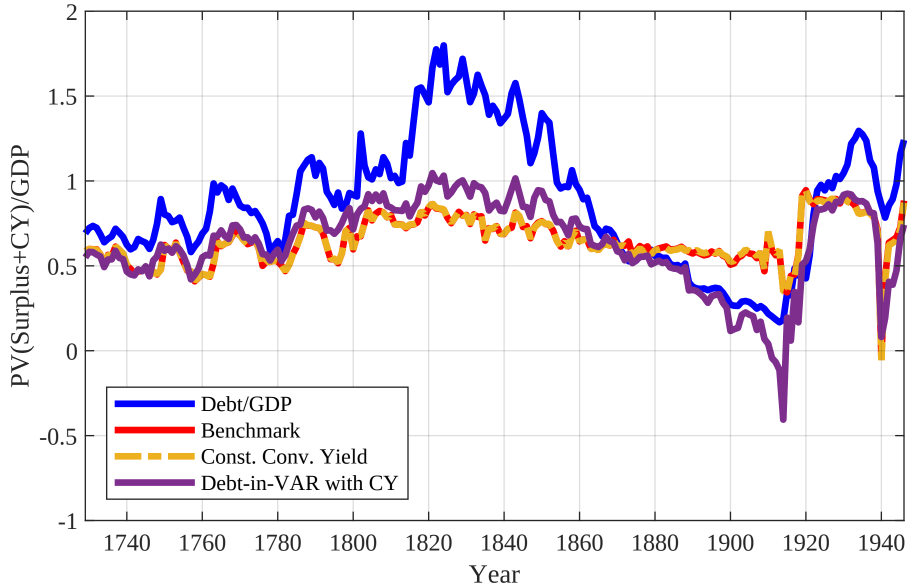
In a second robustness check, we consider a VAR model which includes the log debt-to-GDP ratio in the VAR.[19] We revert to the baseline convenience yield measure. The purple line in Panel A of Figure 7 presents the dynamic fiscal capacity measure for the model with debt in the VAR. The first two columns of Table E.1 report the sub-sample averages. The steady-state fiscal capacity is 36.09%, almost identical to that in the benchmark. The sample average of the dynamic fiscal capacity measure is 63.53%, lower than the sample average of 64.93% in the benchmark case. The correlation between these two measures is 0.89. For completeness, Appendix E.4 reports results for the model with debt in the VAR for the post-WW-II sample era. Our conclusion that debt is below the fiscal bound for the U.K. after WW-II is strengthened.

Third, we estimate a specification that sets the GDP risk premium to 2% compared to 3% in the benchmark since some authors report lower equity premium estimates for the U.K. in the 19th century (Siegel, 2005). This 2% estimate of the GDP risk premium is definitely on the low end of the plausible range. With the assumed convenience yield of 1% that (narrowly) accrues to U.K. Gilts, the true risk premium is only 1%, since the true risk-free rate of interest is 1% point higher than the measured government bond yield. Panel B of Figure 7 plots the dynamic fiscal capacity bound for the case with a 2% risk premium (yellow line) and the benchmark model's 3% risk premium (red line). Fiscal capacity is higher with a lower GDP risk premium; the yellow line is above the red line. The middle panel of Table E.1 report the sub-sample averages. The fiscal capacity with the convenience yields is 78.16% of GDP in the pre-WW-I period and 85.06% of GDP on average in the pre-WW-II period. The ratio of fiscal capacity to debt averages 90.41% before WW-I and 97.70% before WW-II. These calculations show that a low GDP risk premium combined with a large convenience yield results in close to full backing of U.K. debt on average in the early period. However, we see in Panel B of Figure 7 that there remains a large deficit of 50% of GDP after the Napoleonic wars. The correlation between fiscal capacity and debt/GDP is 0.71 before WW-I and 0.65 before WW-II, similar to the benchmark model. After WW-II, the conclusion that

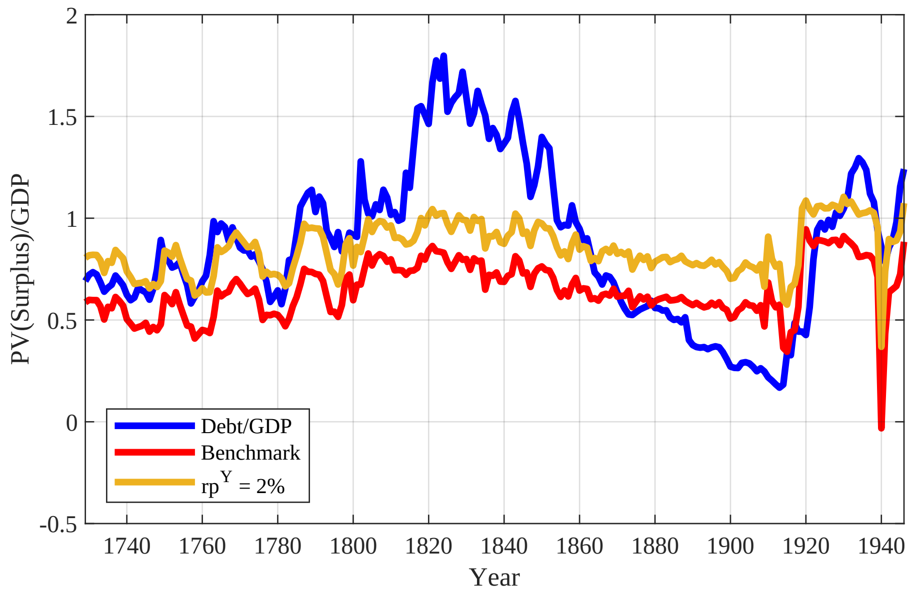
[19] We include both the first difference and the level of the demeaned log debt/GDP ratio in the VAR and impose the cointegration for debt and output with coefficient $(1, -1)$ as we did for tax revenue and spending.

Figure 7: Fiscal Capacity with Convenience Yields: U.K. 1729 – 1946

Panel A: Robustness with Alternative Convenience Yield and with Debt in VAR



Panel B: Robustness with 2% Output Risk Premia



This figure plots the fiscal capacity with convenience yields of the U.K. government over the sample period from 1729 to 1946. The observed debt/GDP ratio is in blue in both panels. Panel A plots the benchmark model (red line), with seigniorage revenue as a constant 0.34% fraction of GDP, the case in which convenience yield is actual long-term interest rate difference in Figure 3 multiplied by the debt/GDP ratio (yellow line), and the case where the debt/GDP ratio is in the VAR model (purple line). The GDP risk premium is 3% in all three cases. Panel B plots the benchmark with 3% GDP risk premium (red line) and a 2% GDP risk premium (yellow line).

there is ample fiscal capacity in the U.K. is strengthened.

5.8 Fiscal Experience of the U.K. Colonies

One further potential concern we explore is that the U.K might have been able to gain extra fiscal capacity by extracting resources from its colonies. Two factors suggest limited impact. First, the realized transfers from colonies to the British central government are already reflected in the realized U.K. government revenue. Second, the literature emphasizes that colonial powers adopted a fiscal *laissez-faire* approach towards their colonies, and that the additional taxation potential was limited (Booth, 2007; Roy, 2019). Colonial governments attained *de facto* financial independence from the U.K. government, and much of the additional tax revenues went to pay for local colonial expenses. For example, wealthier colonies were taxed more to pay a part of the cost of local defense (Stammer, 1967). In addition, it was arguably costly for the British government to exercise its option to tax more.[20] In fact, in the early 20th century, the U.K even had to subsidize the colonies that were in financial trouble.[21]

To explore this concern, we estimate a version of the U.K. model which consolidates U.K. and colonial tax revenues and government spending, as well as debt. Appendix F describes the details and the data sources. The colonial governments were mostly running modest primary deficits, averaging -0.05% of UK GDP for colonies excluding India from 1850 to 1946 and -0.09% for India from 1840 to 1919 (see Figure F.2). We then recompute the U.K.'s fiscal backing, estimating a VAR from 1850 until 1946 using the consolidated tax revenues and government spending inclusive of the colonies. Relative to the benchmark model estimated on this sample, the share of debt that is fiscally backed falls by 4.2% points, strengthening our conclusions (see Figure F.3).

6 The Dutch Fiscal Experience

6.1 Historical Context

Starting in 1542, the central government of the Spanish Low Countries had granted provincial rights to raise taxes and issue debt.[22] The Dutch Republic maintained this decentralized fiscal governance structure after its independence in 1581, which was key to its ability to tap into the

[20] British Parliament passed the Stamp Act to raise money for the Seven Year's War debt burden in 1765. In Boston, colonists rioted and destroyed the house of the stamp distributor. News of these protests inspired similar activities and protests in other colonies, and thus the Stamp Act served as a common cause to unite the 13 colonies in opposition to the British Parliament. The protests resulted the repeal of the Stamp Act by The Taxation of Colonies Act 1778, which declared that Parliament would not impose any tax in any of the colonies of British America or the British West Indies.

[21] The 1929 Colonial Development Act committed the British Government to regularly provide funds to the colonial government (Stammer, 1967).

[22] These provincial debts were implicitly guaranteed by the burghers of these provinces who also had the power to raise taxes at the provincial level.

bond market (de Vries and van der Woude, 1997a). After its secession from Spain in 1581, the Dutch Republic underwent what Schultz and Weingast (2003) call a "financial revolution," marked by its unique ability to borrow large sums of money at low yields. Most of the borrowing was done at the provincial level by issuing longer-maturity debt.

For much of the 17th and 18th centuries, the Dutch Republic was able to borrow at lower rates than even the British crown. The ability to issue long-term debt at low yields gave the Dutch Republic a significant military advantage, allowing it to build a navy that was the largest in the world in the first half of the 17th century.[23] The Spanish kings, who had a history of defaults (Drelichman and Voth, 2016), were forced to issue short-term loans at higher interest rates.

The Dutch provinces had a local monopoly on safe asset provision in the 17th century. Dutch bonds were held widely by domestic private investors, the emerging Dutch upper class, as opposed to foreign bankers (in London) or foreign merchants (in Sweden) (C't Hart, 1993). To be clear, this is a local version of exorbitant privilege.

Having said that, Amsterdam was the leading financial center in Europe in the 17th and 18th century, and the Dutch investors were the relevant investor base in international bond markets. For example, between 1720 and 1770, Dutch investors absorbed a sizable share of the British government debt issuance (Oppers, 1993). Dutch investors could also invest locally in Dutch florins-denominated debt of several foreign sovereigns.

Towards the end of the 18th century, the book value of debt issued by the province of Holland exceeded 200% of GDP.[24] The Netherlands was defeated by French forces in 1795 and was forced to contribute to the French war efforts in Russia.[25] After regaining independence after the defeat of Napoleon in 1814, Dutch public finances were in shambles. The Netherlands spent the 19th century dealing with the overhang from debt incurred in the 18th century, additional spending under Napoleon, and subsequently the secession of an industrializing Belgium in 1830.

6.2 Cash Flows and Debt Dynamics

Prior to 1795, we focus on the debt issued by the province of Holland, as well as its spending and revenue. In the Dutch Republic, the lion's share of the debt financing of the Republic's spending—mostly military—was done by the seven provinces. Transfers from the provinces to the federal government accounted for about 80% of federal spending. The seven provinces were fiscally au-

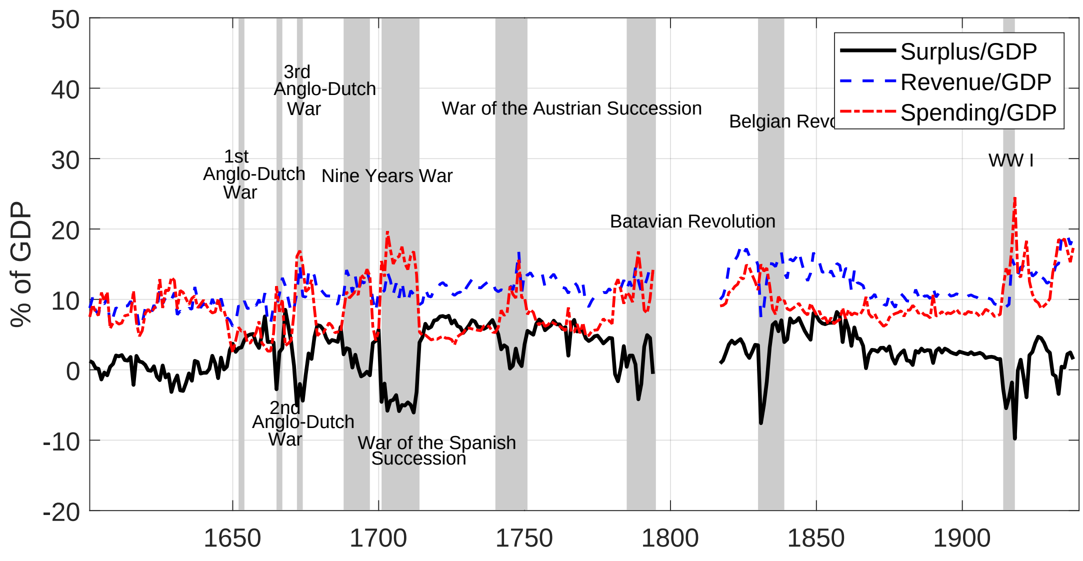
[23]The Dutch defeated the Spanish Habsburgers in their battle for independence, and the Dutch Republic emerged as one the main European powers.

[24]The period from 1780-1787 was one of economic decline and political instability, and loss of colonial territory in the Fourth Anglo-Dutch War, but Holland had began to lose its leading edge in trade starting in the 1730s. Relative macro fundamentals were declining while debt was rising.

[25]The Kingdom of Holland was formally annexed by the French empire in 1810 and it immediately defaulted on 2/3 of the debt.

tonomous. Holland was the largest one and accounted for about half of the total Dutch economy (Liesker and Fritschy, 2004). After 1817, we focus on the Netherlands. The details of data construction are in the Appendix section A.3.[26] Figure 8 plots the time series of fiscal cash flows, with major wars indicated by grey bars, during these two eras. Prior to 1794, Holland ran large surpluses in between wars, punctuated by large, transitory deficits during the wars. The Dutch also adhered to the Barro-Gallatin tax-smoothing recipe. The average primary surplus over this first period was 2.2% of GDP. Table G.1 summarizes the tax revenue to GDP ratio τ and spending to GDP ratio g for two subsample periods.

Figure 8: Dutch Primary Surpluses



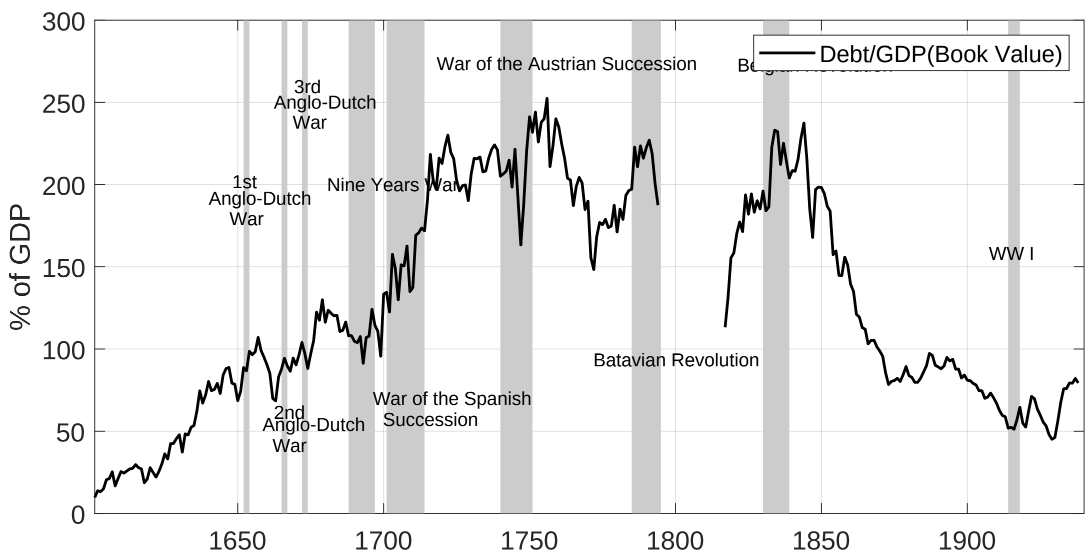
The figure shows the ratio of primary government surpluses to GDP for the province of Holland pre-1794 and the Netherlands from 1815 onwards. The shaded areas are major wars and economic crises: The 2nd Anglo-Dutch War in 1665–1667, the 3rd Anglo-Dutch War 1672–1674, the Nine Years War in 1688–1697, the War of the Spanish Succession 1701–1714, the War of the Austrian Succession in 1740–1748, the Fourth Anglo-Dutch War and the Batavian Revolution in 1781–1795, the Belgian Revolution in 1830–1831, World War I in 1914–1918. We omitted the Eighty years war 1568–1609, the 1st Anglo-Dutch war 1652-54, and the Franco-Dutch War in 1672-78 from the figure.

The province of Holland did not hesitate to tap capital markets. The book value of outstanding government debt in Holland, plotted in Figure 9, was over 200% of GDP during much of the 18th century. The market value of debt was significantly lower than the book value at various points in time. In earlier times (1675, 1693, 1714), Holland's bonds occasionally traded at large discounts, only to recover to par value. However, by 1794, Holland bonds were trading at a 70% discount to book value in secondary markets. The Netherlands effectively defaulted on two-thirds of the

[26] The fiscal data can be downloaded from https://resources.huygens.knaw.nl/gewestelijkefinancien/Spreadsheets.

interest payments in 1810, and the outstanding 2.5%-coupon bonds lost two-thirds of their market value (see van Riel, 2021, pp. 333-335). Our estimate of the market value of debt is plotted as the blue line in Figure 11. The 1828 observation, marked by the pink dot in Panel B, is the market value computed by van Riel (2021) for that year. The details of our estimation of the market value are described in Appendix A.3.2.

Figure 9: The Book Value of Outstanding Debt to GDP



Book value of debt issued by the province of Holland from 1601 to 1794 and the central Dutch government over the sample period from 1817–1914.

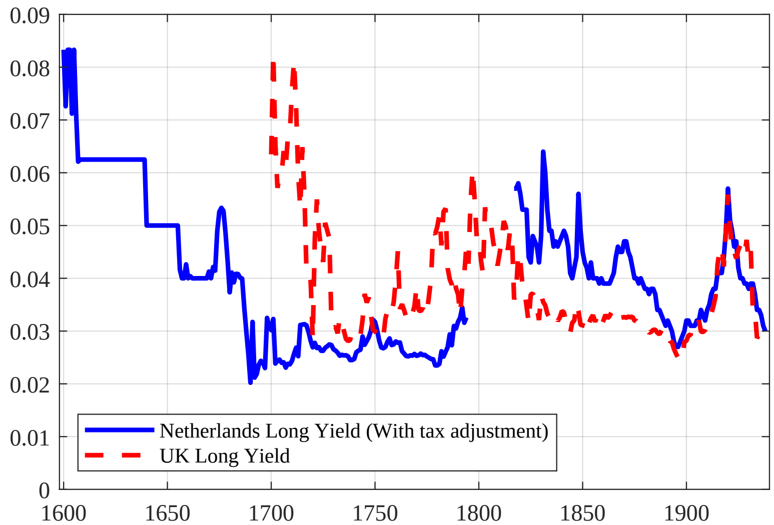
6.3 Convenience Yields

Prior to 1794, there was a large spread between the yields on government bonds issued by the Holland and the U.K. central government. Figure 10 plots the yields on long-term bonds issued by the U.K. central government and Holland from 1730 to 1938. After 1815, we plot yields on debt issued by the government of the Netherlands. The Dutch yields pertain to "losrenten," redeemable annuities, comparable to British consols. After deducting the tax rebate of the interest payment from the Dutch Republic, the effective yields on the long-term bonds issued by Holland are much lower than the yields on the U.K. government bonds before 1794.[27] The average long bond yield is 1.51% lower than for the U.K. This evidence is indicative of a convenience yield earned by the Holland bonds. We impute a 1.5% convenience yield for the Netherlands for the period from 1601

[27] We thank Matthijs Korevaar for explaining this to us.

to 1794. After 1794, we assume that no convenience yields accrue to the Dutch central government. Given the outstanding debt-to-GDP ratio, the convenience yield generates average seigniorage revenue of 1.78% of GDP before 1794.

Figure 10: Long Yields: U.K. vs Holland and the Netherlands



This figure shows the long term yields on U.K. government consols and the annuities ('losrenten') issued by the Province of Holland prior to 1794. After 1814, the yields on long-term bonds issued by the central government of the Netherlands.

6.4 Fiscal Backing

Table 5 summarizes the main results for the province of Holland in the earlier period in column 1 and the Netherlands in the second period in column 2. Until 1794, when it occupied the position as safe asset provider, Holland's debt was not fully backed by surpluses according to our estimates, even after accounting for the sizeable seigniorage revenues from convenience. Because of the high real interest rate and the low real growth rate, the pre-1794 valuation multiple on GDP is low: 15.59.[28] Holland needed to generate 1% of GDP in surpluses or seigniorage revenue to obtain 15.59% of GDP in fiscal backing. The surpluses and the seigniorage add up to 4.17% of GDP, yielding a steady-state fiscal backing estimate of 65.05% of GDP. Turning to the dynamic measure of fiscal backing, its pre-1794 average is 75.29% of GDP. Both measures of fiscal backing are much lower than the average debt/GDP ratio of 118.89%. On average, only 63.32% of the outstanding debt is backed by the fundamentals.

[28] As we did for the U.K. and the U.S., we assume a 3% GDP risk premium.

The red line in Figure 11 plots our estimate for the dynamic measure of fiscal backing.[29] The figure also plots the market value (blue line) and the book value of government debt (green dashed line) relative to GDP. The intertemporal government budget constraint calls for a comparison of the market value of debt with the present value of surpluses. As Panel A of Figure 11 shows, the market value of debt exceeds its fiscal backing throughout the 17th and most of the 18th century. However, in the years leading up to 1800, the market value of debt converges to our measure of fiscal backing. This convergence happens gradually, well prior to Napoleon's invasion, as the Dutch Republic's relative fundamentals begin to deteriorate.

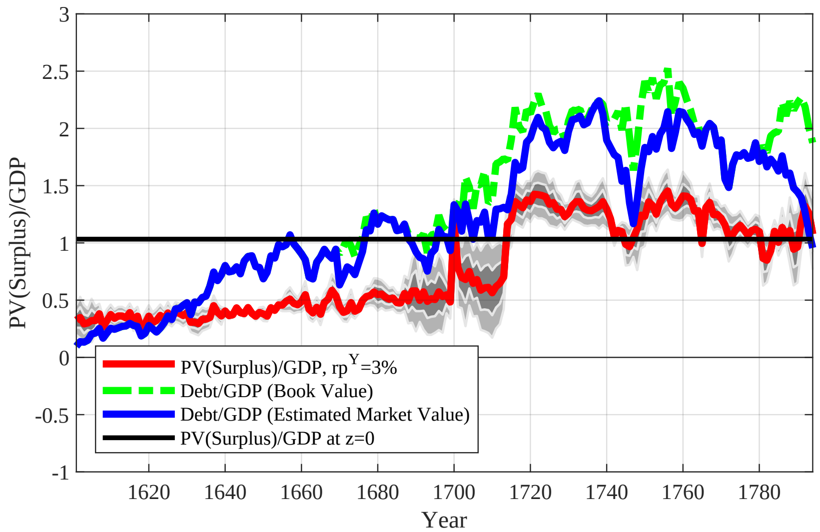
In sum, bond investors award Holland with the privilege of issuing debt beyond its fiscal backing in the 1601–1794 period, much the same way as we found for the U.K. in the 1729–1946 period and for the U.S. in the 1947–2020 period.

Next, we turn to the post-1817 era in column 2 of Table 5. The multiple on GDP is higher (18.31) because of higher growth (1.82%), only partially offset by higher real rates. The Dutch central government now runs even larger surpluses (3.33% of GDP) but no longer earns seigniorage revenue. This produces a steady-state fiscal backing estimate of 61.06% of GDP and an average dynamic fiscal backing average of 60.56% of GDP. Both numbers are similar to the average debt/GDP ratio of 59.13%. Panel B of Figure 11 shows that the market value of Dutch central government debt is fully backed by surpluses throughout the 19th century. Hence, starting in the 19th century, the Dutch seem to have entered a new fiscal regime of full backing. The regime change towards full fiscal backing that occurs around the end of the Dutch Republic is similar to the change that occurred in the U.K. during the interbellum.

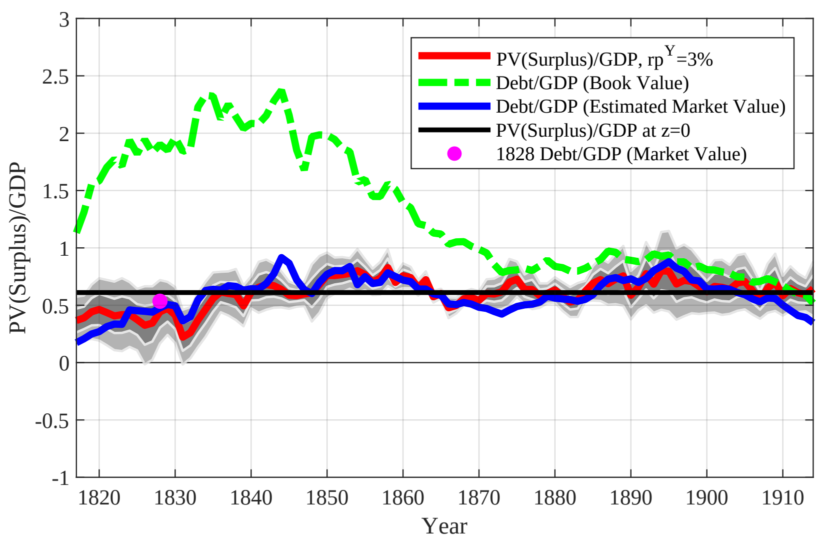
[29]The choice of state variables for the Holland sample (pre-1794) and Netherlands sample (post-1817) is listed in Table G.2 and Table G.3. The VAR companion matrix point estimates for the two samples are listed in Tables G.4 and G.5. Appendix G.3 shows that the results are robust to including additional elements in the VAR.

Figure 11: Fiscal Backing with Convenience Yields: Holland

Panel A:1601–1794 (Province of Holland)



Panel B: 1817–1914 (The Netherlands)



The top two panels plot the dynamic measure of fiscal backing for the Holland government over the sample period from 1601 to 1794 (red line), the steady-state fiscal capacity measure (horizontal black line), and the actual debt/GDP ratio (blue line). Panel A estimates the VAR in two subsamples: 1601–1699 and 1700–1794 and plots the combined estimated fiscal capacity. The GDP risk premium is 3%. We include the seigniorage revenue from the convenience yield of 1.5%. The two-standard-error confidence interval around the dynamic fiscal capacity estimate is generated by bootstrapping 10,000 samples. The bottom panel plots the dynamic fiscal backing for the Dutch government over the sample period from 1817–1914. For more details, see Appendix A.3.

Table 5: Fiscal Capacity: Province of Holland and the Netherlands

	1601 – 1794 Province of Holland	1817 – 1914 The Netherlands
x_0	0.27	1.82
$y_{10}^{\$}$	3.81	4.03
π_0	0.25	-0.11
$y_0^{\$}$	–	3.63
κ_0^Y	0.23	0.20
ρ_Y	0.94	0.95
$\exp(pd_0^Y)$	15.59	18.31
τ_0	10.73	12.25
g_0	8.34	8.92
s_0	2.39	3.33
λ_0	1.5	0
Seign.$/Y$	1.78	0
	Steady-state at $z = 0$	
$PV(S)/Y$	36.83	61.06
$PV(S+CY)/Y$	65.05	61.06
	Sample Averages	
D/Y	118.89	59.13
$PV(S)/Y$	46.86	60.56
$PV(S+CY)/Y$	75.29	60.56
$PV(S+CY)/D$	63.32	102.41
$\rho(PV(S+CY)/Y, D/Y)$	0.94	0.72

The top panel reports the moments of the data that are inputs into the steady-state fiscal capacity estimation. The bottom two panels report estimates of fiscal backing. All values are in percentage points, except for the *pd* ratio $\exp(pd_0^Y)$ and κ_0^Y. We use an unlevered equity premium rp_0^Y of 3% in all subsamples. In case of convenience yields, we use narrow convenience yields, which raise the actual risk-free rate by λ_0 and lower the output risk premium by λ_0, leaving the discount rate unchanged. *D* denotes the estimated market value of debt.

7 Conclusion

Global investors seem to concentrate fiscal capacity in the world's safe asset supplier beyond what is warranted by that country's fiscal fundamentals. This is true even after incorporating seigniorage revenue from convenience yields into the estimate of fiscal capacity. When the hegemon's relative fundamentals deteriorate, this extra fiscal capacity is withdrawn, and bond investors focus again on the country's fundamentals. As the world's global safe haven asset, the U.K. benefited from this extra fiscal capacity prior to WW-I, but lost that privileged status to the U.S. after WW-II. In comparison, the U.S. enjoyed the extra fiscal space only after it became the dominant safe asset supplier after WW-II. We also considered the Dutch experience. Prior to the Napoleonic wars, the Dutch provinces were the local safe asset supplier to a captive market, the Dutch upper class. Throughout the 17th and 18th century, Holland's debt was not fully backed by its surpluses. After the wars, the Dutch central government's debt was fully backed. The Dutch had lost the privilege to the British, and with it, the extra fiscal capacity.

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A Data Sources

A.1 United Kingdom: 1729–2020

The main dataset we use for the U.K. is *A millennium of macroeconomic data* published by the bank of England. The dataset contains a broad set of macroeconomic and financial data for the UK. We also use other data sets as complementing the main dataset. Below we describe how we construct variables in our estimation procedure from the raw data set. All sheets and columns refer to the excel table *A millennium of macroeconomic data* unless described otherwise. We use additional data sources to complement after 2016.

A.1.1 Government Finance

Primary Surplus: For 1729–2016, the raw source for the data is from Mitchell and Mitchell (1988). The government expenditure G is from Sheet A27, Series *Total Expenditure* net of *Interest Payments*. The government revenue T is from Sheet A27, Series *Total receipts*. Please note that our government expenditure and revenue series are adjusted to account for the differences between the fiscal year and the calendar year. This adjustment assumes that annual revenue is evenly distributed across each quarter of the fiscal year, with calendar year values derived from the corresponding fiscal year data.[30] The primary surpluses are the government revenue T minus the government spending before interest payments G. For periods after 2016, we use the ONS (Office of National Statistics) data: We use *ESA Table 2. version 27-07-2021. Data field 'Total expenditure' minus '- Interest, payable(1)' plus 'Interest, receivable(1)'* for government expenditure net of interest payment. We use *ESA Table 2. version 27-07-2021. Data field 'Total Revenue'* for government revenue.

Debt to GDP: We compute market value of debt using aggregate number from each individual bond with the dataset from Ellison and Scott (2020). For post 2016, we first compute the growth rate of market value of debt to GDP using series **GGGDTAGBA188N** from Fred (*General government gross debt for United Kingdom, Percent of GDP, Annual, Not Seasonally Adjusted*), then using 2016 number to compute forward.

A.1.2 State Variables

GDP: For 1729–2016, we use Sheet A8, Column D for real GDP. For nominal GDP, we use Sheet A9, Column D. Both of the GDP series are measured based on the current definition of U.K. (Great Britain and Northern Ireland). For the years 2017–2020, we use Series BKTL (*Gross Domestic Product at market prices: CP: NSA £m*), version dated 12-05-2021, from the UK Office for National Statistics for nominal GDP data. For real GDP, we utilize Series IHYC (*Gross Domestic Product (Expenditure) chained volume index: SA*), also version dated 12-05-2021.

Inflation: For 1729-1946, we use the ratio of real GDP and nominal GDP to get the GDP deflator and the inflation series. From 1946 to 1959, data are sourced from the Fred Series CPIUKQ, titled *Consumer Price Index in the U.K.* with log-differences of the M12 values. For the period 1960 to 1987, data are taken from the Fred Series GBRCPALTT01IXNBM, titled *Consumer Price Index of All Items in the U.K.*, with log-differences of the M12 values. From 1988 to 2020, data are sourced from the UK Office for National Statistics, Series L522, titled CPIH Index 00, version dated 14-07-2021, with log-differences of the M12 values.

Short Rate: We use *Prime Commercial Bill/Paper Rate* in Sheet A31, Column F as our 1-period interest rate in our model for 1729–2016. We use 3 month libor rate, Fred series **GBP3MTD156N**, for 2017–2020.

10-year Rate: We use *United Kingdom 10-year Government Bond Yield* (series **IGGBR10D**) from *Global Financial Data* (GFD) for the entire sample.

Stock Price index: We use *Share price indices* in Sheet A31, Column W as the aggregate stock price index for 1729–2016. We use FTSE All Share index for 2017–2020 from Datastream.

[30] The government finances in the raw data are for fiscal years. For years after 1854, the fiscal year ends on March 31st, so we use linear interpolation to convert fiscal year data to calendar year data. For year prior to 1854, the fiscal year ends on January 5th, so we use the fiscal year number as calendar year number as they are sufficiently close.

Equity Price-Dividend Ratio: We use Golez and Koudijs (2018) for 1729–1812, and 1813 – 1870, We use the short-term interest rate and the long-term interest rate series from Jordà-Schularick-Taylor Macrohistory database (Jordà, Knoll, Kuvshinov, Schularick, and Taylor, 2019). For 1870 – 2015 and dividend yield from FTSE All Share index from Datastream for 2016–2020. The dividend yield for the first sample period is U.K. and Netherland combined.

A.1.3 Unlevered Equity Risk Premium

To compute the unlevered equity premium, we use the following series.

U.K. Equity Premium: We use the equity total return series **eqtr** minus series **billrate** from the Jordà-Schularick-Taylor Macrohistory database.

U.K. Term Premium: We use the government bond total return series **bondtr** minus series **billrate** from the Jordà-Schularick-Taylor Macrohistory database.

U.K. Corporate Bond Yield: The U.K. corporate bond yields taken from the GFD database series **INGBRW** (Great-Britain corporate bond yield).

U.K. Market Value of Corporate Debt: We use the corporate debt series **bdebt** series from the Jordà-Schularick-Taylor Macrohistory database.

U.K. Market Value of Equity: Market cap of equity taken from GFD database series **SCGBRMG** (U.K. Stock Market Capitalization).

The leverage ratio is defined as the market value of corporate debt divided by the sum of the market value of corporate debt plus the market value of corporate equity. The unlevered equity premium is computed as the average leverage ratio times the spread between the corporate bond yield and the short-term government bond yield plus one minus the leverage ratio times the equity premium.

A.2 United States: 1793–2020

A.2.1 Government Finance

Expenditures and Revenue: Our historical (1793–1929) government finance data are dataset assembled by Hall and Sargent (2021), which contain detailed historical government finance information starting 1791. We use *Total ordinary expenditures* minus *Interest on public debt* as the primary spending G. We use *Net Ordinary Receipts* as the government revenue T. The data source of the government expenditures and revenues from 1793 to 1928 are from *the 1940 Annual Report of the Secretary of the Treasury on the State of the Finances*, page 642-650. The federal government expenditures and receipts from 1929 to 2020 are from NIPA Table 3.2. The government revenue is the *Current Receipts* from Table 3.2, and the government spending before net interest payment is *Current Expenditure* minus the net interest payment from Table 3.2.

Debt to GDP: The value of marketable and nonmarketable debt is from Hall, Payne, and Sargent (2018), and GDP data is from Global Financial Database series **GDPUSA**.

A.2.2 State Variables

GDP and Inflation: Our historical real GDP data from 1793 to 1929 is from Johnston and Williamson (2022) *measuringworth.com*. Our inflation data from 1793 to 1929 is from series **CPUSAM** (*United States BLS Consumer Price Index Inflation Rate NSA (with GFD Extension)*) from *Global Financial Data*. The nominal GDP from 1930 to 2020 is from NIPA Table 1.1.5, and inflation from 1930 to 2020 is the change in the GDP price index from NIPA Table 1.1.4. The real GDP growth for the period after 1929 is nominal GDP growth minus inflation.

Short Rate: We use series **TRUSABIM** (*GFD Indices USA Total Return T-Bill Index*) from *Global Financial Data* to compute the return of T-bills to proxy for the short rate from 1793 to 1869. We use series **stir** from Jordà-Schularick-Taylor Macrohistory database from 1870-1928. We use the 1-year CMT for the short rate after 1929 from Fred.

10-year Rate: We use series **IGUSA10D** (*USA 10-year Bond Constant Maturity Yield (with GFD Extension)*) from *Global Financial Data* from 1793 to 1928. The 10-year CMT after 1929 is from Fred.

Equity Price-Dividend Ratio and Dividend Growth: We use series **SYUSAYM** (*S&P 500 Monthly Dividend Yield (with GFD Extension)*) from *Global Financial Data* for dividend yield. We use series **GFUS100MPM** (*GFD Indices USA Top 100 Price Index*) from *Global Financial Data* for total return index for 1793–1871 and series **SPXTRD** (*S&P 500 Total Return Index (with GFD extension)*) from *Global Financial Data* from 1871 to 1928. We use these two series to infer dividend growth. The log price-dividend ratio and the log real dividend growth after 1929 are computed using CRSP database.

A.2.3 Unlevered Equity Risk Premium

To compute the unlevered equity premium, we use the following series.

U.S. Equity Premium: We use the equity total return series **eqtr** minus series **billrate** from the Jordà-Schularick-Taylor Macrohistory database.

U.S. Term Premium: We use the government bond total return series **bondtr** minus series **billrate** from the Jordà-Schularick-Taylor Macrohistory database.

U.S. Corporate Bond Yield: Moody's AAA yield taken from the GFD database series **MOCAAAD**.

U.S. Market Value of Corporate Debt: We use the corporate debt series **bdebt** series from the Jordà-Schularick-Taylor Macrohistory database.

U.S. Market Value of Equity: Market cap of equity taken from GFD database series **USNYCAPM** and **USNQCAPM** (Nasdaq +NYSE Stock Market Capitalization).

A.3 Holland and the Netherlands: 1630–1914

A.3.1 Fiscal data

We use the reconstructed national accounts of Holland created by van Zanden and van Leeuwen (2018). We use the series Holland GDP in current prices labeled (Totaal).The fiscal data for the province of Holland constructed by Liesker and Fritschy (2004) can be downloaded from this website. All series are denominated in guilders. For Revenue, we use the total public revenue excluding loans (**column I**). (1575–1794). (spreadsheet labeled '**3ProvExp2017**') However, we subtract the bond tax revenue collected in Holland. Holland imposed a bond tax on the interest revenue that accrued to investors. This was effectively an interest reduction used to avoid refinancing these bonds when market yields declined. We deduct this tax from the yields. In addition, we also subtract the interest tax revenue collected by Holland from total revenue. For spending, we use the series labeled total general expenditures (spreadsheet labeled '**2GenExp2017**'). For debt, we use Holland's provincial public debt, 1599–1795. The time series for Dutch GDP starting in 1800 is taken from Smits, Horlings, and van Zanden (2000). The time series for debt post-1800 is taken from van Riel (2021). We obtain the government spending and revenue data from 1815 to 1914 from Centraal Bureau voor de Statistiek (2001).

A.3.2 Estimating the Market Value of Debt

Prior to 1794, we have book value of Holland's debt compiled by Liesker and Fritschy (2004). There was no active secondary market until 1670. However, Gelderblom and Jonker (2006) report prices for secondary market transactions in Holland's annuities in Gouda. We use the price data reported for the secondary transactions in term annuities (see Figure 4 in Gelderblom and Jonker (2006)). We use these discounts to par value to approximate the market value of Holland's outstanding debt. Holland's bonds occasionally traded at large discounts (1675, 1693, 1714) only to recover to par value. After 1780, Holland's bond prices started a steep decline. By 1800, the bonds were trading at a 70% discount.

The book value of outstanding Dutch government debt, the dashed line plotted in Figure 11, was near 250% of GDP in the early nineteenth century. The actual market value of debt was much lower. Holland defaulted on two-thirds of the interest payment in 1810, and the outstanding 2.5% coupon bonds lost two-thirds of their market value (see van Riel, 2021, pp. 333-335). Starting in 1815 seven types of government debt with rates of interest that varied between 1.25 and 7 percent (van Riel, 2021) were converted into NWS (Nieuwe Werkelijke Schuld) bonds. These were 2.5% perpetuities.This planned-debt conversion was not done at once. To reduce the interest burden, the government only commits to pay interest on a fraction of the debt (NWS), and the rest becomes 'deferred debt' which is gradually converted to NWS bonds at a constant rate. We estimate the market value of both types of bonds using the information provided by van Riel (2021) with some assumptions. First, the NWS bonds is priced using the actual long-term yield (see Figure 10). The long-term yields are very close to the numbers provided by van Riel (2021) in Appendix G. Compared with the British 3% consol, the average yields for NWS bonds is 1.49% higher from 1813 to 1841. The yields of the deferred debt are not available, but the market value of the deferred debt is 1.9% of its book value in 1828 (see van Riel, 2021, Table 7.4). We assume that the market value is 1.9% of the book value for the deferred debt throughout the sample from 1817 to 1914. We assume the outstanding debt consists of NWS bonds and the deferred debt. In year 1817, the NWS bond is one-third of the total outstanding government debt (in book value), and other two-thirds are the deferred debt. In year 1828, there were 760.1 million guilders in NWS bonds and 837.0 guilders in deferred debt (see van Riel, 2021, Table 7.4). In 1828, there were other types of public debt, e.g., Amortisatiesyndicaat, Domain interest, but this only accounted for about 10% of outstanding public debt. We determine the ratio between NWS bonds and the deferred debt using linear interpolation from the two data points (year 1817 and 1828) given that the deferred debt would be converted to NWS bonds at the constant speed after 1814. If the interpolated value is greater than 1, then we assume all debt is NWS bond.

The book value of Dutch government debt to GDP ratio prior to 1794 is from Liesker and Fritschy (2004) which can be downloaded from this website. The book value of debt to GDP ratio from 1815 to 1913 was generously provided by Arthur van Riel (van Riel, 2021), and the book value to GDP ratio from 1914 to 1939 is from Global Financial Database series **GVDPNLD**.

A.3.3 State Variables

GDP and Inflation: The real GDP data and GDP price deflator from 1601 to 1794 is from van Zanden and van Leeuwen (2018) for the period from 1600 to 1794. We use their corrected GDP price deflator and take log difference to calculate the inflation. The GDP price deflator from 1815 to 1912 is taken from Smits, Horlings, and van Zanden (2000), and the GDP price deflator from 1913 to 1939 is constructed by dividing the nominal GDP from GFD (series GDPNLD) by the real GDP from GFD (series GDPCNLD). The real GDP is estimated by dividing the GFD series GDPNLD by the GDP price deflator.

Yields: The time series for Dutch yields (1601-1794) on the 'losrenten' issued by the province of Holland was generously provided to us by Matthijs Korevaar (Korevaar, Francke, and Eichholtz, 2021). This series was constructed from four differences sources: Homer and Sylla (1996); Gelderblom and Jonker (2011); Eichholtz, Koedijk, and Others (1996) and the following website https://www.ent1815.nl/m/maandelykse-nederlandsche-mercurius-1756–1807/. The time series for yields (1815-1914) is from Centraal Bureau voor de Statistiek (2001).

Dividends and Dividend Yields: We compute the dividend yields for the sample period 1629 to 1794 using the data from Golez and Koudijs (2018), specifically by dividing column D_real by P_real. To address the frequent occurrence of zero dividends in the data, we utilize a 10-year rolling average for D_real. For real dividend growth, we calculate the log-difference of the 10-year rolling average of D_real.

B Consumption Growth Betas

Table B.1 reports the regression results. The first two columns report the regressions of the change in the log of τ on GDP growth. The next two columns report the same for results for the change in the log of g. In the pre-WW-II era, the slope coefficient is negative, consistent with a-cyclical or even counter-cyclical surpluses.

Table B.1: Cyclicality of US and UK Government Finance

Panel A: 1830 – 1914

	$\Delta \log T_{us}$	$\Delta \log T_{uk}$	$\Delta \log G_{us}$	$\Delta \log G_{uk}$	Δs_{us}	Δs_{uk}
	(1)	(2)	(3)	(4)	(5)	(6)
const	-0.01	0.02**	0.02	0.07***	-0.00*	-0.00*
	(0.02)	(0.01)	(0.02)	(0.02)	(0.00)	(0.00)
real consumption growth	0.71**	-0.07	0.24	-1.95**	0.01	0.10
	(0.30)	(0.33)	(0.39)	(0.96)	(0.01)	(0.08)
Observations	44	85	44	85	44	85
R^2	0.12	0.00	0.01	0.05	0.01	0.02
Adjusted R^2	0.10	-0.01	-0.01	0.04	-0.01	0.01
Residual Std. Error	0.08	0.05	0.10	0.16	0.00	0.01
F Statistic	5.87**	0.05	0.43	4.13**	0.57	1.43

Note: *p<0.1; **p<0.05; ***p<0.01

Panel B: 1830 – 1946

	$\Delta \log T_{us}$	$\Delta \log T_{uk}$	$\Delta \log G_{us}$	$\Delta \log G_{uk}$	Δs_{us}	Δs_{uk}
	(1)	(2)	(3)	(4)	(5)	(6)
const	0.05**	0.03***	0.08*	0.08***	-0.00	-0.01***
	(0.03)	(0.01)	(0.05)	(0.02)	(0.00)	(0.00)
real consumption growth	-0.05	-0.46**	-0.62	-2.76***	0.07	0.75***
	(0.49)	(0.21)	(0.85)	(0.57)	(0.08)	(0.12)
Observations	76	117	76	117	76	117
R^2	0.00	0.04	0.01	0.17	0.01	0.25
Adjusted R^2	-0.01	0.03	-0.01	0.16	-0.00	0.24
Residual Std. Error	0.19	0.07	0.33	0.19	0.03	0.04
F Statistic	0.01	4.74**	0.50	23.45***	0.87	38.50***

Note: *p<0.1; **p<0.05; ***p<0.01

Panel C: 1947 – 2020

	$\Delta \log T_{us}$	$\Delta \log T_{uk}$	$\Delta \log G_{us}$	$\Delta \log G_{uk}$	Δs_{us}	Δs_{uk}
	(1)	(2)	(3)	(4)	(5)	(6)
const	-0.03*	0.02***	0.07***	0.04***	-0.02***	-0.01**
	(0.01)	(0.01)	(0.02)	(0.01)	(0.00)	(0.00)
real consumption growth	1.79***	0.29	-0.99**	-0.60*	0.56***	0.30**
	(0.36)	(0.18)	(0.42)	(0.31)	(0.10)	(0.12)
Observations	74	74	74	74	74	74
R^2	0.26	0.03	0.07	0.05	0.31	0.08
Adjusted R^2	0.24	0.02	0.06	0.04	0.30	0.07
Residual Std. Error	0.06	0.03	0.07	0.05	0.02	0.02
F Statistic	24.67***	2.56	5.59**	3.81*	31.76***	6.43**

Note: *p<0.1; **p<0.05; ***p<0.01

This table reports the regression results of log cash flow growth on real consumption growth for both U.S. and U.K. The first two columns report the regressions of the change in the log of T on consumption growth. The next two columns report the same for results for the change in the log of G. The last two columns report the same for results for the change in surplus/GDP. Panel A and Panel B report the regression results for the pre-1914 sample and pre-1946 sample respectively. For the UK, the sample starts from 1830. For the US, the sample starts from 1870. Panel C reports the results for the sample from 1947 to 2020.

C VAR Coefficient Estimates

C.1 The VAR System for the U.K.

We estimate equations 1-6, 7, and 9 of (8) using OLS, separating the pre-1946 and post-1946 samples. We do not zero out any of the elements in Ψ even if they are statistically indistinguishable from zero. The point estimates of $\boldsymbol{\Psi}$ for both U.K. samples are reported in Panels A and B of Table C.1, respectively. Lagged macro-finance variables affect fiscal variables and vice versa. Consistent with the long-run mean reversion dynamics imposed by cointegration, $\Psi_{[7,8]} < 0$ and $\Psi_{[9,10]} < 0$ in both samples (and those coefficients are statistically significant). The cross-terms also have the expected sign: $\Psi_{[7,10]} > 0$ and $\Psi_{[9,8]} > 0$ for both samples. The estimates of $\Sigma^{\frac{1}{2}}$ for both samples are reported in Appendix C.1.

Table C.1: VAR Estimates Companion Matrix $\boldsymbol{\Psi}$ for the U.K.

	π_{t-1}	$y^{\$}_{t-1}(1)$	$y^{\$,spr}_{t-1}$	x_{t-1}	$\Delta\log d_{t-1}$	pd_{t-1}	$\Delta\log\tau_{t-1}$	$\log\tau_{t-1}$	$\Delta\log g_{t-1}$	$\log g_{t-1}$
Panel A: 1729– 1946 Sample										
π_t	0.35	-0.09	0.25	0.25	-0.02	0.01	0.13	-0.02	0.02	0.01
$y^{\$}_t(1)$	0.00	1.12	0.60	0.06	0.00	0.02	0.00	-0.00	0.01	0.00
$y^{\$,spr}_t$	0.00	-0.16	0.36	-0.04	-0.00	-0.01	-0.00	0.00	-0.00	0.00
x_t	-0.05	0.01	0.31	-0.08	-0.00	-0.01	-0.02	0.01	0.05	-0.01
$\Delta\log d_t$	-0.08	1.68	-0.38	0.24	-0.19	0.33	0.15	0.11	-0.07	-0.07
pd_t	-0.22	-2.80	-1.73	-0.43	0.12	0.55	-0.27	-0.08	-0.01	0.03
$\Delta\log\tau_t$	0.26	0.64	0.70	0.43	-0.03	-0.03	0.11	-0.06	0.03	0.04
$\log\tau_t$	0.26	0.64	0.70	0.43	-0.03	-0.03	0.11	0.94	0.03	0.04
$\Delta\log g_t$	0.59	-2.27	-1.16	0.56	0.01	-0.12	-0.37	0.06	0.45	-0.09
$\log g_t$	0.59	-2.27	-1.16	0.56	0.01	-0.12	-0.37	0.06	0.45	0.91
Panel B: 1947–2020 Sample										
	π_{t-1}	$y^{\$}_{t-1}(1)$	$y^{\$,spr}_{t-1}$	x_{t-1}	$\Delta\log d_{t-1}$	pd_{t-1}	$\Delta\log\tau_{t-1}$	$\log\tau_{t-1}$	$\Delta\log g_{t-1}$	$\log g_{t-1}$
π_t	0.51	0.32	0.36	0.32	-0.03	-0.02	-0.07	0.06	-0.01	0.02
$y^{\$}_t(1)$	0.19	0.94	0.69	0.19	0.07	0.02	-0.11	-0.07	0.02	-0.04
$y^{\$,spr}_t$	-0.09	-0.06	0.09	-0.03	-0.09	-0.02	-0.00	0.03	-0.02	0.06
x_t	-0.24	0.33	1.02	0.30	-0.01	0.02	-0.01	-0.04	-0.04	0.04
$\Delta\log d_t$	-0.41	0.29	1.41	1.12	0.18	0.01	0.10	0.03	-0.01	0.04
pd_t	-2.78	1.77	3.99	-3.88	-0.18	0.57	1.27	0.51	-0.27	-0.57
$\Delta\log\tau_t$	0.08	-0.22	-0.96	0.05	-0.08	0.00	0.49	-0.23	-0.17	0.10
$\log\tau_t$	0.08	-0.22	-0.96	0.05	-0.08	0.00	0.49	0.77	-0.17	0.10
$\Delta\log g_t$	0.26	-0.38	-1.30	-0.32	-0.08	-0.05	-0.19	0.21	0.28	-0.33
$\log g_t$	0.26	-0.38	-1.30	-0.32	-0.08	-0.05	-0.19	0.21	0.28	0.67

The Cholesky decomposition of the residual variance-covariance matrix, $\Sigma^{\frac{1}{2}}$, multiplied by 100 for readability is given by:

Pre-1946 Sample:

$$100 \times \Sigma^{\frac{1}{2}} = \begin{pmatrix} 3.75 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.17 & 0.94 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -0.14 & -0.86 & 0.27 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.21 & 0.19 & -0.12 & 2.95 & 0 & 0 & 0 & 0 & 0 & 0 \\ -4.82 & -0.25 & 1.28 & 1.56 & 13.50 & 0 & 0 & 0 & 0 & 0 \\ 0.84 & -0.44 & -3.75 & 0.53 & -12.53 & 7.33 & 0 & 0 & 0 & 0 \\ -2.00 & -0.55 & 0.32 & -2.23 & -0.65 & -0.01 & 5.10 & 0 & 0 & 0 \\ -2.00 & -0.55 & 0.32 & -2.23 & -0.65 & -0.01 & 5.10 & 0.00 & 0 & 0 \\ -1.03 & -1.66 & 3.12 & -1.30 & -1.55 & -4.37 & 4.13 & 0.00 & 16.01 & 0 \\ -1.03 & -1.66 & 3.12 & -1.30 & -1.55 & -4.37 & 4.13 & 0.00 & 16.01 & 0 \end{pmatrix}$$

Post-1946 Sample:

$$100 \times \Sigma^{\frac{1}{2}} = \begin{pmatrix} 2.36 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.39 & 1.44 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.04 & -0.81 & 0.71 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -0.33 & 0.51 & -0.12 & 1.87 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1.65 & 0.21 & -0.41 & 0.01 & 5.43 & 0 & 0 & 0 & 0 & 0 \\ -5.05 & -2.55 & -2.93 & 3.14 & -2.77 & 14.65 & 0 & 0 & 0 & 0 \\ 0.78 & 0.35 & 0.45 & -0.82 & -0.10 & 0.04 & 1.85 & 0 & 0 & 0 \\ 0.78 & 0.35 & 0.45 & -0.82 & -0.10 & 0.04 & 1.85 & 0.00 & 0 & 0 \\ 0.58 & -0.31 & 0.81 & -2.79 & -0.53 & -0.17 & 0.14 & 0.00 & 2.44 & 0 \\ 0.58 & -0.31 & 0.81 & -2.79 & -0.53 & -0.17 & 0.14 & 0.00 & 2.44 & 0 \end{pmatrix}$$

In this matrix, the last two columns are all zero. This is because the dependent variables $\log \tau_t - \log \tau_0$ and $\log g_t - \log g_0$ do not have independent shocks. For example, $\log \tau_t - \log \tau_0$ can be expressed as

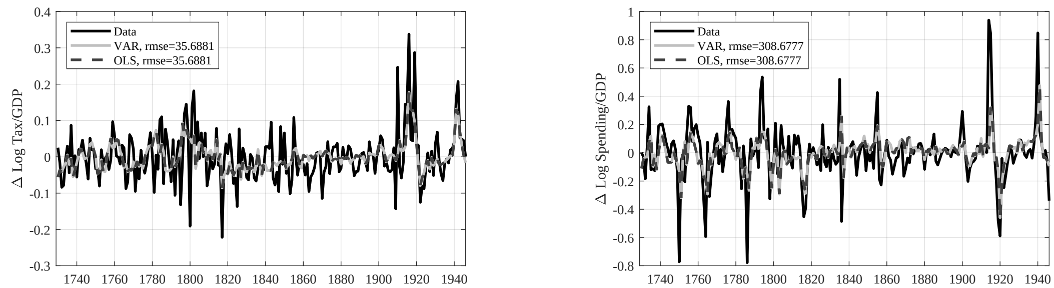
$$\begin{aligned} \log \tau_t - \log \tau_0 &= \Delta \log \tau_t + (\log \tau_{t-1} - \log \tau_0) \\ &= (e'_{\Delta\tau}\mathbf{\Psi} + e'_{\tau})z_{t-1} + e'_{\Delta\tau}\mathbf{\Sigma}^{\frac{1}{2}}\boldsymbol{\varepsilon}_t, \end{aligned}$$

which loads on the first eight shocks in the same way as $\Delta \log \tau_t - \mu_0^{\tau}$.

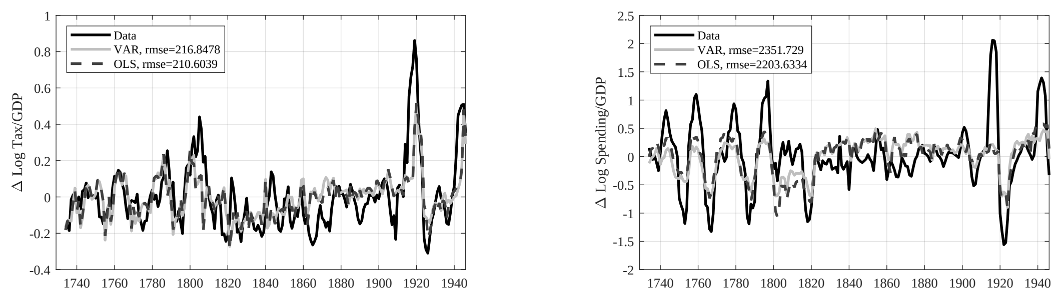
Figures C.1 and C.2 evaluate the forecasting performance of the VAR model. They plot expected cumulative spending and revenue growth over the next one, five, and ten years against realized future spending and revenue growth, for each of the two subsamples. To assess predictive accuracy, we compare the prediction of the benchmark annual VAR to that of the best linear forecaster at that horizon using the root mean squared error (RMSE) as our criterion. By design, the VAR prediction is the best linear forecast at the one-year horizon, but not at the five- and ten-year horizons. Overall, predictive accuracy of the VAR is similar to that of the best linear forecast at the five- and ten-year horizons. The pre-1946 sample has larger RMSEs than the post-1946 sample. This evidence leads us to conclude that the VAR implies reasonable behavior of long-run fiscal cash flows.

Figure C.1: Cash Flow Forecasts: 1729 – 1946

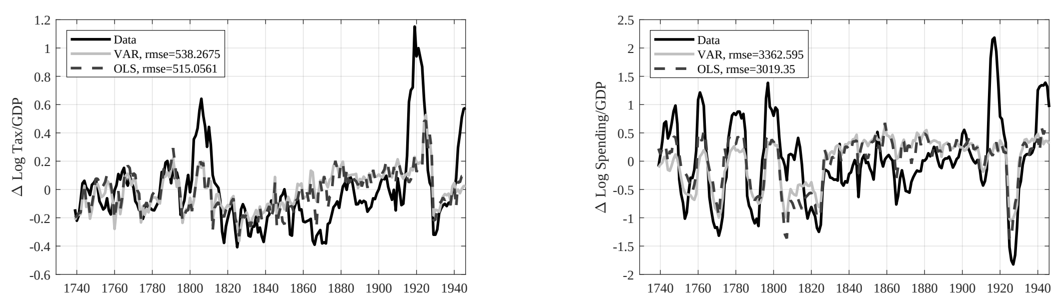
Panel A: 1Yr Forecast of $\Delta\tau$ and Δg



Panel B: 5Yr Forecast of $\Delta\tau$ and Δg



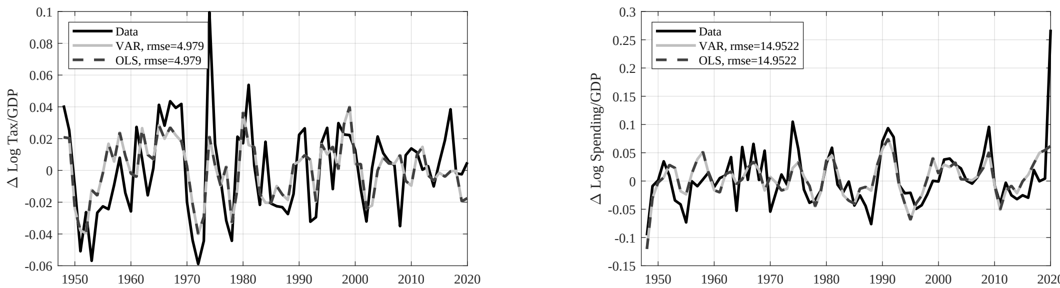
Panel C: 10Yr Forecast of $\Delta\tau$ and Δg



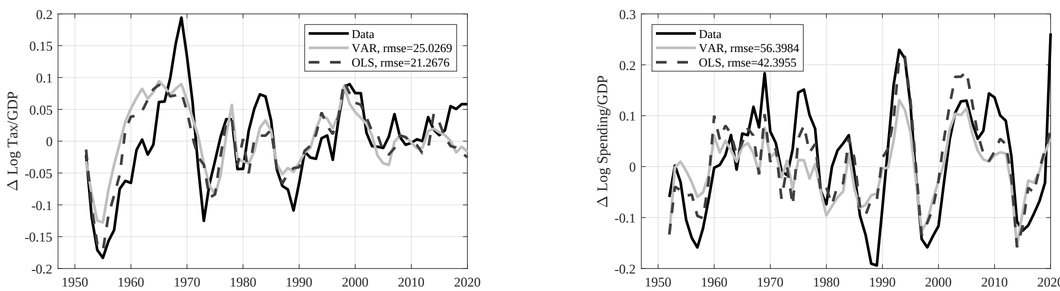
We plot the actual log tax and spending growth rates over 1-year, 5-year and 10-year rolling windows in solid black lines. The value at each year represents the *k*-year growth rates that end at that year. We also plot these rates as forecasted by our pre-1946 VAR model in gray lines and these rates as forecasted by the OLS model using the pre-1946 sample in dash black lines. The value at each year represents the *k*-year growth rates condition on the information *k* years ago.

Figure C.2: Cash Flow Forecasts: 1947 – 2020

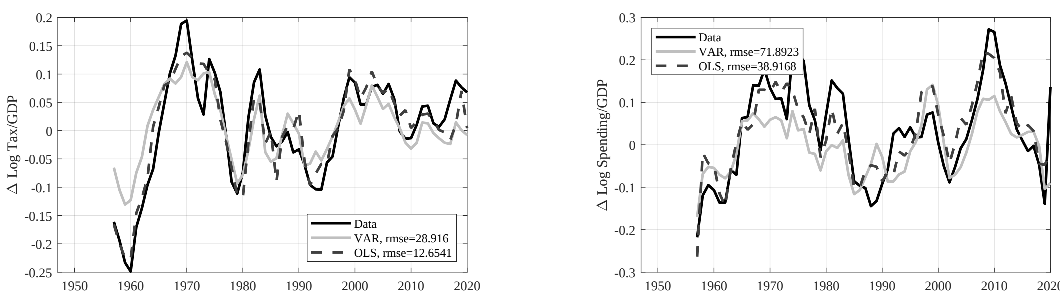
Panel A: 1Yr Forecast of $\Delta\tau$ and Δg



Panel B: 5Yr Forecast of $\Delta\tau$ and Δg



Panel C: 10Yr Forecast of $\Delta\tau$ and Δg



We plot the actual log tax and spending growth rates over 1-year, 5-year and 10-year rolling windows in solid black lines. The value at each year represents the *k*-year growth rates that end at that year. We also plot these rates as forecasted by our post-1946 VAR model in gray lines and these rates as forecasted by the OLS model using the post-1946 sample in dash black lines. The value at each year represents the *k*-year growth rates condition on the information *k* years ago.

C.2 The VAR System for the U.S.

Table C.2 and Table C.3 summarize the variables we include in the state vector, in order of appearance of the VAR. All state variables are demeaned by their respective sample averages. Figures C.3 and C.4 plot the forecasting performance of the VAR model in the same way with the UK.

Table C.2: VAR Estimates $\boldsymbol{\Psi}$: 1793 – 1946 U.S. Sample

	π_{t-1}	$y^{\$}_{t-1}(1)$	$y^{\$,spr}_{t-1}$	x_{t-1}	$\Delta \log d_{t-1}$	pd_{t-1}	$\Delta \log \tau_{t-1}$	$\log \tau_{t-1}$	$\Delta \log g_{t-1}$	$\log g_{t-1}$
π_t	0.21	0.66	1.23	0.15	0.07	0.01	0.02	-0.01	0.04	-0.00
$y^{\$}_t(1)$	0.04	1.35	0.98	0.01	0.01	0.02	-0.00	0.01	0.00	-0.00
$y^{\$,spr}_t$	-0.03	-0.43	-0.09	-0.01	-0.01	-0.02	-0.00	-0.01	-0.00	0.00
x_t	0.03	1.33	2.42	0.30	0.03	0.05	-0.00	0.03	0.02	-0.02
$\Delta \log d_t$	-0.32	7.32	7.39	0.57	-0.08	0.48	-0.03	-0.04	-0.05	0.04
pd_t	-0.23	-7.38	-7.72	-0.56	-0.09	0.46	0.13	0.03	0.03	-0.04
$\Delta \log \tau_t$	-0.02	-7.79	-8.04	0.70	0.20	-0.28	-0.08	-0.30	-0.13	0.27
$\log \tau_t$	-0.02	-7.79	-8.04	0.70	0.20	-0.28	-0.08	0.70	-0.13	0.27
$\Delta \log g_t$	1.02	0.13	4.56	0.59	-0.11	-0.37	-0.08	0.09	0.15	-0.26
$\log g_t$	1.02	0.13	4.56	0.59	-0.11	-0.37	-0.08	0.09	0.15	0.74

Table C.3: VAR Estimates $\boldsymbol{\Psi}$: 1947 – 2020 U.S. Sample

	π_{t-1}	$y^{\$}_{t-1}(1)$	$y^{\$,spr}_{t-1}$	x_{t-1}	$\Delta \log d_{t-1}$	pd_{t-1}	$\Delta \log \tau_{t-1}$	$\log \tau_{t-1}$	$\Delta \log g_{t-1}$	$\log g_{t-1}$
π_t	0.52	0.26	-0.13	-0.05	0.03	0.01	0.11	-0.08	-0.01	0.04
$y^{\$}_t(1)$	0.08	0.90	0.01	0.15	0.08	0.01	-0.04	-0.02	0.01	0.08
$y^{\$,spr}_t$	-0.05	-0.02	0.59	-0.13	-0.05	-0.01	0.02	0.02	0.01	-0.04
x_t	-0.27	0.21	0.30	0.17	0.07	0.01	-0.08	-0.09	-0.03	0.09
$\Delta \log d_t$	0.06	0.14	0.71	0.16	0.41	0.06	-0.37	-0.31	-0.15	0.16
pd_t	-2.23	0.06	1.27	-0.91	-0.27	0.73	-0.08	0.49	0.40	-0.58
$\Delta \log \tau_t$	-0.53	0.84	-0.01	0.06	0.14	0.06	0.30	-0.62	0.09	0.11
$\log \tau_t$	-0.53	0.84	-0.01	0.06	0.14	0.06	0.30	0.38	0.09	0.11
$\Delta \log g_t$	0.83	-0.49	-0.77	0.10	-0.33	-0.06	0.36	-0.19	0.36	-0.56
$\log g_t$	0.83	-0.49	-0.77	0.10	-0.33	-0.06	0.36	-0.19	0.36	0.44

The following matrix is the $\Sigma^{\frac{1}{2}}$ from the VAR estimates for the Pre-1946 Sample:

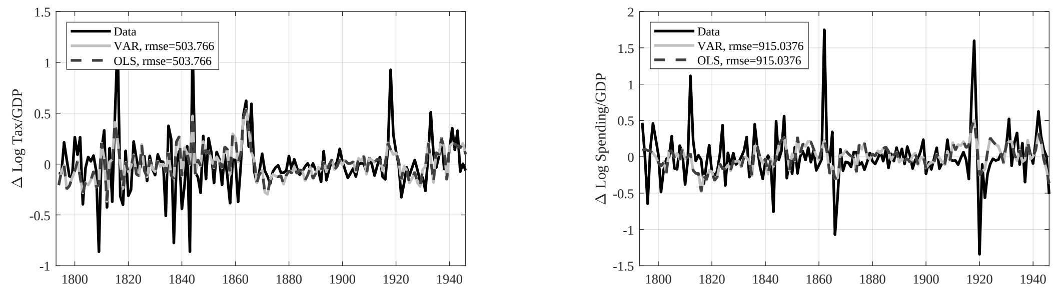
$$100 \times \Sigma^{\frac{1}{2}} = \begin{pmatrix} 5.82 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.12 & 1.13 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -0.04 & -1.02 & 0.30 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.98 & 0.43 & -0.50 & 4.20 & 0 & 0 & 0 & 0 & 0 & 0 \\ -3.64 & -1.16 & -3.04 & 2.52 & 13.68 & 0 & 0 & 0 & 0 & 0 \\ -1.08 & -0.63 & -3.04 & 0.97 & -10.46 & 13.47 & 0 & 0 & 0 & 0 \\ 3.35 & 2.32 & -2.52 & 0.28 & 2.61 & -0.17 & 21.84 & 0 & 0 & 0 \\ 3.35 & 2.32 & -2.52 & 0.28 & 2.61 & -0.17 & 21.84 & 0.00 & 0 & 0 \\ 7.92 & -1.81 & -1.12 & 2.75 & -0.21 & 1.27 & 5.57 & 0.00 & 28.52 & 0 \\ 7.92 & -1.81 & -1.12 & 2.75 & -0.21 & 1.27 & 5.57 & 0.00 & 28.52 & 0.00 \end{pmatrix}$$

The following matrix is the $\Sigma^{\frac{1}{2}}$ from the VAR estimates for the Post-1946 Sample:

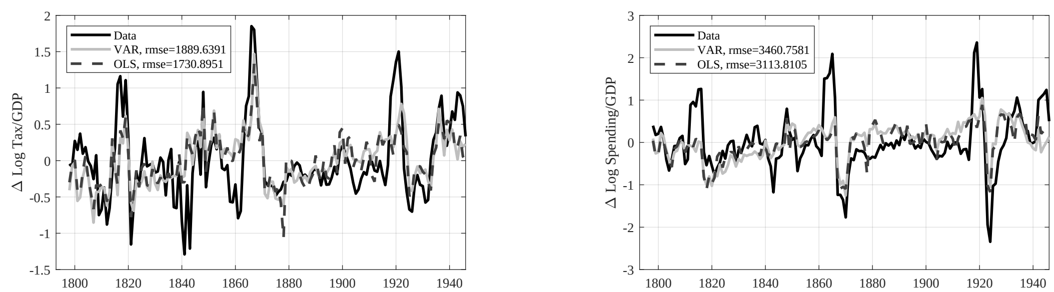
$$100 \times \Sigma^{\frac{1}{2}} = \begin{pmatrix} 1.06 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.39 & 1.38 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -0.08 & -0.56 & 0.49 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.13 & 0.75 & -0.26 & 1.90 & 0 & 0 & 0 & 0 & 0 & 0 \\ -0.95 & 1.42 & -0.24 & 0.59 & 4.93 & 0 & 0 & 0 & 0 & 0 \\ -1.99 & -1.03 & 0.76 & -2.39 & -2.86 & 14.56 & 0 & 0 & 0 & 0 \\ 0.51 & 1.03 & -0.03 & 1.40 & 0.92 & 0.27 & 3.08 & 0 & 0 & 0 \\ 0.51 & 1.03 & -0.03 & 1.40 & 0.92 & 0.27 & 3.08 & 0.00 & 0 & 0 \\ 0.11 & -1.46 & 0.01 & -2.69 & -1.74 & 0.02 & 0.49 & 0.00 & 4.24 & 0 \\ 0.11 & -1.46 & 0.01 & -2.69 & -1.74 & 0.02 & 0.49 & 0.00 & 4.24 & 0.00 \end{pmatrix}$$

Figure C.3: Cash Flow Forecasts: 1793 – 1946

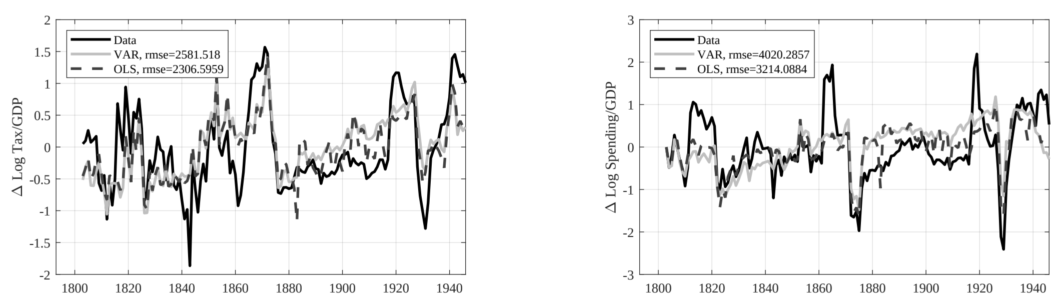
Panel A: 1Yr Forecast of $\Delta\tau$ and Δg



Panel B: 5Yr Forecast of $\Delta\tau$ and Δg



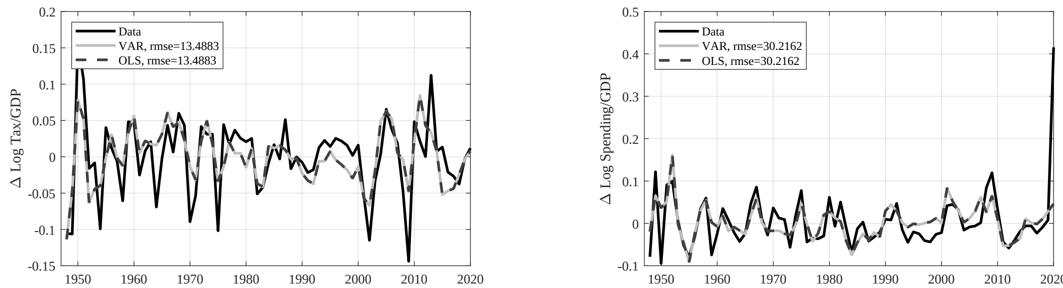
Panel C: 10Yr Forecast of $\Delta\tau$ and Δg



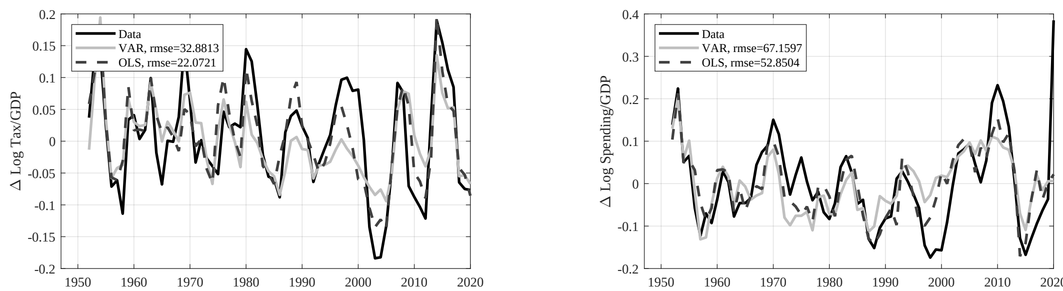
We plot the actual log tax and spending growth rates over 1-year, 5-year and 10-year rolling windows in solid black lines. The value at each year represents the *k*-year growth rates that end at that year. We also plot these rates as forecasted by our pre-1946 VAR model in gray lines and these rates as forecasted by the OLS model using the pre-1946 sample in dash black lines. The value at each year represents the *k*-year growth rates condition on the information *k* years ago.

Figure C.4: Cash Flow Forecasts: 1947 – 2020

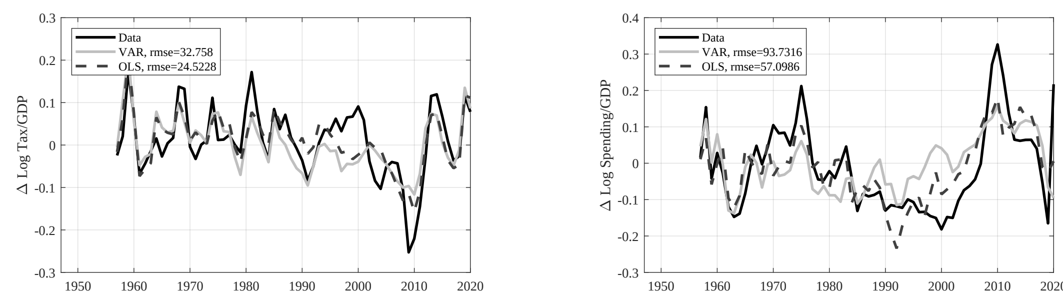
Panel A: 1Yr Forecast of $\Delta\tau$ and Δg



Panel B: 5Yr Forecast of $\Delta\tau$ and Δg



Panel C: 10Yr Forecast of $\Delta\tau$ and Δg



We plot the actual log tax and spending growth rates over 1-year, 5-year and 10-year rolling windows in solid black lines. The value at each year represents the *k*-year growth rates that end at that year. We also plot these rates as forecasted by our post-1946 VAR model in gray lines and these rates as forecasted by the OLS model using the post-1946 sample in dash black lines. The value at each year represents the *k*-year growth rates condition on the information *k* years ago.

D Derivation of Upper Bound

This section derives the Campbell and Shiller (1988) decomposition for the spending and the tax claim, which is used in the derivation of the upper bound.

Consider the return on a claim to the government's tax revenue:

$$r_{t+1}^T = \log \frac{P_{t+1}^T + T_{t+1}}{P_t^T} = \log \frac{T_{t+1}}{T_t} \frac{(1+\exp(pd_{t+1}^T))}{\exp(pd_t^T)}.$$

We use pd_t^T to denote the log price-dividend ratio on the tax revenue claim: $pd_t^T = \log P_t^T - \log T_t$, where price is measured at the end of the period and the dividend flow is over the same period. Campbell and Shiller (1988) log-linearize the return equation around the mean log price/dividend ratio to derive the following expression for log returns on the tax claim:

$$r_{t+1}^T = \Delta \log T_{t+1} + \kappa_1^T pd_{t+1}^T + \kappa_0^T - pd_t^T,$$

with linearization coefficients as functions of the mean of the log price/dividend ratio pd_0^T:

$$\kappa_1^T = \frac{e^{pd_0^T}}{e^{pd_0^T}+1} < 1, \qquad \kappa_0^T = \log(1+\exp(pd_0^T)) - \kappa_1^T pd_0^T.$$

By iterating forward on the linearized return equation, imposing a no-bubble condition: $\lim_{j\to\infty}(\kappa_1^T)^j pd_{t+j}^T = 0$, and taking expectations, we derive the following expression for the log price/dividend ratio of the tax claim:

$$pd_t^T = \frac{\kappa_0^T}{1-\kappa_1^T} + \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^T)^{j-1}\Delta \log T_{t+j}\right] - \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^T)^{j-1} r_{t+j}^T\right].$$

We use rp_t^T to denote the risk premium on tax claims relative to the long bond:

$$\mathbb{E}_t[r_{t+1}^T] = yspr_t^\$ + y_t^\$(1) + rp_t^T.$$

We assume constant risk premia on the tax and spending claims, which we denote as rp_0^T and rp_0^G. We use $\boldsymbol{e}_{y1}$ and $\boldsymbol{e}_{yspr}$ to denote the column vectors that select the short rate and the yield spread. Because the state vector follows VAR(1) dynamics, we can compute expected return as follows:

$$\mathbb{E}_t\left[r_{t+j}^T\right] = y_0^\$(1) + yspr_0^\$ + rp_0^T + (\boldsymbol{e}_{y1} + \boldsymbol{e}_{yspr})'\boldsymbol{\Psi}^{j-1}\boldsymbol{z}_t \tag{C.1}$$

The DR (discount rate) term is given by the following expression:

$$DR_t^T \stackrel{\text{def}}{=} \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^T)^{j-1} r_{t+j}^T\right] = \frac{y_0^\$(1) + yspr_0^\$ + rp_0^T}{1-\kappa_1^T} + (\boldsymbol{e}_{y1} + \boldsymbol{e}_{yspr})'(I - \kappa_1^T\boldsymbol{\Psi})^{-1}\boldsymbol{z}_t.$$

The CF (cash flow) term is given by the following expression:

$$CF_t^T \stackrel{\text{def}}{=} \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^T)^{j-1}\Delta \log T_{t+j}\right] = \frac{x_0+\pi_0}{1-\kappa_1^T} + (\boldsymbol{e}_\pi + \boldsymbol{e}_x + \boldsymbol{e}_{\Delta\tau})'\boldsymbol{\Psi}(I-\kappa_1^T\boldsymbol{\Psi})^{-1}\boldsymbol{z}_t,$$

We end up with the following expressions for the price/dividend ratio on the tax and spending claims:

$$pd_t^T = pd_0^T + [(\boldsymbol{e}_\pi + \boldsymbol{e}_x + \boldsymbol{e}_{\Delta\tau})'\boldsymbol{\Psi} - (\boldsymbol{e}_{y1} + \boldsymbol{e}_{yspr})'](I-\kappa_1^T\boldsymbol{\Psi})^{-1}\boldsymbol{z}_t, \tag{C.2}$$

where $\boldsymbol{e}_{\Delta\tau}$ selects the tax-to-GDP growth rate in the state vector, and $(pd_0^T, \kappa_0^T, \kappa_1^T)$ solve:

$$pd_0^T = \frac{x_0 + \pi_0 - y_0^\$(1) - yspr_0^\$ - rp_0^T}{(1-\kappa_1^T)} + \frac{\kappa_0^T}{(1-\kappa_1^T)}, \qquad \kappa_1^T = \frac{e^{pd_0^T}}{e^{pd_0^T}+1}, \qquad \kappa_0^T = \log(1+\exp(pd_0^T)) - \kappa_1^T pd_0^T. \quad \text{(C.3)}$$

Similarly, the log price/dividend ratio of the spending claim:

$$pd_t^G = \frac{\kappa_0^G}{1-\kappa_1^G} + \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^G)^{j-1}\Delta \log G_{t+j}\right] - \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^G)^{j-1} r_{t+j}^G\right].$$

We can derive a similar expression for the spending claim.

We use $\widetilde{CF}_t^i$ and $\widetilde{DR}_t^i$ to denote the mean-zero time-varying components of the cash flow and discount rate terms. The implied present value of surpluses/GDP ratio is given by:

$$\frac{PV_t^S}{Y_t} = \tau_t \exp(pd_0^T + \widetilde{CF}_t^T - \widetilde{DR}_t^T) - g_t \exp(pd_0^G + \widetilde{CF}_t^G - \widetilde{DR}_t^G).$$

To derive some intuition, we can evaluate the expression at $\boldsymbol{z} = 0$, i.e., when all variables are at their unconditional mean. In this case, the present value of surpluses/GDP ratio is given by:

$$\frac{PV_t^S}{Y_t}(\boldsymbol{z} = 0) = \tau_0 \exp(pd_0^T) - g_0 \exp(pd_0^G).$$

D.1 Upper Bound on Debt Valuation

To derive an upper bound, we equate the expected returns on taxes and spending to the expected return on GDP: $rp_0^Y = rp_0^G = rp_0^T$. This delivers an upper bound on the valuation of future surpluses, because it maximizes the value of the tax claim, and minimizes the value of the spending claim. Given these 2 assumptions, we derive the following expression for the implied log price/dividend ratio on the tax claim and the spending claim:

$$\begin{aligned}
pd_t^T &= pd_0^Y + \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^Y)^{j-1}(\Delta \log T_{t+j} - (x_0+\pi_0))\right] - \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^Y)^{j-1}(r_{t+j}^Y - (yspr_0^\$ + y_0^\$(1) + rp_0^Y))\right], \\
pd_t^G &= pd_0^Y + \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^Y)^{j-1}(\Delta \log G_{t+j} - (x_0+\pi_0))\right] - \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^Y)^{j-1}(r_{t+j}^Y - (yspr_0^\$ + y_0^\$(1) + rp_0^Y))\right]. \quad \text{(C.4)}
\end{aligned}$$

The long-run growth rate of tax and spending equals the long-run growth rate of output: $x_0 + \pi_0$. That follows directly from co-integration. We use a constant GDP risk premium rp_0^Y. We can back this number out of the unconditional equity risk premium by unlevering the equity premium. We use $\boldsymbol{e}_\pi$ to denote a column vector of zero with a 1 as the first element. The DR (discount rate) term is defined by:

$$DR_t^T = DR_t^G = DR_t^Y = \frac{y_0^\$(1) + yspr_0^\$ + rp_0^Y}{1-\kappa_1^Y} + (\boldsymbol{e}_{y1} + \boldsymbol{e}_{yspr})'(I - \kappa_1^Y \boldsymbol{\Psi})^{-1}\boldsymbol{z}_t.$$

The CF (cash flow) term for the tax claim is defined by:

$$CF_t^T = \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^Y)^{j-1}\Delta \log T_{t+j}\right] = \frac{x_0+\pi_0}{1-\kappa_1^Y} + (\boldsymbol{e}_\pi + \boldsymbol{e}_x + \boldsymbol{e}_{\Delta\tau})'\boldsymbol{\Psi}(I - \kappa_1^Y\boldsymbol{\Psi})^{-1}\boldsymbol{z}_t.$$

The CF (cash flow) term for the spending claim is defined by:

$$CF_t^G = \mathbb{E}_t\left[\sum_{j=1}^{\infty}(\kappa_1^Y)^{j-1}\Delta\log G_{t+j}\right] = \frac{x_0+\pi_0}{1-\kappa_1^Y} + (\boldsymbol{e}_\pi + \boldsymbol{e}_x + \boldsymbol{e}_{\Delta g})'\boldsymbol{\Psi}(I-\kappa_1^Y\boldsymbol{\Psi})^{-1}\boldsymbol{z}_t.$$

We use $\widetilde{CF}_t^i$ and $\widetilde{DR}_t^i$ to denote the time-varying components. Hence, we end up with the following expressions for the price/dividend ratio on the tax and spending claims:

$$\begin{aligned}
pd_t^T &= pd_0^Y + [(\boldsymbol{e}_\pi + \boldsymbol{e}_x + \boldsymbol{e}_{\Delta\tau})'\boldsymbol{\Psi} - (\boldsymbol{e}_{y1} + \boldsymbol{e}_{yspr})'](I-\kappa_1^Y\boldsymbol{\Psi})^{-1}\boldsymbol{z}_t,\\
pd_t^G &= pd_0^Y + [(\boldsymbol{e}_\pi + \boldsymbol{e}_x + \boldsymbol{e}_{\Delta g})'\boldsymbol{\Psi} - (\boldsymbol{e}_{y1} + \boldsymbol{e}_{yspr})'](I-\kappa_1^Y\boldsymbol{\Psi})^{-1}\boldsymbol{z}_t.
\end{aligned} \tag{C.5}$$

A first-order Taylor expansion yields the following expression:

$$\frac{\overline{PV}_t^S}{Y_t} \approx (\tau_t - g_t)\exp(pd_0^Y) + \tau_t(\widetilde{CF}_t^T - \widetilde{DR}_t^T)\exp(pd_0^Y) - g_t\exp(pd_0^Y)(\widetilde{CF}_t^G - \widetilde{DR}_t^G).$$

This expression can be simplified. We obtain the following intuitive expression for an upper bound on the PDV of surpluses:

$$\frac{\overline{PV}_t^S}{Y_t} \approx \exp(pd_0^Y)\left((\tau_t - g_t)\left(1-\widetilde{DR}_t^Y\right) + \tau_t\widetilde{CF}_t^T - g_t\widetilde{CF}_t^G\right).$$

Suppose the country currently runs a primary surplus of zero. The discount rate effects cancel out, again to a first-order approximation. When the country runs a zero primary surplus, the upper bound on the value of debt/GDP is positive only if the expected tax revenue growth exceeds expected spending growth:

$$\frac{\overline{PV}_t^S}{Y_t} \approx \exp(pd_0^Y)\tau_t\left(\widetilde{CF}_t^T - \widetilde{CF}_t^G\right) > 0 \textit{ iff } \widetilde{CF}_t^T > \widetilde{CF}_t^G.$$

This can be further simplified to yield the following expression:

$$\frac{\overline{PV}_t^S}{Y_t} \approx \exp(pd_0^Y)\tau_t\left(\boldsymbol{e}_{\Delta\tau} - \boldsymbol{e}_{\Delta g}\right)'\boldsymbol{\Psi}(I-\kappa_1^Y\boldsymbol{\Psi})^{-1}\boldsymbol{z}_t.$$

The discount rate dynamics and the dynamics of GDP growth are irrelevant (to a first-order approximation) for the upper bound. What matters is the dynamics in tax/GDP and spending/GDP. In other words, the expected cumulative effect of mean reversion in taxes has to outweigh the expected cumulative effect of mean-reversion in spending.

D.2 Upper Bound with Convenience Yields

We can write the intertemporal budget constraint with convenience yield seigniorage revenue as:

$$D_t = \mathbb{E}_t\left[\sum_{j=1}^{\infty} M_{t,t+j}^{\$}(T_{t+j} + K_{t+j})\right] + K_t - \mathbb{E}_t\left[\sum_{j=1}^{\infty} M_{t,t+j}^{\$}G_{t+j}\right].$$

where

$$K_{t+j} \overset{\text{def}}{=} \sum_{h=1}^{H} Q_{t+j}^{\$}(h)P_{t+j}^{\$}(h)\left(1-e^{-\lambda_{t+j}(h)}\right), \quad \forall j \geq 0.$$

We use the variable TK to represent the combined tax and seigniorage revenues as a fraction of the current tax revenue.

Next, we include the seigniorage revenue from the convenience yields in the government revenue. The observed nominal Treasury yield $y_t^{\$}(1)$ is given by the following expression:

$$y_t^{\$}(1) = \rho_t^{\$}(1) - \lambda_t,$$

where $\rho_t^{\$}(1)$ is the one-period nominal risk-free rate. We include the one-period nominal risk-free rate in the VAR:

$$\boldsymbol{e}_{y1}'\boldsymbol{z}_t \stackrel{\text{def}}{=} \rho_t^{\$}(1) = y_t^{\$}(1) + \lambda_t.$$

The DR (discount rate) term is defined by:

$$DR_t^i = \frac{y_0^{\$}(1) + \lambda_0 + yspr_0^{\$} + rp_0^i}{1 - \kappa_1^i} + (\boldsymbol{e}_{y1} + \boldsymbol{e}_{yspr})'(I - \kappa_1^i \boldsymbol{\Psi})^{-1}\boldsymbol{z}_t,$$

where $i \in \{TK, G\}$. The implied upper bound is given by:

$$\frac{\overline{PV}_t^S}{Y_t} = k_t + (\tau_t + k_t)\exp(pd_0^T + \widetilde{CF}_t^{TK} - \widetilde{DR}_t^{TK}) - g_t \exp(pd_0^G + \widetilde{CF}_t^G - \widetilde{DR}_t^G).$$

Alternatively, we can evaluate the expression at $\boldsymbol{z} = 0$, i.e., when all variables are at their unconditional mean:

$$\frac{\overline{PV}_t^S}{Y_t}(\boldsymbol{z} = 0) = k_0 + (\tau_0 + k_0)\exp(pd_0^T) - g_0 \exp(pd_0^G),$$

where $pd_0^i, \kappa_0^i, \kappa_1^i$ solve

$$pd_0^i = -\frac{(y_0^{\$}(1) + \lambda_0 + yspr_0^{\$} + rp_0^i) - (x_0 + \pi_0)}{(1 - \kappa_1^i)} + \frac{\kappa_0^i}{(1 - \kappa_1^i)}, \qquad \kappa_1^i = \frac{e^{pd_0^i}}{e^{pd_0^i} + 1}, \qquad \kappa_0^i = \log(1 + \exp(pd_0^i)) - \kappa_1^i pd_0^i.$$

E Additional Tables and Figures

E.1 Primary Surpluses During Recessions

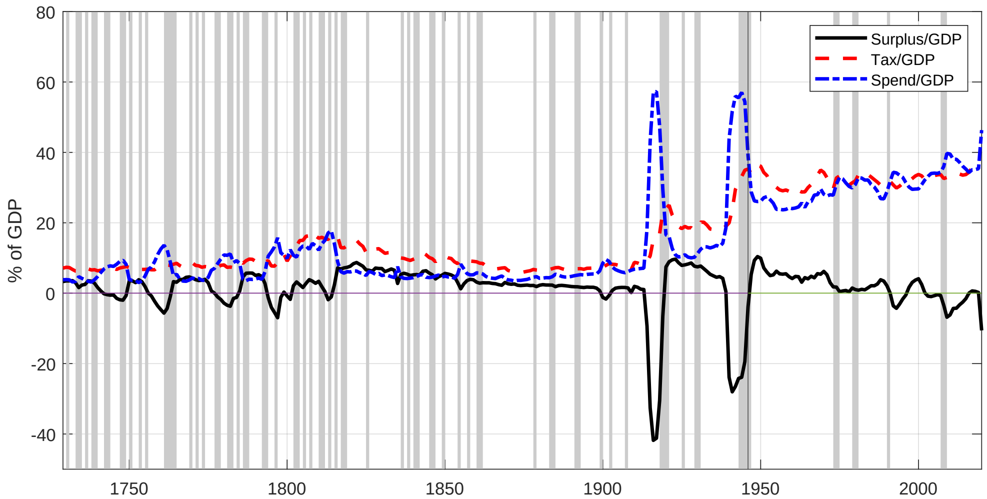
Figure E.1 shows primary surpluses relative to GDP in the U.K. (Panel A) and the U.S. (Panel B). Shaded areas are recessions, as defined by Dimsdale and Thomas (2019) for the U.K. and as dated by Davis (2006) for the 1796–1840 period and NBER recessions thereafter for the U.S.

E.2 Fiscal Impulse Responses United Kingdom

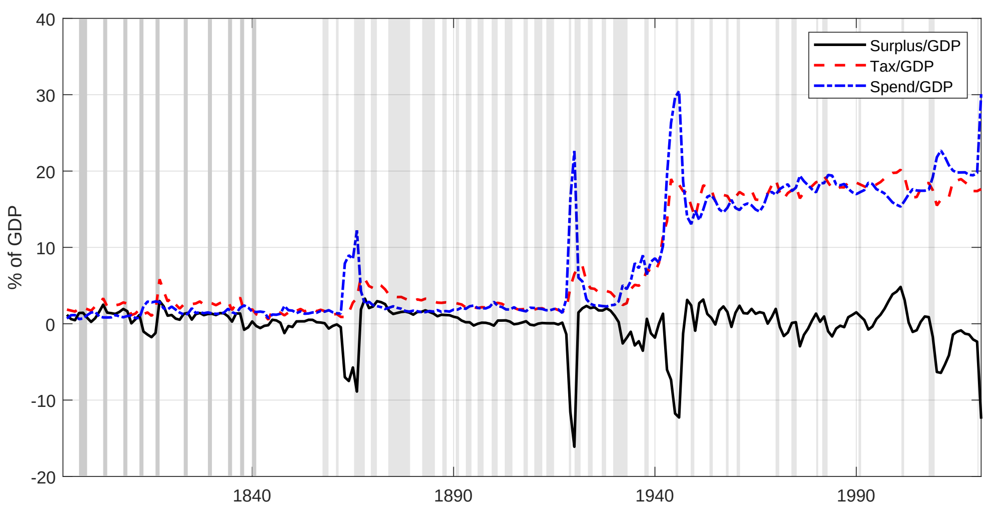
Figures E.2 and E.3 show impulse-response functions for the pre-1946 and post-1946 samples, respectively. They show the response of Tax/GDP, Spending/GDP, and Surplus/GDP to a 1% point increase in spending/GDP (panel A), a 1% point decrease in tax revenues/GDP (panel A), and a 1% point increase in GDP growth (panel C).

Figure E.1: Primary Surpluses in Recessions versus Expansions

Panel A: United Kingdom 1729 – 2020

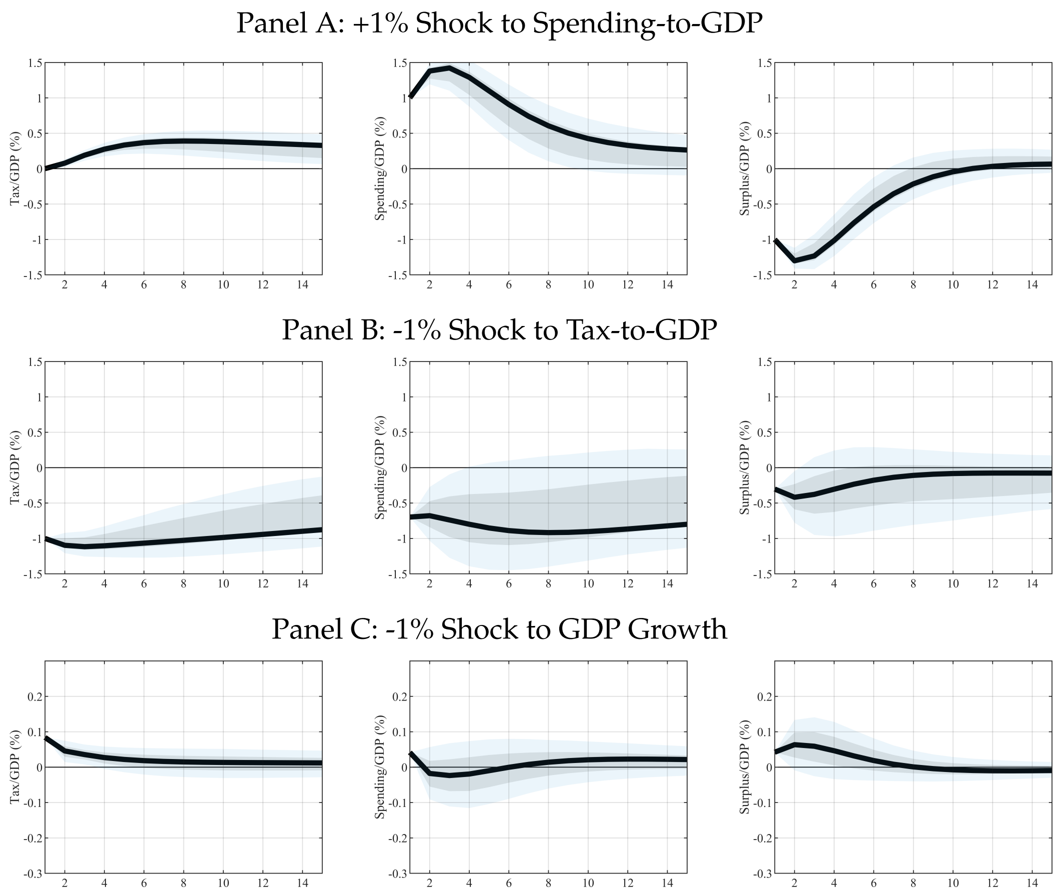


Panel B: United States



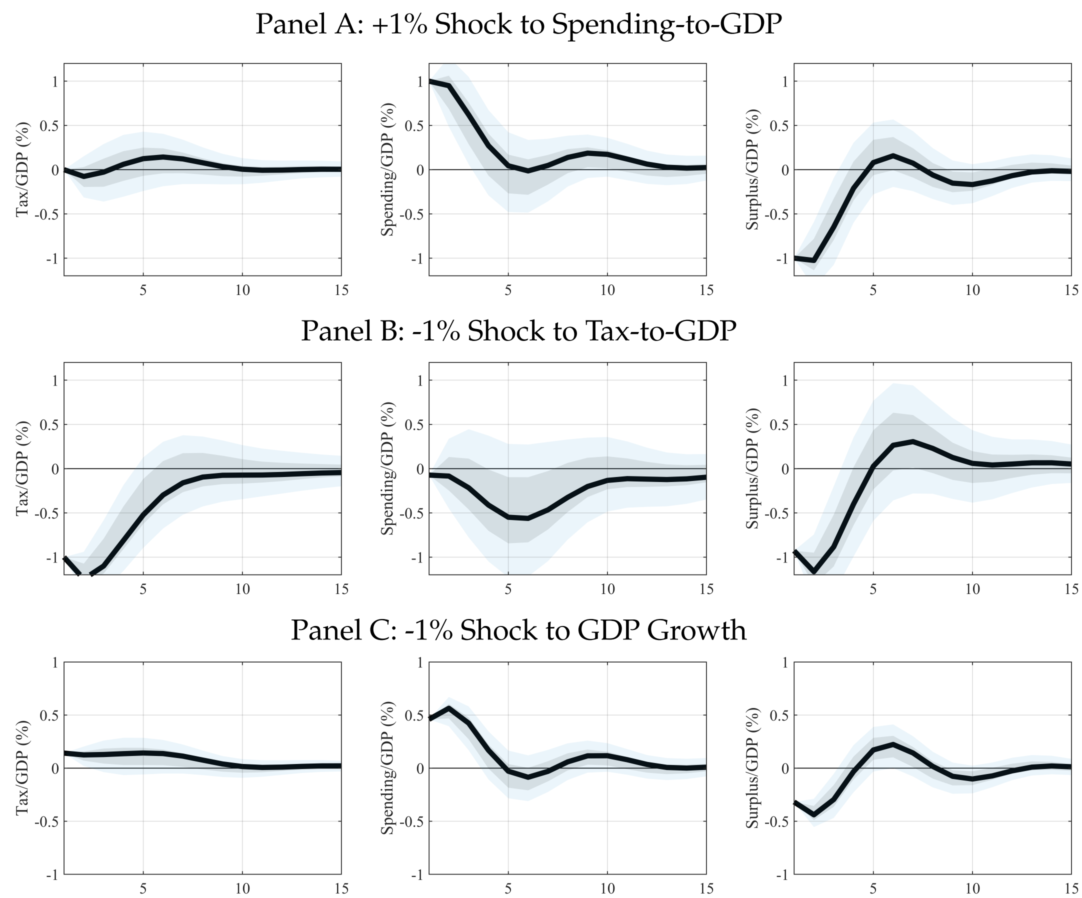
The figure shows the ratios of government spending, tax revenue, and primary surpluses to GDP for the U.K. from 1729 to 2020 (Panel A) and the U.S. from 1793 to 2020 (Panel B). The primary surpluses are the government revenue minus government spending before interest payments. Shaded areas are recessions, as defined by Dimsdale and Thomas (2019) for the U.K. and as dated by Davis (2006) for the 1796–1840 period and NBER recessions thereafter for the U.S.

Figure E.2: Impulse Response: 1729 – 1946 United Kingdom



The solid black line shows the impulse responses for the benchmark VAR. The impulse in the top row is a +1 percentage point shock to spending growth. The impulse in the middle row is a -1 percentage point shock to tax revenues. The impulse in the bottom row is a -1 percentage point shock to GDP growth x_t. We plot the one- and two-standard-deviation confidence intervals based on bootstrapping over 10,000 rounds.

Figure E.3: Impulse Response: 1947 – 2020 United Kingdom

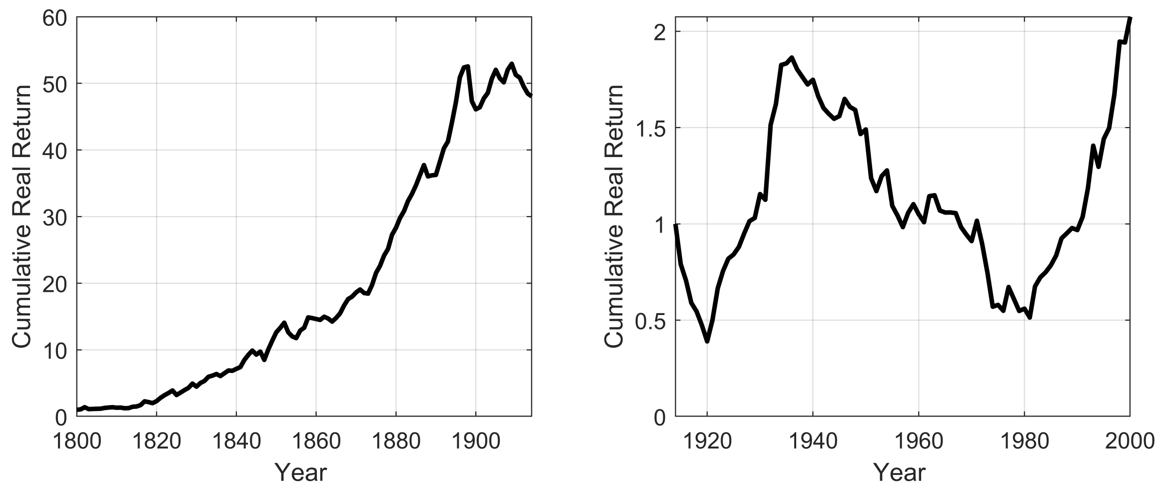


The solid black line shows the impulse responses for the benchmark VAR. The impulse in the top row is a +1 percentage point shock to spending growth. The impulse in the middle row is a -1 percentage point shock to tax revenues. The impulse in the bottom row is a -1 percentage point shock to GDP growth x_t. We plot the one- and two-standard-deviation confidence intervals based on bootstrapping over 10,000 rounds.

E.3 Historical Real Return on U.K. Government Bonds

Figure E.4 plots the cumulative real return for U.K. government bonds from 1800 to 2000. Across the 19th century, the Gilts generated a consistently high real return for investors. However, in the 20th century, although the UK Gilts no longer had convenience yield, the real return was much lower then the previous century.

Figure E.4: U.K. Government Bonds: Cumulative Real Return



This figure plots the cumulative real return on U.K. government bonds from 1800 to 2000. The left panel is 1800–1914, and the right panel is 1914–2000. Year 1800 and 1914 are normalized to 1 respectively. We calculate nominal returns on each gilt in the Ellison and Scott (2020) data, and then compute the quantity weighted average return for each year. The real return is calculated as the difference between the nominal return and the inflation rate.

E.4 Robustness Checks U.K.: Debt-in-VAR, Alternative Convenience Yields, Lower GDP Risk Premium

This section shows more details on the results of three robustness checks for the U.K. described in the main text. Table E.1 reports the summary statistics on fiscal cash flows and fiscal backing for three robustness checks. The first one includes debt in the VAR. The second one lowers the GDP risk premium to 2% from its benchmark value of 3%. The third one assumes convenience yields are a constant fraction of GDP in the pre-1946 period.

The main text presents the results for the model with the debt/gdp ratio as an extra state variable in the VAR for the U.K. in the pre-war sample. Here, we repeat this exercise for the post-war sample. We include both the first difference and the level of the demeaned log debt/GDP ratio in the VAR and impose the cointegration for debt and output with coefficient (1, -1) as we did for tax revenue and spending. For the post-war U.K. sample, we find an eigenvalue greater than 1 for the VAR companion matrix when we include the debt/GDP ratio in the VAR. Therefore, we remove the unit root in the debt/GDP series by removing a separate sub-sample mean pre- and post-2007 from the log debt/GDP ratio. This procedure posits a structural break in the log debt/GDP ratio in 2007.

The dynamic fiscal capacity measure for this model is shown as the yellow line in Figure E.5. The orange line plots the benchmark case (no debt in the VAR) and the blue line is the observed debt/GDP ratio. The yellow and orange lines are very close until about the year 2000. After 2000, the fiscal capacity increases faster for the model with debt in the VAR. This occurs because the model with debt in the VAR and a structural break in the debt/GDP ratio in

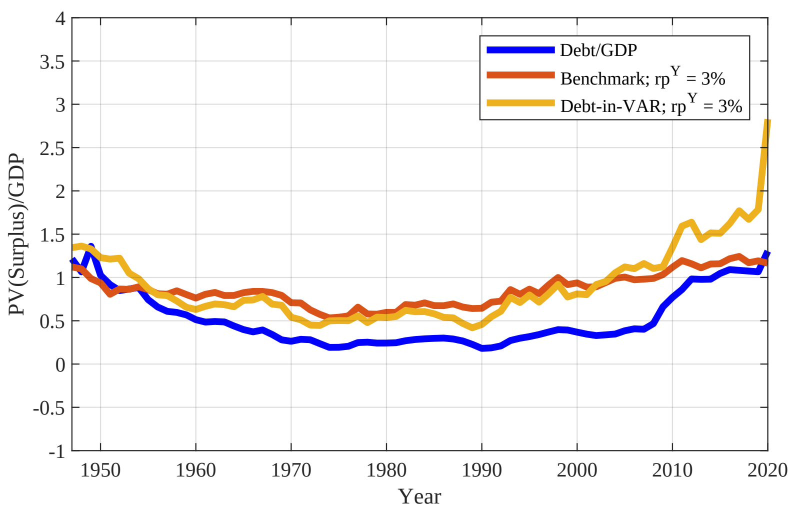
Table E.1: Analysis of Fiscal Backing for the U.K.: Robustness

	Debt in VAR		$rp^Y = 2\%$			**Constant Conv. Yields**	
	1729 – 1946	1947 – 2020	1729 – 1914	1729 – 1946	1947 – 2020	1729 – 1946	1947 – 2020
	Steady State at $z = 0$						
$PV(S)/Y$	28.59	73.13	63.05	37.21	126.09	28.59	73.13
$PV(S+CY)/Y$	36.09	73.13	71.08	47.04	126.09	35.96	73.13
$PV(S+CY)/D$	41.45	136.58	82.22	54.03	235.48	41.30	136.58
	Sample Averages						
$PV(S)/Y$	45.62	90.57	71.05	76.18	148.54	58.34	85.46
$PV(S+CY)/Y$	63.53	90.57	78.16	85.06	148.54	64.87	85.46
$PV(S)/D$	52.39	169.14	82.19	87.50	277.41	67.01	159.60
$PV(S+CY)/D$	72.97	169.14	90.41	97.70	277.41	74.51	159.60
$\rho(PV(S+CY)/Y, D/Y)$	0.89	0.86	0.71	0.65	0.81	0.62	0.79

The table reports estimates of fiscal capacity for the U.K. under different model specifications. All values are in percentage points, except for the correlation coefficient ρ. In three separate panels, we report the estimates of fiscal capacity in the model with the debt/GDP ratio in the VAR (left panel), the benchmark specification with an unlevered equity or output risk premium rp_0^Y of 2% (middle panel), and the seignoirage revenue as a fixed fraction 0.47% of GDP as in Figure 3 (right panel). D denotes the market value of debt.

2007 generates higher surplus predictability once the low-frequency component in debt/GDP is removed. The high debt/GDP ratio at the end of the sample coincides with higher future surpluses creating extra fiscal capacity relative to the benchmark model. The estimates for the fiscal capacity under this model specification is reported in Table E.1. Our main conclusion that the observed debt/GDP ratio is below the fiscal capacity bound in the post-WW-II period for the U.K. is strengthened.

Figure E.5: U.K. Fiscal Capacity Post 1947: Debt in the VAR

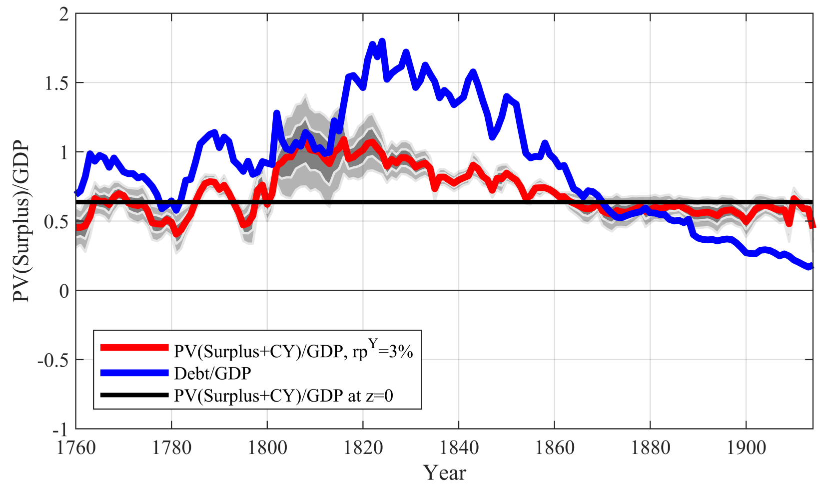


The figure plots the fiscal capacity of the U.K. government over the sample period from 1947 to 2020 for the model with debt/GDP ratio in the VAR. The yellow line plots the fiscal capacity estimated using the VAR with debt/GDP ratio. For comparison, the orange line plots the benchmark case without debt in the VAR. The blue line is the observed debt/GDP ratio in the data. The GDP risk premium is 3%.

E.5 Fiscal Capacity in the U.K. During and After Industrial Revolution

The Industrial Revolution began in the U.K. around 1760. It greatly improved productivity growth. Real GDP growth increased from 0.8% pre-1760 to 1.75% in 1760–1914. Higher economic growth increases the valuation ratio of the GDP claim and boosts fiscal capacity. We estimate the fiscal capacity for U.K. during the period from 1760 to 1914, and Figure E.6 plots our estimates. The outstanding debt is above the estimated fiscal capacity until the start of the 20th century. On average, the fiscal backing is 70.50% of GDP, lower than the average outstanding debt 89.76% of GDP. The correlation between the estimated fiscal capacity and debt-to-GDP ratio is 0.79. Our conclusion is that the U.K. enjoys spare fiscal capacity during this period stands.

Figure E.6: Fiscal Capacity: U.K. After Industrial Revolution from 1760 to 1914



This figure plots U.K. fiscal capacity during and after Industrial Revolution (starting in 1760). The fiscal capacity includes the seigniorage revenue from convenience yields. 2-standard-error confidence intervals around the dynamic fiscal capacity is generated by bootstrapping 10,000 samples. We also report the steady-state upper bound evaluated at $z = 0$, and the actual debt/GDP ratio. We report the benchmark case with a GDP risk premium of 3%.

E.6 Additional Structural Break for the U.S. in 1860

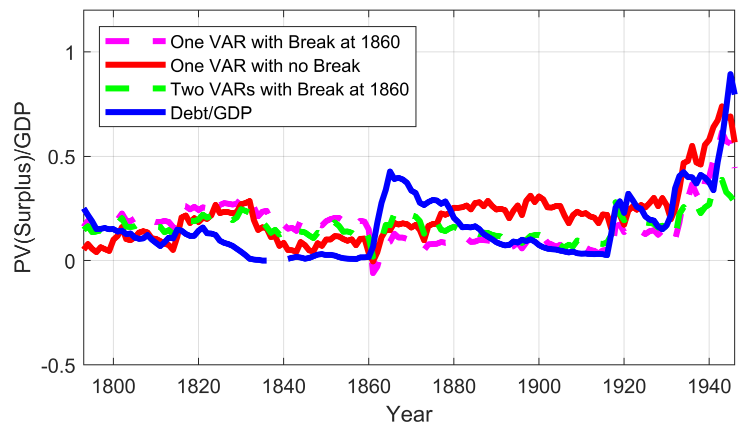
The pre-WW-II U.S. has gone through structural changes in the federal government institutions. There is considerable evidence that the government's tax revenue T increased significantly after the Civil War. Before the Civil War, the federal government relied on customs duties and land sales as the main source of revenue. During the Civil War, the federal government started to implement a host of new taxes, permanently increasing its tax base. Based on the Chow test for a structural break in the mean of g and τ over the sample period from 1794 to 1914, the F-statistics for the year 1860 were 8.27 for the spending-to-GDP ratio and 8.53 for the tax-to-GDP ratio. Consequently, the null hypothesis of a structural break in 1860 cannot be rejected for the pre-WW-I U.S. sample.

We conduct two robustness checks of our analysis for the pre-WW-II U.S. sample, with results in Figure E.7 and Table E.2. First, we demean the levels and the growth rates of tax-to-GDP ratio and spending-to-GDP ratio using two different subsamples means with the subsample split in year 1860. We then re-estimate the dynamics of fiscal backing using one VAR over the sample from 1793 to 1946. The pink dash line in Figure E.7 shows the estimated fiscal backing. The sample average is 17.05% of GDP, which is close to the fiscal backing estimate of 21.08% in our benchmark specification (red solid line). Second, we estimate the fiscal backing using a separate VAR for each of the two subsamples: 1793 to 1860 and 1861 to 1946. This specification not only allows for different means for the fiscal cash flows but also for different dynamics. The green dashed line in Figure E.7 shows a pattern similar to our benchmark specification. The subsample average of fiscal capacity is 16.33% before 1860 and 16.13% after 1860, both of which are close to the benchmark estimates.

E.6.1 Three Historical Episodes

We study three historical episodes of special interest: 1793–1799, the War of 1812, and the Civil War. Table E.3 provides a decomposition of the upper bound in each period. The first row reports the primary surplus. The second row reports

Figure E.7: Fiscal Capacity with Structural Break: U.S. 1793 – 1946



This figure plots the fiscal capacity of the U.S. government over the sample period from 1793 to 1946. The observed debt/GDP ratio is in blue. The red line is the fiscal capacity for the pre-WWII sample under our benchmark specification, one VAR without structural break in 1860. The pink dashed line is the fiscal capacity with one VAR for the entire pre-WWII sample with both level and growth of tax/GDP ratio and spending/GDP ratio demeaned using two subsample means (pre-1860 and post-1860). The green dashed line shows the fiscal capacity by estimating two subsample VARs (pre-1860 and post-1860).

the debt/GDP ratio. The third row reports the steady-state fiscal capacity obtained using the steady-state valuation ratio. This measure holds expected future cash-flows and discount rates constant. The final two rows add the time-varying cash flow components and discount rates, respectively, to arrive at the final fiscal upper bound estimate. Panel A is for our benchmark model while Panel B is for the model that allows for separate means and dynamics for the state variables in the period before 1860 and in the period after 1860, discussed earlier in this appendix.

1793–1799 In the first episode from 1793–17999, the federal government was running primary surpluses of around 0.9% of GDP. Hamilton's projected future surplus for the 1790s which led him to believe that the U.S. could pay back the debt it owed to foreigners in full and give a roughly 20% haircut to the domestic investors. Hamilton's projections were reasonable, based on both the surplus in 1790 and the realized surpluses in the years thereafter. Our baseline model in Panel A of Table E.3 predicts an upper bound of 5.60% of GDP. Our estimated $PV(S)$ is low in this period despite the primary surpluses because the price-dividend ratio of the spending claim is higher than that of the tax claim. The third row, which uses the price-dividend ratio of the GDP claim for both revenue and spending claims, shows a much higher fiscal backing estimate (36.71%), well above the debt/GDP ratio. The fourth row shows that considering expected future cash-flow growth rates significantly lowers the estimate of fiscal backing (to 7.31%). This reflects higher VAR-predicted spending growth and lower VAR-predicted tax revenue growth over the 1793-99 period, induced by mean reversion dynamics in tax and spending/GDP. The VAR model anticipates the higher government spending and tax revenues that occur after 1860, and which increase the long-run mean of τ and g in the pre-WW-II regime (and more so for spending than for tax revenues).

The results for the specification with an additional structural break in 1860 are reported in Panel B of Table E.3. The mean-reversion effect of the cash flows is substantially weaker in this specification. This makes sense since the mean values of spending/GDP and tax revenue/GDP ratios, to which these ratios mean-revert, are now substantially lower than in Panel A. The upper bound on the present value of surpluses is now 14.17% of GDP and 78% of outstanding debt, which is very close to Hamilton's estimate that the U.S. could service about 85% of its debt during this period.

Table E.2: Fiscal Backing for the Pre-WW II U.S.: Structural Break around Civil War

	One VAR with Break	Two VARs with Break	
	1793-1946	1793-1860	1861-1946
$\log \tau$	-3.62	-3.94	-3.36
$\log g$	-3.80	-4.27	-3.44
$\Delta\tau$ %	1.54	-0.36	3.03
Δg %	2.02	0.73	3.04
	Sample Averages		
$PV(S)/Y$ %	17.05	16.33	16.13
$PV(S)/D$ %	103.48	204.90	71.21
$\rho(PV(S)/Y, D/Y)$	0.46	0.18	0.84

The top panel reports the sample averages of the level and the growth of log(tax revenue) and log(spending) in the data. The bottom panel report estimates of fiscal backing for the U.S. pre-WW-II sample for both one VAR where we demean the cash flows using two different subsample means before and after 1860, and two VAR specification where we estimate the dynamics of fiscal backing separately for two subsamples: 1793 to 1860 and 1861 to 1946.

1812–1815 The second episode for the U.S. we investigate more closely is the War of 1812. The U.S. was running primary deficits, 1.35% on average over the 1812–1815 period. Our benchmark model in Panel A of Table E.3 produces an estimate for the PDV of future surpluses of 8.01% of GDP, which can be understood as the result of primary deficits valued at the valuation ratio of GDP (which result in an estimate of -56.85% in row 3), and offsetting cash flow dynamics resulting from mean-reversion in future spending and tax revenues, which substantially increase the upper bound estimate in this period (row 4 vs. row 3). The VAR sees through the temporary nature of the war and predicts higher future tax revenue and lower spending. The same is true for the model with an additional structural break in 1860 in Panel B, which ends up with an estimate for the upper bound that is somewhat higher, at 13.77% of GDP. The debt remains below the upper bound on fiscal capacity in this period for this model.

1861–1865 In the third episode of interest, the Civil War, the pattern from the earlier period 1812-15 repeats itself. The federal government runs primary deficits of nearly 6% of GDP. Row 3 indicates a present value of these deficits of -248.59% of GDP in Panel A of Table E.3 under constant discount rates and expected cash flow growth rates. However, the baseline upper bound estimate is 8.79% of GDP (row 5) because the VAR looks through this transitory increase in deficits; expected future revenues and spending indicate higher future surpluses (row 4 vs. row 3). The results are qualitatively similar in Panel B for the robustness check with a structural break in 1860.

The Union started the war with almost no debt, but the debt quickly grew from 1% in 1860 to 27% in 1864 and briefly exceeds our upper bound on fiscal capacity. The Union ended up in serious fiscal trouble and had to resort to financial repression. During the Civil War, Salmon P. Chase, the Secretary of the Treasury, was constantly struggling to raise enough funds to pay for the war effort. In 1862, Congress passed the Legal Tender Act which allowed the Treasury to issue Treasury Notes that were legal tender and hence had to be accepted as payment. These notes, colloquially referred to as greenbacks, could be used to pay back debts, even those debts that had been contracted under the gold standard. The Treasury Notes were not backed by gold or silver. They did not pay interest and did not have a maturity date. Such provisions were unusual in those days. The U.S. federal government was for the very first time issuing paper currency. The Union government did not stop there. In 1863, Congress passed the National Banking Act which reinserted the U.S. federal government into the banking system. Banks that were chartered as National Banks were allowed to issue uniform banknotes up to $500,000, but these had to be backed by Treasury bonds deposited with the Treasury. These

Table E.3: Decomposition PDV of Surplus for the U.S.

Panel A: Benchmark Model (No Structural Break in 1860)			
	1793-1799	1812-1815	1861-1865
$\tau - g$	0.87	-1.35	-5.91
D/Y	18.07	11.29	25.80
$\tau e^{pd_0} - g e^{pd_0}$	36.71	-56.85	-248.59
$\tau e^{pd_0 + \widetilde{CF}^T} - g e^{pd_0 + \widetilde{CF}^G}$	7.31	9.51	10.28
$\tau e^{pd_0 + \widetilde{CF}^T - \widetilde{DR}} - g e^{pd_0 + \widetilde{CF}^G - \widetilde{DR}}$	5.60	8.01	8.79

Panel B: Structural Break in 1860; two VARs			
	1793-1799	1812-1815	1861-1865
$\tau - g$	0.87	-1.35	-5.91
D/Y	18.07	11.29	25.80
$\tau e^{pd_0} - g e^{pd_0}$	25.74	-39.86	-373.22
$\tau e^{pd_0 + \widetilde{CF}^T} - g e^{pd_0 + \widetilde{CF}^G}$	15.70	13.64	12.21
$\tau e^{pd_0 + \widetilde{CF}^T - \widetilde{DR}} - g e^{pd_0 + \widetilde{CF}^G - \widetilde{DR}}$	14.17	13.77	10.22

The table reports a decomposition of the fiscal backing measure over different episodes in the U.S. pre-WWII sample. Panel A reports the decomposition for our benchmark VAR model without a structural break in 1860. Panel B reports the decomposition from the model with an additional break in 1860, where we estimate two separate VARs before and after 1860. All numbers are expressed as percentage of U.S. GDP.

notes were identical in all states, much like the notes issued by the Bank of England. The Act also imposed a 2% tax on notes issued by the states in order to discourage the states' issuance. The National Banking scheme was favored by Chase because it was designed to encourage investors to buy and hold interest-bearing bonds, not as inflationary as paper currency.

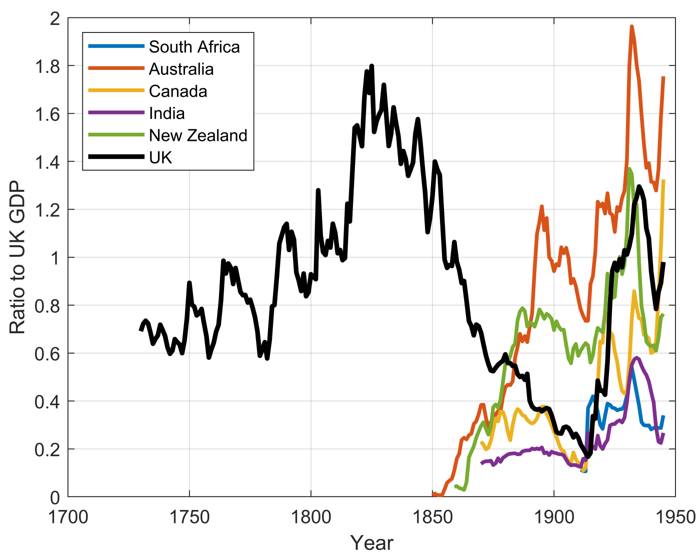
F U.K. Colonial Government Finances and Debt

F.1 Data

The historical GDP data for the colonial countries (Canada, India, New Zealand, Australia, South Africa) is from Global Financial Data, series **GDPCAN, GDPIND, GDPNZL,GDPAUS, GDPZAF**. The historical debt data is also from GFD, series **GVDCZAF, GVDCCAN, GVDCNZL, GVDCIND, GVDCAUS**.

We divide each country's debt by its GDP to get the debt-to-GDP ratio for each of the dominions and colonies for which we have data. Figure F.1 shows the result. Australia, Canada and New Zealand borrowed a substantial amount of debt starting in the late nineteenth century. The debt to GDP ratio for Australia reached almost 200% in 1932. The large increase in the colonial debt in the late nineteenth century was facilitated by the passing of the Colonial Stock Act in 1900. The Act awarded trustee status to colonial loans (Jessop, 1976). Before 1900, the holders of trusts could only invest in colonial debt if explicitly stated in the trust documents (Sargent, Hall, Ellison, Scott, James, Dabla-Norris, De Broeck, End, Marinkov, and Gaspar, 2019).

Figure F.1: Consolidated Government Debt: British Empire



This figure plots the market value of government debt to GDP ratio for the U.K. government and five colonial governments prior to WWII including South Africa, Australia, Canada, India and New Zealand. Data Source: Global Financial Database.

The historical colonial government finance data is available from Xu (2018) for all British colonies except India and from the *Statistical Abstract Relating to British India* for India (Great Britain. India Office, 1920). The data set from Xu (2018) contains the nominal value of government revenue and spending of the provinces and regions when they were British colonies. A region is in the data only while it is a British colony. For the countries for which we that we have public debt and GDP data (Canada, New Zealand, Australia, South Africa), we map colonies into countries using the mapping in Table F.1. The sample period is 1854-1946; Table F.2 reports the individual sample periods for each colony. For colonies that do not report data continuously, we use linear interpolation to fill in missing values.

The raw data in Xu (2018) come from the Colonial Blue Books published by the British Colonial Office. The data do not have India because India was not under the auspices of British Colonial Office, but rather the British India Office.

Table F.1: Mapping between Countries and British Colonies

Country	British Colonies
Australia	Western Australia, New South Wales, Tasmania Queensland, Gold Coast
South Africa	Victoria, Natal, Basutoland Bechuanaland, Cape of Good Hope
New Zealand	New Zealand
Canada	Vancouver, New Brunswick, British Columbia Nova Scotia, Newfoundland, Prince Edward Island

This table provides the mapping between countries and the areas of the countries that were British colonies.

We collect British India government finance from *Statistical Abstract Relating to British India* published by British India Office. The sample period for India is 1840 to 1919. The statistics books are published roughly once every ten years, and we consolidate data from the individual books. The series we use for each statistic book is summarized in Table F.3.

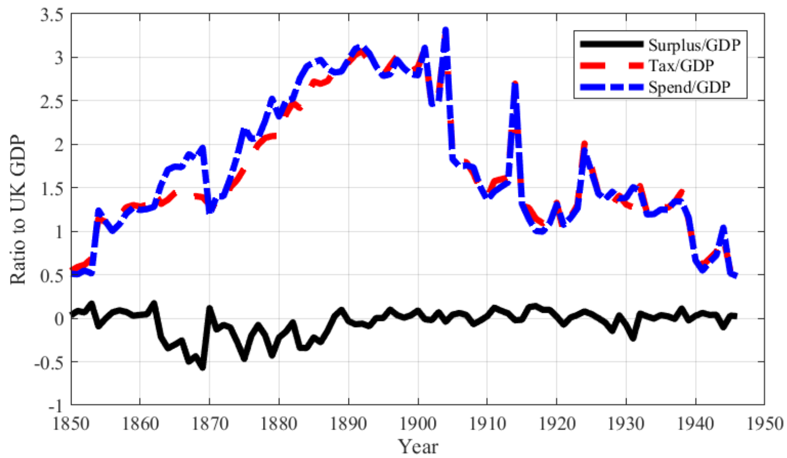
F.2 Results

Figure F.2 shows the revenue, spending and surplus for the colonial governments. Panel (A) plots the colonial government finances as a percentage of UK GDP with all colonies combined except British India, and Panel (B) plots the ones for British India. We observe while the tax and spending have some modest fluctuations, the surpluses are mostly close to 0 except for the 1860s when the surpluses go negative.

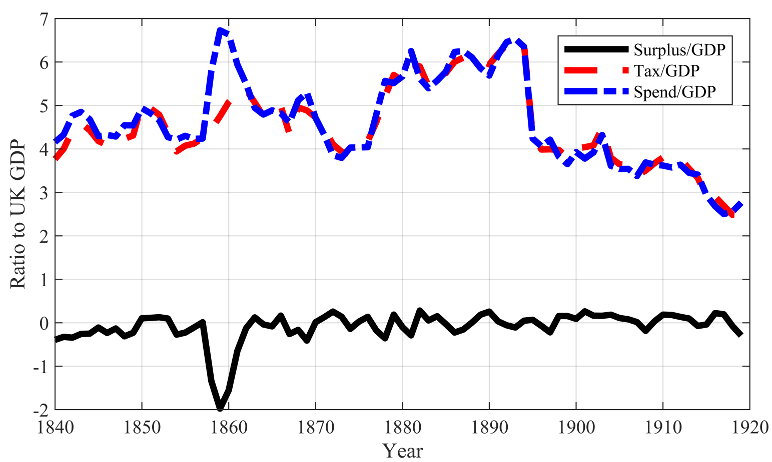
Figure F.3 plots the dynamic estimates of the fiscal for the sample period 1850-1946. Since this sample is different from our main pre-WW-I sample, so is the baseline estimate of fiscal backing. relate to that new baseline, adding colonial debt reduces the extent of fiscal backing by 3.07%, thereby strengthening our conclusions about the lack of fiscal backing for the U.K. during its period of global hegemony.

Figure F.2: UK Colonial Governments Finance

Panel A: All Colonies excluding India



Panel B: British India



This figure plots the government finances of British colonial governments by year. For Panel A, we consolidate all British colonial governments excluding India using the data from Xu (2018). The sample period is from 1850 to 1946. For Panel B, we use data from *Statistical abstract relating to British India*. The revenue, expenditure and surplus are all in percentage of U.K. GDP. The sample period is from 1840 to 1920.

Table F.2: Sample Period for British Colonies

Colony Name	Sample Start	Sample End	Colony Name	Sample Start	Sample End
Antigua	1850	1884	New Zealand	1850	1924
Bahamas	1850	1944	Newfoundland	1854	1932
Barbados	1850	1946	Nigeria	1914	1939
Basutoland	1884	1946	Northern Nigeria	1900	1913
Bechuanaland	1891	1946	Northern Rhodesia	1924	1946
Bermuda	1850	1946	Nova Scotia	1850	1866
British Columbia	1860	1866	Nyasaland	1903	1938
British Guiana	1850	1943	Palestine	1921	1944
British Honduras	1854	1943	Prince Edward Island	1850	1871
Cape of Good Hope	1850	1908	Queensland	1860	1901
Cayman Islands	1916	1946	Seychelles	1903	1939
Ceylon	1850	1944	Sierra Leone	1850	1946
Cyprus	1879	1946	Solomon Islands	1921	1941
Dominica	1851	1932	Somaliland	1900	1946
Falkland Island	1850	1944	South Australia	1850	1925
Fiji	1876	1940	Southern Nigeria	1900	1913
Gambia	1850	1946	Southern Rhodesia	1923	1932
Gibraltar	1850	1946	St. Christopher	1850	1893
Gold Coast	1850	1946	St. Helena	1850	1941
Grenada	1850	1938	St. Lucia	1850	1934
Heligoland	1851	1889	St. Vincent	1850	1934
Hong Kong	1850	1939	Straits Settlements	1861	1946
Ionian Islands	1850	1863	Swaziland	1906	1946
Jamaica	1850	1945	Tanganyika	1920	1946
Kenya	1900	1946	Tasmania	1850	1924
Labuan	1850	1888	Tobago	1851	1898
Lagos	1862	1904	Trinidad	1850	1899
Leeward Islands	1885	1945	Trinidad & Tobago	1894	1945
Malta	1850	1944	Turks and Caicos	1851	1946
Mauritius	1850	1946	Uganda	1901	1945
Montserrat	1854	1888	Vancouver	1862	1865
Natal	1850	1907	Victoria	1854	1904
Nevis	1854	1882	Virgin Islands	1854	1946
New Brunswick	1850	1865	Western Australia	1850	1914
New South Wales	1850	1914			

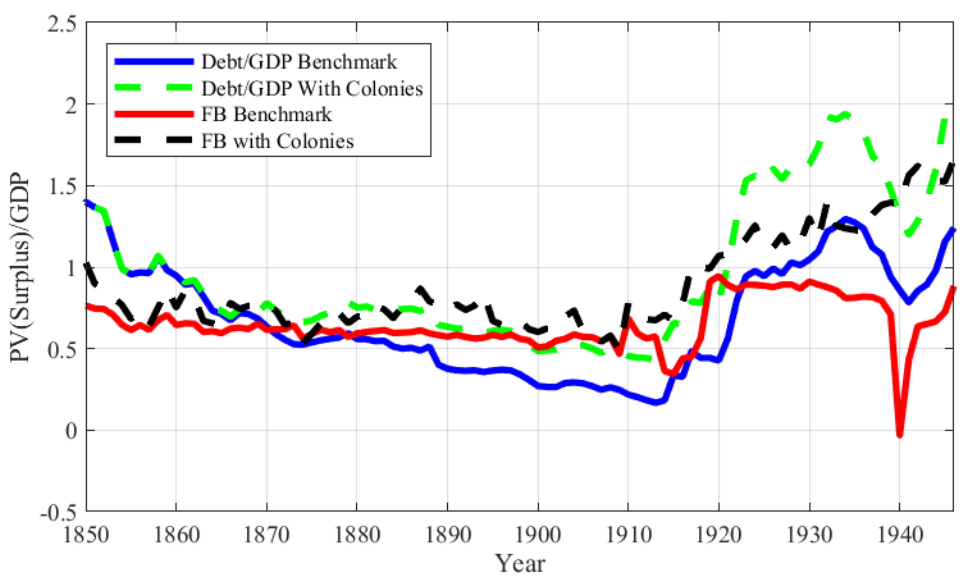
This table reports the sample period for each British Colony in Xu (2018) that is used in the paper.

Table F.3: Series in *Statistical Abstract Relating to British India*

Book Name	Series Name for Revenue	Series Name for Spending
From 1840 to 1865	Gross Revenue.	Gross Expenditure.
From 1860 to 1869	Gross Revenue.	Gross Expenditure.
From 1867/8 to 1876/7	Gross Revenue.	Total Expenditure.
From 1885-86 to 1894-95	Gross Revenue. Total	Expenditure.Total.
From 1894-95 to 1903-04	Gross Revenue. Total	Expenditure Charged to Revenue. Total
From 1903-04 to 1912-13	Gross Revenue. Total	Expenditure Charged to Revenue. Total
From 1910-11 to 1919-1920	Gross Revenue. Total	Expenditure Charged to Revenue. Total

This table summarizes the source of the British Indian public finance data. The first column is the book name of the *Statistical Abstract Relating to British India*. The second column is the series name for the revenue data, and the third column is the series name for the spending data.

Figure F.3: Fiscal Capacity: Consolidating Colonial Government Finance



This figure plots the dynamic fiscal capacity estimates with consolidated British colonial governments over the benchmark estimates for the sample period 1850-1946. The black dashed line is the estimated fiscal capacity by consolidating the colonial government finances to the UK central government. We run the VAR on the period with τ and g being the sum of the central government and colonial government revenue and spending respectively.

G Holland and the Netherlands

G.1 Summary Statistics for the Fiscal Variables

Table G.1 provides summary statistics for the fiscal variables for the Province of Holland (1601–1794) and the country of The Netherlands (1817–1914).

Table G.1: Summary Statistics of Government Finance

	mean	std	min	25%	50%	75%	max
	Panel A: Province of Holland 1601–1794						
τ	10.7	1.9	6.0	9.2	10.9	12.0	16.8
g	8.6	3.6	2.5	5.8	7.8	10.8	19.9
$\tau - g$	2.2	3.4	-6.8	-0.2	2.8	5.1	8.5
	Panel B: The Netherlands 1817–1914						
τ	12.3	2.5	7.4	10.3	11.0	14.7	17.4
g	8.9	2.0	6.2	7.8	8.2	9.1	15.0
$\tau - g$	3.3	2.6	-7.6	2.2	2.8	4.5	8.2

Note: The table reports summary statistics for the ratio of government spending to GDP (g) and the ratio of tax revenue to GDP (τ) for the province of Holland in Panel A and the Netherlands in Panel B. The spending (g) excludes interest payments. The surplus is the primary surplus ($\tau - g$).

G.2 VAR for Holland and Netherlands

Table G.2 and Table G.3 summarize the variables we include in the state vector, in order of appearance of the VAR. All state variables are demeaned by their respective sample averages. Table G.4 and Table G.5 report the estimated Ψ matrices.

Table G.2: State Variables for 1601 – 1794

Position	Variable	Mean	Description
1	π_t	π_0	Log Inflation
2	$y_t^{\$}(10)$	$y_0^{\$}(10)$	Log 10-Year Nominal Yield
3	x_t	x_0	Log Real GDP Growth
4	$\Delta \log \tau_t$	μ_τ	Log Tax Revenue-to-GDP Growth
5	$\log \tau_t$	$\log \tau_0$	Log Tax Revenue-to-GDP Level
6	$\Delta \log g_t$	μ_g	Log Spending-to-GDP Growth
7	$\log g_t$	$\log g_0$	Log Spending-to-GDP Level

G.3 Fiscal Backing with Expanded VAR

Figure G.1 plots the dynamics of fiscal backing when including dividend growth, log dividend level and log price-dividend ratio as state variables. The result is very close to our benchmark estimates.

Table G.3: State Variables for 1817 – 1914

Position	Variable	Mean	Description
1	π_t	π_0	Log Inflation
2	$y_t^{\$}(1)$	$y_0^{\$}(1)$	Log 1-Year Nominal Yield
3	$yspr_t^{\$}$	$yspr_0^{\$}$	Log 10-Year Minus Log 1-Year Nominal Yield Spread
4	x_t	x_0	Log Real GDP Growth
5	$\Delta \log \tau_t$	μ_τ	Log Tax Revenue-to-GDP Growth
6	$\log \tau_t$	$\log \tau_0$	Log Tax Revenue-to-GDP Level
7	$\Delta \log g_t$	μ_g	Log Spending-to-GDP Growth
8	$\log g_t$	$\log g_0$	Log Spending-to-GDP Level

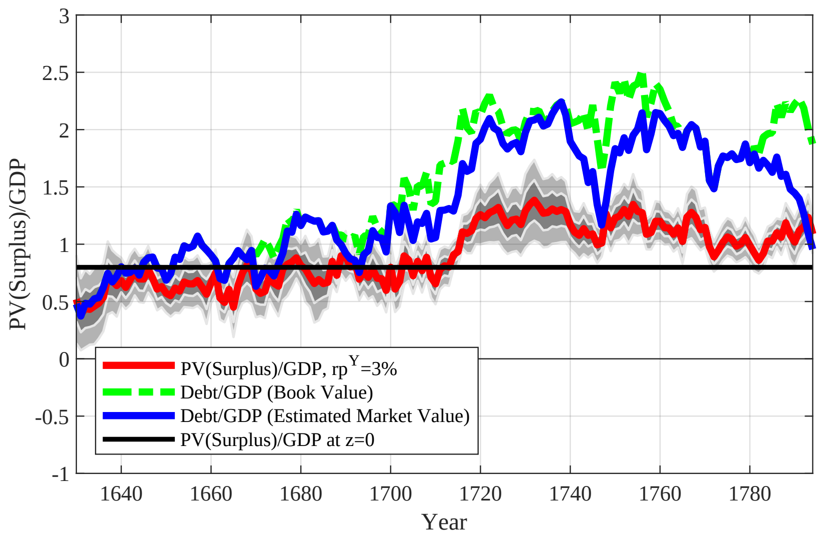
Table G.4: VAR Estimates $\mathbf{\Psi}$: 1601 – 1794 Sample

	π_{t-1}	$y_{t-1}^{\$}(10)$	x_{t-1}	$\Delta \log \tau_{t-1}$	$\log \tau_{t-1}$	$\Delta \log g_{t-1}$	$\log g_{t-1}$
π_t	0.17	-0.17	-0.01	0.01	0.04	0.00	0.00
$y_t^{\$}(10)$	0.00	0.96	0.00	0.00	-0.00	-0.00	0.00
x_t	0.26	-0.22	-0.23	0.04	0.17	-0.01	-0.00
$\Delta \log \tau_{t-1}$	-0.36	0.83	-0.08	-0.18	-0.48	0.05	0.04
$\log \tau_{t-1}$	-0.36	0.83	-0.08	-0.18	0.52	0.05	0.04
$\Delta \log g_{t-1}$	-0.44	2.76	0.15	0.19	-0.39	0.11	-0.15
$\log g_{t-1}$	-0.44	2.76	0.15	0.19	-0.39	0.11	0.85

Table G.5: VAR Estimates $\mathbf{\Psi}$: 1817 – 1914 Sample

	π_{t-1}	$y_{t-1}^{\$}(1)$	$y_{t-1}^{\$,spr}$	x_{t-1}	$\Delta \log \tau_{t-1}$	$\log \tau_{t-1}$	$\Delta \log g_{t-1}$	$\log g_{t-1}$
π_t	0.06	-1.92	-1.34	-0.02	-0.07	0.10	0.03	-0.01
$y_t^{\$}(1)$	0.02	0.62	0.09	-0.01	0.00	0.00	-0.01	0.00
$y_{t-1}^{\$,spr}$	-0.00	0.34	0.78	-0.02	-0.01	-0.00	0.01	0.00
x_t	-0.03	-0.25	-0.15	-0.29	-0.04	-0.02	0.01	0.01
$\Delta \log \tau_{t-1}$	-0.44	1.35	3.40	1.03	-0.01	-0.31	-0.04	-0.01
$\log \tau_{t-1}$	-0.44	1.35	3.40	1.03	-0.01	0.69	-0.04	-0.01
$\Delta \log g_{t-1}$	-0.09	3.93	-0.02	0.47	-0.04	0.06	-0.23	-0.16
$\log g_{t-1}$	-0.09	3.93	-0.02	0.47	-0.04	0.06	-0.23	0.84

Figure G.1: Robustness for Netherlands: Adding Stock Market Variables to VAR 1630–1794



Here we plot the dynamic measure of fiscal backing for the Holland government over the sample period from 1630 to 1794 (red line), the steady-state fiscal capacity measure (horizontal black line), the estimated market value of debt/GDP ratio (blue line), and the actual book value debt/GDP ratio (green line). We added the stock price/dividend ratio and dividend growth as additional VAR variables. The GDP risk premium is 3%. We include the seigniorage revenue from the convenience yield of 1.5%. The two-standard-error confidence interval around the dynamic fiscal capacity estimate is generated by bootstrapping 10,000 samples.