Three World Wars: Fiscal-Monetary Consequences*

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> What a Government spends the public pay for. There is no such thing as an uncovered deficit. But in some countries, it seems possible to please and content the public, for a time at least, by giving them in return for the taxes that they pay, finely engraved acknowledgements on water-marked paper. The income tax receipts, which we in England receive from the surveyor, we throw into the waste paper basket; in Germany they call them bank-notes and put them into their pocketbooks; in France they are termed Rentes and are locked up in the family safe.
>
> John Maynard Keynes, 1924, *A Tract on Monetary Reform*, pp. 68-69.

1 Introduction

This is a 40th birthday party for Sargent and Wallace (1981), so we begin by saying what our new paper shares with that old one and what it does not. Sargent and Wallace combined a sequence of consolidated government budget constraints with the following additional components:

1. a quantity-theory style demand function for base money
2. a fixed gross real interest rate on inflation-indexed risk-free government bonds that exceeds unity, the economy's growth rate
3. a rational expectations equilibrium concept

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4. a Stackelberg timing protocol in which a fiscal authority once-and-for-all arbitrarily chooses sequences of government expenditures and taxes and issues a sequence of risk-free indexed bonds to cover the gap

5. a monetary authority that uses open-market operations to set a sequence of central bank balance sheets and growth rates in base money that deliver a present value of inflation-tax revenues sufficient to finance the present value of the net-of-interest deficit sequence with which the fiscal authority confronts it at time 0.

In that setting, Sargent and Wallace studied how different budget-feasible paths for base money affect equilibrium sequences of inflation rates. When the fiscal authority presents it with a present value of a net-of-deficit sequence that is positive, the more it temporarily uses open market operations suppress inflation rates, the larger inflation rates the monetary authority has to deliver eventually. That is Sargent and Wallace's "unpleasant" consequence of the real rate of return on risk-free bonds exceeding the economy's growth rate.

In this paper, we drop components (1)-(5) and retain only the sequence of consolidated government budget constraints. Because we assume less, we can make fewer predictions. We proceed in the Becker (1962) spirit of deducing restrictions only from budget constraints while ignoring all other components of a more complete model.[1] We do not theorize about determinants of demand functions for base money or of monetary and fiscal decision rules, as has been done fruitfully by Bassetto (2002), Davig et al. (2011), Leeper et al. (2013), Bi et al. (2013), Leeper et al. (2021), and others who have constructed more complete versions of a "fiscal theory of the price level" than Sargent and Wallace offered. Instead, in the spirit of Friedman (1952) and along lines begun by Hall and Sargent (2021), we assemble long time series of Treasury accounts and Federal Reserve balance sheets, and, in light of consolidated federal government budget constraints, watch for patterns, especially across episodes of big wars. We focus on similarities and differences between the US government's "War on COVID-19" and two twentieth century World Wars. So far, the US "War on COVID-19" shares these features with those World Wars:

- Surges in federal government expenditures largely financed by issuing interest bearing debt and base money

- The Federal Reserve System's direct and indirect support of federal bond prices and an expanded Fed balance sheet

- Negative labor supply shocks, in the form of sequestering soldiers away from civilian employment during the two World Wars, and in the forms of lockdown mandates that diverted

[1] Hansen (2014) describes applications of a formal approach to quantitative work that says *something* without saying *everything*.

workers into unemployment and voluntary withdrawals from the labor force during the COVID-19 pandemic

- Extensive government restrictions on domestic and international travel and trade
- An adverse world-wide shock

We don't yet know whether the War on COVID-19 will share the following twentieth century pattern:

- Permanent postwar increases in government spending as a share of GDP

We offer a caveat that is especially relevant for analyzing the monetary-fiscal policy coordination issues that Sargent and Wallace (1981) discussed. Organizing our entire analysis around a single consolidated government budget constraint prevents us from highlighting potential conflicts between the Treasury and the Federal Reserve that can emerge when the Federal Reserve pays interest on excess reserves, as it has since 2008. Bassetto and Messer (2013) analyze these sources of stress by uncoupling a version of the consolidated budget constraint used in this paper into separate budget constraints for the Treasury and the Federal Reserve. Those two budget constraints are linked through transfers of monopoly profits (seigniorage transfers) that the Fed ordinarily makes to the Treasury and the occasional transfers that the Treasury occasionally sends back to the Fed in order to repair the Fed's balance sheet after it has suffered portfolio losses caused by increases in long-term nominal interest rates. A Fed portfolio strategy that, like quantitative easing (QE), is financed by excess reserves on which the Fed promises to pay interest exposes the Fed to the risk of going hat-in-hand to the Congress and Treasury to get funds to make those payments. By reassigning lines of authority between the Federal Reserve and the Treasury, that risk subverts the Fed's independence. In subsequent work, we plan to extend the decomposition of the consolidated government budget constraint that we deploy in section 5 to a two-budget constraint analysis along the lines of Bassetto and Messer (2013). Such an analysis promises to shed light on prospects that the presence of the interest-on-reserves policy combined with aggressive QE deployed during the War on COVID-19 will disrupt some of patterns observed for the two twentieth century World Wars when the Fed did not pay interest on reserves.

1.1 Twentieth Century World Wars

Twentieth Century World Wars had large and permanent effects on fiscal policies and the institutional arrangements for choosing and implementing them. Many of those effects were not anticipated by authors of actions that provoked them. Big wars are Exhibit A for a "Law of Unintended Consequences" that belies the rational expectations equilibrium concept that is a pillar for "Fiscal Theories of Price Levels" and their special "Unpleasant Monetarist Arithmetic" case.

But that law leaves intact the consolidated government budget constraint is another component of those theories.[2]

A way to think about the future is to detect past patterns and to anticipate that they will persist. In what amounts to a macroeconomic application of Becker's (1962) observation that budget constraints alone substantially restrict outcomes, this paper organizes observations about components of US federal government's budget constraints during and after the 20th century's two World Wars, then detects patterns.[3] Patterns that especially interest us involve monetary and fiscal policy instruments.

Twentieth century World Wars led the US and other belligerent governments to embrace aspects of what Germans called "War Socialism" in the form of new government interventions and controls, relaxation of anti-trust rules to permit cartels, price controls, government subsidies of maritime insurance and shipbuilding, rationing, forced saving, and more. Kennedy (1980) describes many such collectivist measures used in the US during WWI, lessons that Herbert Hoover, Franklin D. Roosevelt, and other high WWI government officials drew from them, and how those lessons shaped policies that Presidents Hoover and Roosevelt would later deploy in response to the Great Contraction, a national emergency that both presidents likened to World War I. Rothbard (2017, chs. 12-13) describes how Progressive leaders and intellectuals including John Dewey, Walter Lippman, and Richard T. Ely wrote that World War I presented unprecedented opportunities permanently to reshape and expand the economic role of the federal government. Some arithmetic consequences are recorded in the Federal Reserve balance sheets and federal government budget constraints that we present in this paper.

1.2 Reader's Guide

Section 2 describes impacts COVID-19 has had so far and summarizes government responses. Section 3 describes US federal government data on expenditures, revenues, and interest-bearing debt as well as Federal Reserve balances sheets from 1900 to 2021. During the three wars, taxes increased far less than expenditures and thus growth in interest-bearing debt and non-interest bearing money were the government's primary sources of revenues. We note that after both twentieth century World Wars, federal expenditures as percents of GDP did not return to ratios but instead to higher levels than before the wars. We describe the Federal Reserve's support for the Treasury market during each war. Section 4 describes adjustments that we make to the government's records on debt and interest payments in order to align them with concepts from macroeconomic theory. Section 5 employs the government budget constraint to decompose changes in federal revenues during the three wars. We confirm an impression conveyed graphically

[2]For connections among fiscal theories of the price level, unpleasant monetarist arithmetic, and other doctrines about monetary-fiscal policy outcomes, see Ljungqvist and Sargent (2018, sect. 27.3).

[3]A pattern-detection exercise involves pattern-imposition.

in section 3, namely, that all three wars were financed chiefly through debt and money growth. Further, while World War I and World War II were financed primarily by issuing interest-bearing debt, the government's response to COVID was financed primarily by issuing base money, at least nominally. However, much of that additional base money took the form of bank reserve deposits at the Fed, on which the Fed has paid interest since November 2008, so those reserves should be counted as interest-bearing federal debt. That motivates a back-of-the-envelope adjustment to the Fed's balance sheet that we describe in section 4. Section 6 shows that the price level rose dramatically during and after both World Wars. Real returns to bondholders mirrored these price increases so that bondholders were forced to accept large negative returns in the twelve years after the start of each World War. Section 7 tells a story about how returns that WWI Captain Harry Truman earned on his Liberty bonds permanently affected his attitudes about how wars should be financed. In Section 8, we acknowledge important differences between the years after World War II and today. These differences indicate that the federal government will have more difficulty using inflation to impose real losses on its creditors today than it did immediately after World War II.

2 COVID-19

COVID-19 came to the US in late January 2020. As we write, the virus has killed over 700,000 Americans. It stressed health care systems. Governments at all levels responded with expenditures and commands. In mid-March 2020, state governments began implementing shelter-in-place policies and shutting down non-essential businesses. Layoffs rose sharply and new hiring fell. GDP fell 9.5% in the second quarter of 2020. The unemployment rate hit 14.8% of the labor force in April 2020 and, as we show in the figure 1, in May 2020, the number of persons receiving unemployment insurance exceeded 7% of the total population. That peak is more than three times higher than has been observed since the start of this data series in the early 1970s. In comparison, at their peaks, in World Wars I and II, respectively, 2.8% and 8.6% of the total population served on active military duty.

Between January 2020 and June 2021, the US federal government responded to COVID-19 by authorizing over $4.8 trillion in additional spending. That amounted to 20% of a year's worth of GDP.[4] President Trump signed The Coronavirus Aid, Relief, and Economic Security Act (The CARES Act) on March 27, 2020. It authorized $2 trillion in additional spending that expanded unemployment benefits, started a Paycheck Protection Program[5], and presented one-

[4]In 1918, Congress authorized $1 million to suppress the Spanish influenza and other communicable diseases of which the Public Health Service spent only $837,410.09. See Glass (1919, pp. 533-535,541). US GDP in 1919 was $79 billion.

[5]This program made loans to small businesses that were forgivable if the owners kept employees on the payroll during the pandemic.

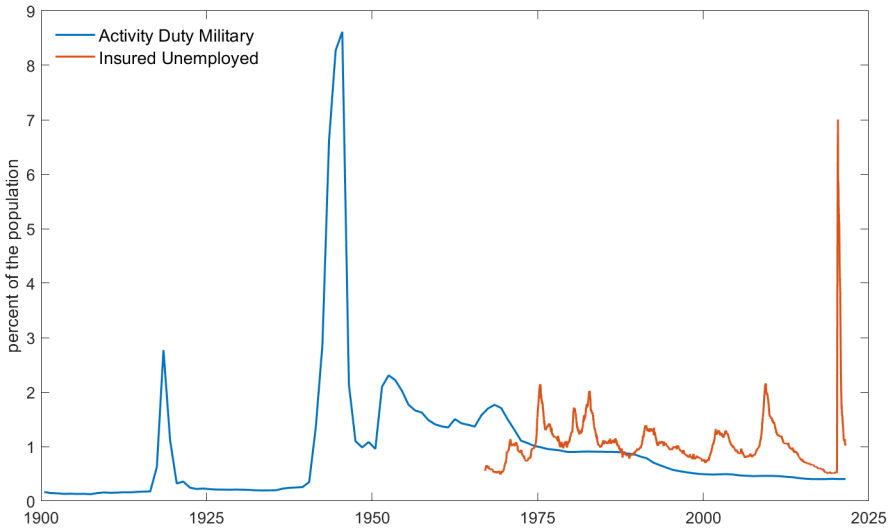


Figure 1: Activity Duty Military and Unemployed Persons Receiving Insurance as Percentages of total Population: 1900-2021

time payments of $1,200 to persons who earn under $75,000.

In December 2020, President Trump signed the Consolidated Appropriations Act, 2021, which included an additional $900 billion of COVID-related spending. In March 2021, President Biden signed the American Rescue Plan authorizing $1.9 trillion in further COVID-related spending.

As we write, the US Congress is considering two additional spending bills: a Build Back Better Act that would authorize up to $3.5 trillion in spending over the next ten years, and an Infrastructure Investment and Jobs Act that would authorize $1 trillion in spending, also over the next ten years.

3 Revenues, Outlays, Debt, and Fed Credit

In figure 2, we plot actual annual federal outlays (net of official interest payments) and tax receipts as percents of GDP from 1900 to 2021. From 2022 to 2031, we plot the Biden Administration's forecasts (released in April 2021) of outlays and revenues assuming that the Biden Administration's pending spending proposals become law.

- Outlays spike during World War I, World War II, and COVID-19.
- In World War I and World War II, tax receipts increased to cover only small shares of wartime spending. During COVID-19, tax receipts as a share of GDP rose very little.

- After World Wars I and II, government spending fell while tax revenues remained elevated, so that the government ran a primary surplus for many years. These patterns are consistent with tax-smoothing responses to *temporary* government spending surges.
- World War I and World II were both followed by permanent increases in federal expenditures as fractions of GDP. The Biden Administration plans that this will also be the case after the COVID-19 pandemic ends.
- As a fraction of GDP, The federal government's response to the Great Recession of 2008 was similar to its response to the Great Depression of the 1930s.

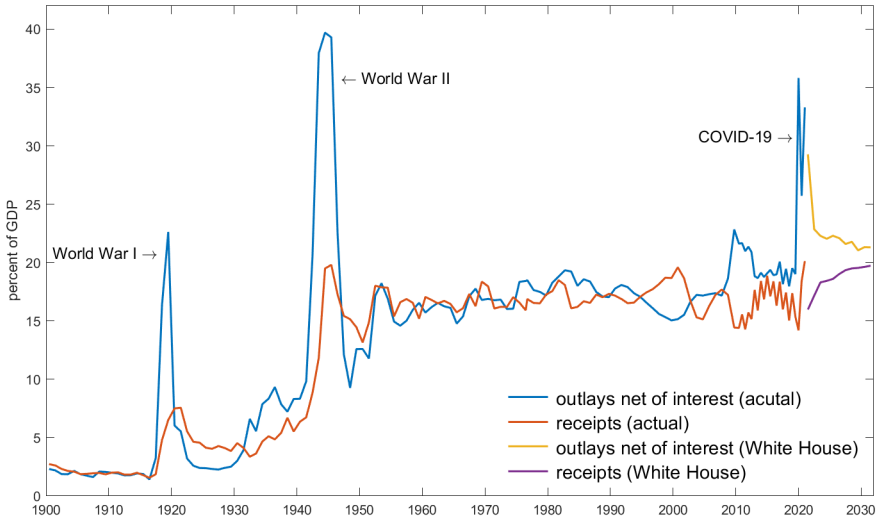


Figure 2: Outlays and Receipts: 1900-2031

Outlays are net of official interest payments. 1900-2010 annual by fiscal year; 2011-present monthly data aggregated to 6-month periods. Outlays and Receipts from 2021-2031 are the Administration's estimates under the President's 2022 budget.

Figure 3 plots the net-of-interest (also called the primary) deficit. Three large surges correspond to World War I, World War II, and COVID-19. To finance those deficits, the federal government could issue interest-bearing debt or non-interest bearing debt called base money.

We use two methods to decompose the par value of the total Treasury interest-bearing debt into four ownership classes. In figure 4 we display outstanding gross debts as shares of GDP from 1900 to 2021. Then in table 1 we record par values of federal debt at starts and ends of wars. We note that

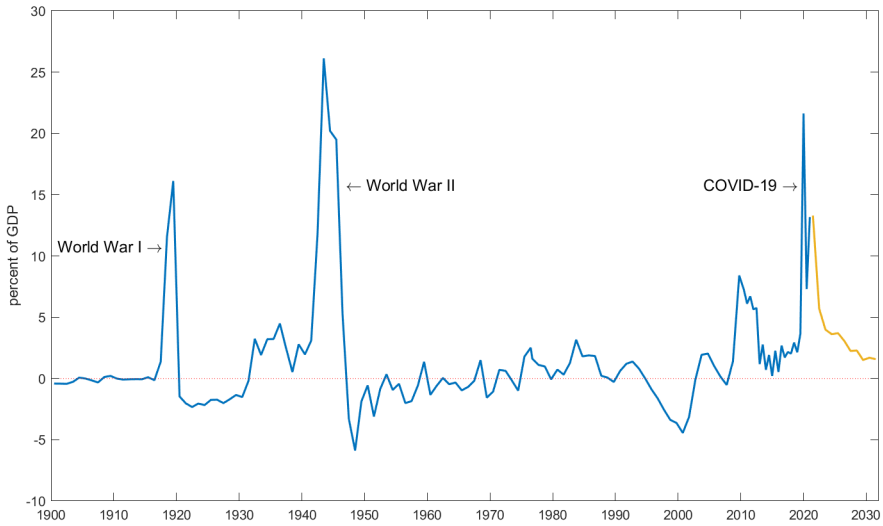


Figure 3: Primary Deficit: 1900-2031

1900-2010 annual by fiscal year; 2011-present monthly data aggregated to 6-month periods. 2021-2031 are the Administration's estimates under the President's 2022 budget.

- At the end of June 2021, of the $28.5 trillion (measured at its par value) of total debt outstanding, the Federal Reserve owned 18% ($5.1 trillion), government accounts and trust funds owned 22% ($6.2 trillion), foreign investors owned 25% ($7.2 trillion), and domestic private investors owned 35% ($10.0 trillion).
- Immediately prior to the COVID-19 crisis, the Federal Reserve owned 10% of the federal debt.
- Between December 2019 and June 2021 the par value of Treasury debt increased by $5.3 trillion, and the debt/GDP ratio rose from 107.0% to 125.5%. The largest purchasers of this new debt were the Federal Reserve which bought 53% of the new debt and domestic private investors who bought 36%.
- Before World War I, nearly all Treasury debt was held by private investors.
- The Federal Reserve bought Treasury debt during both twentieth century World Wars, as we discuss below.

Deficits not financed by issuing interest-bearing bonds are financed by issuing non-interest bearing debt, sometimes called "base money" because it qualifies as reserves for regulated banks.

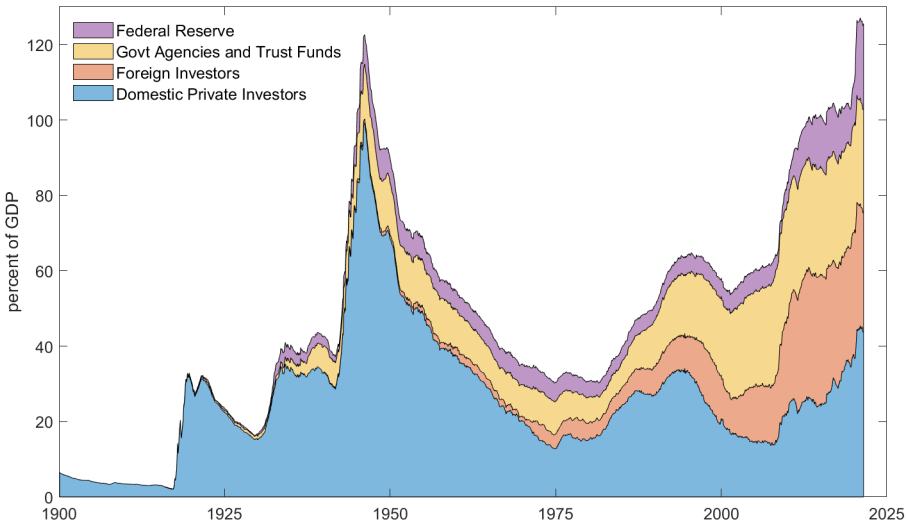


Figure 4: Par Value of US Treasury Debt by Ownership as a Percent of GDP: 1900 to 2021

	World War I		World War II		COVID-19	
	1914:5	1918:12	1939:9	1945:12	2019:12	2021:6
Federal Reserve	$0	$0.3115	$2.80	$19.41	$2,303.5	$5,128.3
	+0.312		+16.61		+2,824.8	
Gov't Agencies and Trust Funds	0	0.1070	6.55	31.88	6,030.9	6,199.6
	+0.107		+25.33		+168.7	
Foreign Investors†	–	–	–	2.40	6,844.2	7,202.2
					+358.0	
Domestic Private Investors	1.1893	20.6574	31.51	224.42	8,045.2	9,999.3
	+19.468		+192.91		+1,954.1	
Total	$1.1893	$21.0759	$40.86	$278.11	$23,223.8	$28,529.4
	+19.887		+237.25		+5,305.6	

Table 1: Treasury Debt Ownership at Starts and Ends of Three Wars

The debt is measured at its par value in billions of nominal dollars. The number below and center is the change in the debt holding for each ownership class.
† Treasury records on holdings by foreign investors begin December 1939.

We call this Federal Reserve Credit and measure it by the sum of Bills Discounted and the Market Value of Treasury Debt Held by the Fed.

Figure 5 portrays Fed balance sheets during the three big wars.[6] Although details differ, during all three big wars, the Federal Reserve supported the Treasury market.

- During World War I, the Fed directly purchased just 1.5% of the debt issued to finance the war, the green shaded area of panel 5a. However, through its "Borrow and Buy" program, the Fed encouraged individual investors to finance purchases of Treasury debt by borrowing from local banks, which then discounted those loans at the Fed's discount window. The Fed also lent at preferred discount rates to banks if those banks used the proceeds to purchase Treasury securities that the Fed then accepted as collateral. See the tan area of panel 5a. The Fed discounted and held as collateral up to $2 billion in federal debt – roughly 10% of the new debt – through this program. Thus, during this period, up to 10% of the Treasury debt reported to be held by the private investors (and colored blue in figure 4) was held by the Fed (and thus should actually be colored purple).[7]

- During World War II, the Fed purchased 7% of the newly issued debt. See the green area of panel 5c. Further, to protect investors of marketable securities from rising interest rates and declining bond prices, in 1942 the Treasury and the Federal Reserve agreed to fix interest rates on Treasury securities. As a consequence of fixing an upward-sloping yield curve and the Treasury's desire to issue securities across the full range of maturities, there was little private demand for low-yielding short-term securities, and the Fed served "buyer of last resort" for these bills and certificates. Between 1944 and 1948, the Fed held between 40 and 89 percent of the outstanding Treasury bills. Private investor holdings were more heavily weighted toward long-term Treasury notes and bonds.[8]

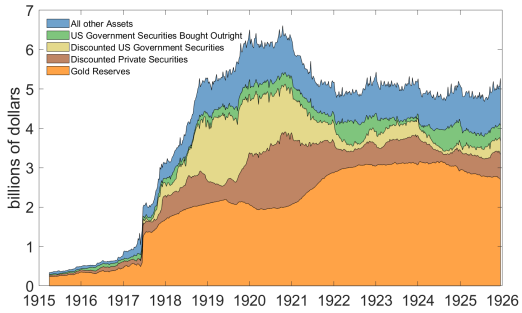
- During the COVID-19 pandemic, from December 2019 to June 2021, the Fed balance sheet grew from $4.2 to $8.1 trillion; trillion; $2.8 trillion of the increase was due to the Fed's purchases of Treasury debt, the green area of panel 5e. An additional increase of $1.1 trillion was largely due to the Fed's support of private financial markets. The Fed's mortgage backed securities holdings increased from $1.4 to $2.3 trillion, contained within the brown area of panel 5e. A noticeable difference between the 2004-2021 period and earlier periods is the existence of Treasury deposits with the Federal Reserve, the red area in panel 5f. The large gap between the government's borrowing and its spending reflects that the Treasury has retained substantial "cash-on-hand."

[6] By way of contrast, we include figure 6, which shows that Fed balance sheets during times of peace contained far fewer "surprises" in terms of altered portfolio shares.

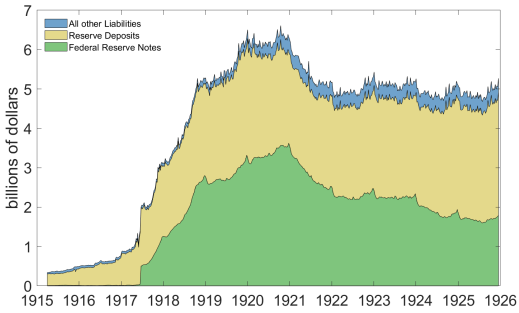
[7] For more about this program and its political consequences, see Hall and Sargent (2019).

[8] See Garbade (2012, pp. 342-344) and Hall and Sargent (2021, pp. 859-862) for more about this.

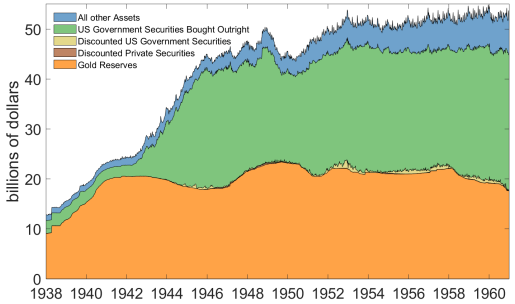
In all three wars, the Federal Reserve financed its support for the Treasury market by increasing the monetary base. In particular, from December 2019 to June 2021, the monetary base increased from $3.4 to $5.9 trillion. Of this $2.5 trillion increase, Federal Reserve notes in circulation increased $0.4, and reserve deposits (net of Treasury deposits at the Fed) increased $2.1 trillion.



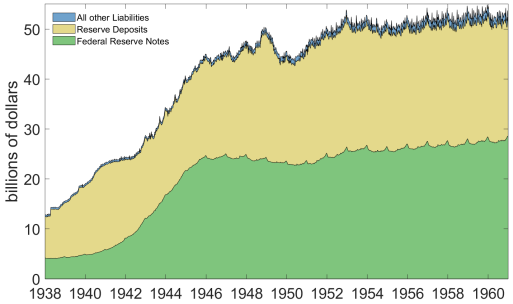
(a) Assets: 1915-1925



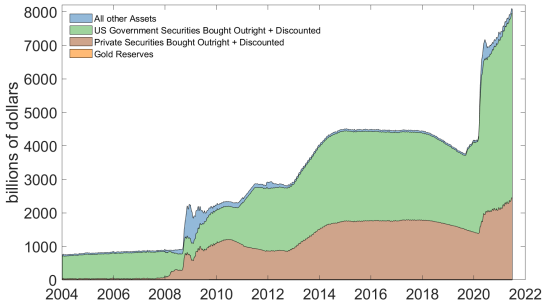
(b) Liabilities: 1915-1925



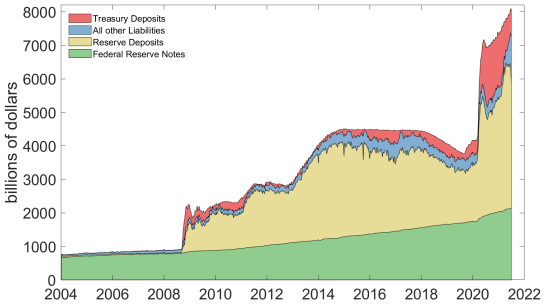
(c) Assets: 1938-1960



(d) Liabilities: 1938-1960

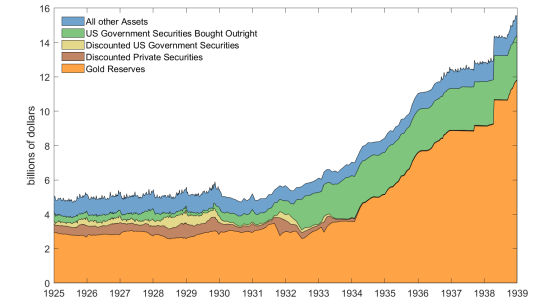


(e) Assets: 2004-2021

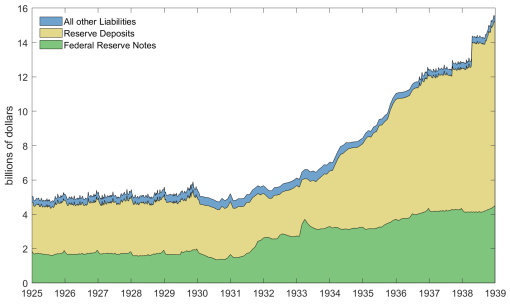


(f) Liabilities: 2004-2021

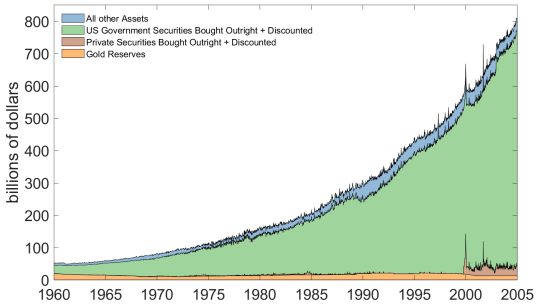
Figure 5: Federal Reserve Balance Sheets During Three Wars



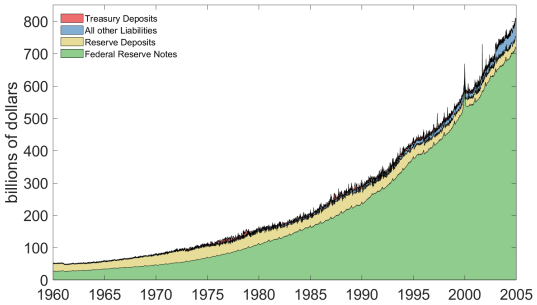
(a) Assets: 1925-1938



(b) Liabilities: 1925-1938



(c) Assets: 1960-2004



(d) Liabilities: 1960-2004

Figure 6: Federal Reserve Balance Sheets During Two "Peacetimes"

4 Adjustments to the Fiscal Accounts

We have adjusted the US Treasury's accounts to align them with macroeconomic theory. Specifically, we adjust the federal government's measures of debt outstanding and interest payments to its creditors. We make three adjustments to the US Treasury's record of total public debt outstanding.

1. We net out holdings by the Federal Reserve and Government Agencies and Trust Funds. Thus, we include only interest-bearing government debt held by private investors.

2. We net out Treasury operating cash from the Federal Reserve's debt holdings.[9]

3. We measure Treasury debt by its market value rather than its par value.

The market value takes into account differences between interest rates and coupon rates when debt was issued as well as changes in market interest rates and payment prospects since the debt was issued. The market values answers the question: how much must the government pay now if it were to repurchase the entire portfolio of privately-held debt at current market prices?

Figure 7 shows par values of interest-bearing Treasury debt in red and market values of Treasury interest-bearing debt in blue from 1900 to 2021. While the two series usually track each other closely over time, they have sometimes differed. Since December 2018, market values have exceeded par values. From December 2019 to June 2021, the market value of

- total Treasury debt outstanding increased \$5.6 trillion from \$24.00 to \$29.65 trillion,
- the sum of domestic privately held and foreign holdings increased \$2.3 trillion from \$15.22 to \$17.51 trillion,[10]
- Federal Reserve holdings increased \$3.2 trillion from \$2.66 to \$5.82 trillion, and
- Government Account holdings increased \$0.2 trillion from \$6.12 to \$6.32 trillion.

However, in November 2008, the Federal Reserve began paying interest on reserve deposits, effectively making them perfect substitutes for interest-bearing federal debt. To acknowledge that change in Fed operating procedures, the green line in figure 7 graphs the sum of the par values of the privately held Treasury debt and interest-bearing reserve deposits at the Federal Reserve, i.e., the tan area in panel 5f).[11] Counting reserves at the Fed as interest-bearing debt increases the

[9] Alternatively, we could net out Treasury cash balances from the private sector's debt holdings. For World War I and World War II, these cash balances are small, and this choice does not affect the results. During COVID-19, these cash balances are large, so this choice impacts the share of revenue we allocate to money growth versus the share we allocate to growth in interest-bearing debt.

[10] We do not have sufficiently detailed data on foreign holdings to compute their market values separately from domestic private investors.

[11] Reserve deposits are net Treasury deposits with the Federal Reserve.

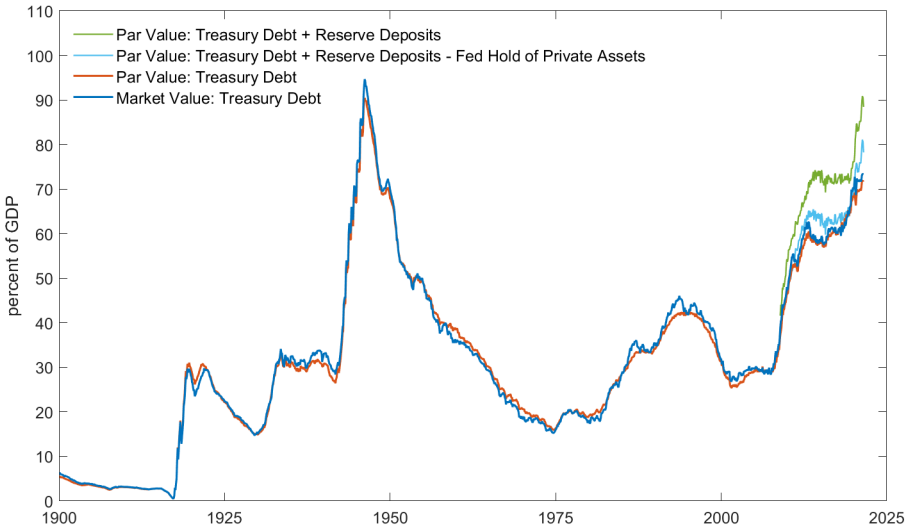


Figure 7: Par and Market Values of US federal Debt Held by Domestic Private Investors and Foreign Investors as Percents of GDP: 1900 to 2021. From November 2008 to June 2021, the green line plots the sum of the par value of privately-held Treasury debt and reserve deposits at the Federal Reserve. The light blue line subtracts the Federal Reserve's holdings of private assets from the sum reported in the green line.

ratio of privately-held federal debt to GDP from 72% to 88.5% as of June 20, 2021. Because the Fed used some the revenues generated by issuing those reserve deposits to purchase private assets, this green line overstates Federal interest bearing debt held by the public. To adjust for that, the light blue line in figure 7 plots the par value of the privately-held Treasury debt *plus* reserve deposits at the Federal Reserve *minus* Federal Reserve holdings of privately issued securities (i.e., the brown area in panel 5e). The gap between the green and light blue lines measures reserve deposits that are "backed" by private securities, a feature of Fed open market operations that is a throw-back to the "real bills" doctrine written into the original 1913 legislation that created the Fed.

We make one further adjustment to the US Treasury's accounts. We record *ex post* holding period returns instead of the government accounts' measure of interest payments on federal debt.

5 Government Budget Arithmetic

Our accounts use the following representation of the federal government's nominal budget constraint at time t:

$$G_t + r_{t-1,t}B_{t-1} = T_t + (B_t - B_{t-1}) + (M_t - M_{t-1}) + OM_t \tag{1}$$

where

$$
\begin{aligned}
G_t &= \text{Government outlays (net of official interest payments)} \\
B_{t-1} &= \text{Nominal market value of interest bearing government debt held by private investors at the end of } t-1 \\
r_{t-1,t} &= \text{Nominal value-weighted holding period return between } t-1 \text{ and } t \\
T_t &= \text{Tax receipts} \\
M_t - M_{t-1} &= \text{Change in Federal Reserve credit} \\
OM_t &= \text{Funding by Other Means}
\end{aligned}
$$

Funding by Other Means includes dollar deposits with and letters of credit to the IMF, changes in special drawing rights certificates issued to Federal Reserve Banks, and net activity of various loan financing activities.

Following Hall and Sargent (2021), we decompose wartime increases in federal revenue. We start by dividing each term in equation (1) by nominal GDP, which we denote Y_t, and rearranging terms

$$
\begin{aligned}
\frac{G_t}{Y_t} + r_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} &= \frac{T_t}{Y_t} + \left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}}\right) + \frac{M_t - M_{t-1}}{Y_t} + \frac{OM_t}{Y_t} + g_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} \\
&\quad + \pi_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} + r_{t-1,t}(\pi_{t-1,t} + g_{t-1,t})\frac{B_{t-1}}{Y_{t-1}} \qquad (2)
\end{aligned}
$$

where $g_{t-1,t}$ denotes the net growth rate of real GDP, and $\pi_{t-1,t}$ denotes the net inflation rate. The two terms on the left side are government purchases plus transfers as a share of GDP and interest payments on government debt as a share of GDP, respectively. The first four terms on the right side are sources of government revenue as shares of GDP: taxes, new borrowing, money creation and other means. The next two terms record the diminution of the debt/GDP ratio due to real GDP growth and inflation. The final term is a cross-term.

Define a "peacetime baseline" version of equation (2):

$$
\begin{aligned}
\left(\frac{G}{Y}\right)^{base} + \left(r_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{base} &= \left(\frac{T}{Y}\right)^{base} + \left(\frac{B}{Y} - \frac{B_{-1}}{Y_{-1}}\right)^{base} + \left(\frac{M - M_{-1}}{Y_{-1}}\right)^{base} \\
&\quad + \left(\frac{OM}{Y}\right)^{base} + \left(g_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{base} + \left(\pi_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{base} \\
&\quad + \left(r_{-1,0}(\pi_{-1,0} + g_{-1,0})\frac{B_{-1}}{Y_{-1}}\right)^{base}. \qquad (3)
\end{aligned}
$$

Subtracting equation (3) from equation (2):

$$\begin{aligned}
\frac{G_t}{Y_t} - \left(\frac{G}{Y}\right)^{base} \quad + \quad & \left[r_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} - \left(r_{-1,0}\frac{B_{-1}}{Y_{-1}} \right)^{base} \right] \;=\; \left[\frac{T_t}{Y_t} - \left(\frac{T}{Y} \right)^{base} \right] \\
& + \left[\left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}} \right) - \left(\frac{B}{Y} - \frac{B_{-1}}{Y_{-1}} \right)^{base} \right] \\
& + \left[\frac{M_t - M_{t-1}}{Y_t} - \left(\frac{M - M_{-1}}{Y_{-1}} \right)^{base} \right] \\
& + \left[\frac{OM_t}{Y_t} - \left(\frac{OM}{Y} \right)^{base} \right] \\
& + \left[g_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} - \left(g_{-1,0}\frac{B_{-1}}{Y_{-1}} \right)^{base} \right] \;+\; \left[\pi_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} - \left(\pi_{-1,0}\frac{B_{-1}}{Y_{-1}} \right)^{base} \right] \\
& + \left[r_{t-1,t}(\pi_{t-1,t} + g_{t-1,t})\frac{B_{t-1}}{Y_{t-1}} - \left(r_{-1,0}(\pi_{-1,0} + g_{-1,0})\frac{B_{-1}}{Y_{-1}} \right)^{base} \right]. \qquad (4)
\end{aligned}$$

For each war, we sum equation (4) from the beginning to the end of the war.

$$\underbrace{\sum_{t=T_1}^{T_2}\left[\frac{G_t}{Y_t}-\left(\frac{G}{Y}\right)^{base}\right]}_{\text{government spending}} + \underbrace{\sum_{t=T_1}^{T_2}\left[r_{t-1,t}\frac{B_{t-1}}{Y_{t-1}}-\left(r_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{base}\right]}_{\text{nominal return on debt}} = \underbrace{\sum_{t=T_1}^{T_2}\left[\frac{T_t}{Y_t}-\left(\frac{T}{Y}\right)^{base}\right]}_{\text{explicit tax revenue}}$$
$$+\underbrace{\sum_{t=T_1}^{T_2}\left[\left(\frac{B_t}{Y_t}-\frac{B_{t-1}}{Y_{t-1}}\right)-\left(\frac{B}{Y}-\frac{B_{-1}}{Y_{-1}}\right)^{base}\right]}_{\text{interest-bearing debt growth}}$$
$$+\underbrace{\sum_{t=T_1}^{T_2}\left[\frac{M_t-M_{t-1}}{Y_t}-\left(\frac{M-M_{-1}}{Y_{-1}}\right)^{base}\right]}_{\text{money growth}}$$
$$+\underbrace{\sum_{t=T_1}^{T_2}\left[\frac{OM_t}{Y_t}-\left(\frac{OM}{Y}\right)^{base}\right]}_{\text{other means}}$$
$$+\underbrace{\sum_{t=T_1}^{T_2}\left[g_{t-1,t}\frac{B_{t-1}}{Y_{t-1}}-\left(g_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{base}\right]}_{\text{debt dilution via real GDP growth}} + \underbrace{\sum_{t=T_1}^{T_2}\left[\pi_{t-1,t}\frac{B_{t-1}}{Y_{t-1}}-\left(\pi_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{base}\right]}_{\text{debt default via inflation}}$$
$$+\underbrace{\sum_{t=T_1}^{T_2}\left[r_{t-1,t}(\pi_{t-1,t}+g_{t-1,t})\frac{B_{t-1}}{Y_{t-1}}-\left(r_{-1,0}(\pi_{-1,0}+g_{-1,0})\frac{B_{-1}}{Y_{-1}}\right)^{base}\right]}_{\text{cross-term}} \quad (5)$$

where T_1 is the first year of the war or the first year of US involvement, and T_2 is the final year of the war. We construct each term's peacetime baseline as the mean of the appropriate term for the five years immediately prior to the start of the war.

Columns (1) and (2) of table 2 report spending from the left side of equation (5). Columns (4) and (5) report wartime changes in tax revenues and debt relative to prewar baselines. Columns (6)-(8) report wartime changes in money growth, real GDP growth, and inflation. Column (9) reports the sum of changes in other means, the cross term, and a sum of residuals.[12] For each war, entries in the first row are percents of GDP, and values in columns (4)-(9) sum to column (3). Units are percents of GDP and we sum over years; for example, the total cost of World War II over the four years between 1941 and 1945 was 116.48% of a single year's GDP. The numbers in the second row are percentages of the sum of war-related government spending and payouts to bondholders (column (3)) accounted for by each term on the right side of equation (5). The same row shows that payouts to bondholders during the war equal 2% of a year's GDP, bringing the

[12]We have data on "other means" only since 2010.

total cost of the war to 118.48%. How did the government pay for these outlays? Taxes comprised 30% of revenues, interest-bearing debt contributed another 46%, and money growth comprised 10%. The remaining 14% of costs were contributed by growth in GDP and the price level as well as the cross-term and errors.

For the two other wars, revenue decompositions are

- World War I: 20.8% taxes, 74.6% interest-bearing debt, 7% money growth, and -2.4% from the remaining terms.
- COVID-19: 4% taxes, 18.4% interest-bearing debt, 68.4% money growth, and 9.2% from the remaining terms.

This decomposition confirms numerically what figures 2, 4, and 5 illustrate visually: during all three wars, the federal government financed its expenditures primarily by issuing interest-bearing debt and non-interest bearing money rather than increasing taxes. In the First and Second World Wars, the federal government relied chiefly on interest-bearing debt to raise revenue; while so far in War on COVID-19, money growth has been government's main source of revenue.

From the relative increases in debt holdings that we report in table 1, our finding that less than 1/5 of the costs of federal government's COVID-19 response was financed by interest-bearing debt may seem low. During the COVID war, domestic and foreign private investors purchased 43% of newly issued federal debt (measured at par value). However, in the five years prior to the COVID-19 pandemic, the federal government consistently ran primary deficits largely financed mostly by interest-bearing debt purchased by private investors. Our decomposition assumes that roughly half of the COVID-era increase in privately held debt would have occurred in the absence of the pandemic.

We noted above that since 2008 the Federal Reserve has paid interest on reserve deposits. The decomposition reported in table 2 implicitly counts these reserves as part of base money.[13] If, instead, we counted those reserves as interest-bearing federal debt and subtracted them from our measure of Fed credit, then the revenue decomposition for the COVID-19 war would become:

- 4% taxes, 48.0% interest-bearing debt, 38.4% money growth, and 9.6% from the remaining terms.

This adjustment would thus re-allocates roughly 30% of the revenues from money growth to interest bearing debt. It has no impact of the share of revenue from explicit taxation.[14]

[13] We construct our measure of Fed credit from the asset side of the Fed's balance sheet rather than the liability side.

[14] Since some of the excess reserves were used to purchase private assets (e.g., mortgage backed securities, municipal bonds, ...), we subtracted private assets from excess reserves. We regard this as a back-of-the-envelope calculation that values reserve deposits and private assets at their par values and does not account interest payments on excess reserves in a best possible way.

War Start - End (US entry -)	(1) government spending $\frac{G_t}{Y_t}$	(2) payouts on debt $r_t \frac{B_{t-1}}{Y_{t-1}}$	(3) (1)+(2)	(4) tax revenue $\frac{T_t}{Y_t}$	(5) debt growth $\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}}$	(6) money growth $\frac{M_t - M_{t-1}}{Y_t}$	(7) GDP growth $g_t \frac{B_{t-1}}{Y_{t-1}}$	(8) inflation $\pi_t \frac{B_{t-1}}{Y_{t-1}}$	(9) Other
World War I									
1914:7 - 1918:11	36.11	0.43	36.54	6.83	26.76	3.41	0.52	1.22	-2.21
				18.7	73.2	9.3	1.4	3.4	-6.0
(1917:4 -)	36.93	0.30	37.23	7.76	27.79	2.59	0.05	0.76	-1.73
				20.8	74.6	7.0	0.1	2.1	-4.6
World War II									
1939:9 - 1945:8	129.50	0.10	129.60	49.91	54.78	11.32	15.42	9.62	-11.45
				38.5	42.3	8.7	11.9	7.4	-8.8
(1941:12 -)	116.48	2.00	118.48	35.80	54.53	11.96	8.99	6.05	1.14
				30.2	46.0	10.1	7.6	5.1	1.0
COVID-19									
2020:1 - 2021:6	19.26	0.94	20.20	0.82	3.72	13.81	0.39	1.60	-0.15
				4.0	18.4	68.4	2.0	7.9	-0.7

Table 2: Decomposition of Wartime Revenue from Equation 5

For each war, the elements in first row are in percent of GDP. Columns (4)-(9) sum to column (3). The numbers in the second row are percentages of the sum of war-related spending and returns to bondholders (column (3)) accounted for by each term on the right side of equation (5). Column (9) is the sum of other means, the cross term, and a residual.

6 Returns to Bondholders

All three wars were mainly financed by issuing interest-bearing bonds and base money. So how well did bondholders do in years after the wars? We cannot yet answer this question for the COVID-19 period, but we can for World Wars I and II. The short answer is: not well. Largely through increases in the price level, the federal government delivered large negative real returns to owners of federal bonds.[15]

Figure 8 compares the natural log of the US price level for the 12 years after the start of World War I with a period of the same length after the start of World War II. For each war, we normalize the price level by the transformation $100 \times (logP_t - logP_{\text{start of war}})$, so a series records cumulative percentage changes in the price level after war's start. The blue line reports the log of the price level for the 15 months following the outbreak of COVID-19.

Figure 8 confirms how the price level rose during both World Wars. In World War I, the price level peaked in 1919 more than 70% higher than its pre-war level. The price level subsided during the short but deep 1920-1921 depression but remained about 55% higher above its 1914 level ten years after the war.

Controls postponed price level increases after World War II. A surge in the price level accompanied the lifting of price controls in 1946. For both twentieth century world wars, the price level stood at roughly 55% higher between 7 to 12 years after the war. This enduring increase in the price level contributed to low real holding period returns to bondholders, as we now show in figure 9.

Each line in figure 9 reports cumulative real values coming from continually reinvesting in a value-weighted re-balanced portfolio of all outstanding US Treasury securities, starting with an initial investment of \$100.[16] Although real values of the Treasury's portfolio initially rose during both twentieth century World Wars, as the price level rose, real returns fell. For the post-World War I period, rising interest rates drove bond prices down so that by June 30, 1920, long-term bonds traded 10 to 15% below their par value. Combined with a higher price level, these low bond prices contributed to cumulative real losses of nearly 50% to federal bondholders. A reduction in the price level and decreased interest rates in the early 1920s helped boost the value of the Treasury's portfolio; but even by 1926, the value of the Treasury's portfolio had still not returned to its pre-war value in real terms.

Mindful of the post-World War I experience, Treasury officials reduced interest rate risk by fixing bond yields during World War II. That kept nominal returns on the Treasury's portfolio

[15] None of the three big wars after 1900 replicated the high real returns on federal government debt paid by the US in the War of 1812 and the Civil War. See Hall and Sargent (2014, 2021).

[16] The real value at time t is $100 \times \prod_{s=\text{start of war}}^{t} \frac{1+r_{s,s+1}}{1+\pi_{s,s+1}}$, where $r_{s,s+1}$ is the nominal net return on the portfolio between month s and $s+1$ and $\pi_{s,s+1}$ is the inflation rate between month s and $s+1$. Thus, the units are start-of-war dollars.

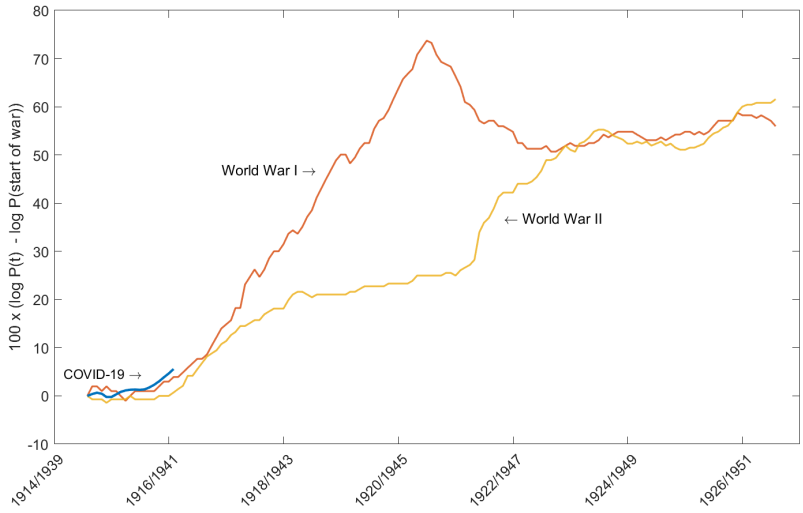


Figure 8: Natural Log of the Price Level During and After Each War

This figure displays $100 \times (logP_t - logP_{\text{start of war}})$, where P_t is the CPI for All Urban Consumers. Ticks on the x-axis correspond to January for the 1914 to 1926 period and March for the 1939 to 1951 period. For the COVID-19 war, the series begins January 2020 and ends June 2021.

low and stable during the 1940s, but movements in real returns mirrored movements in the price level. As a result, by 1951, the Treasury's portfolio was worth only 70 percent of its pre-war value.

The blue lines in figures 8 and 9 report the price level and cumulative returns for the COVID-19 period. Both lines track corresponding lines for the twentieth century world wars.

7 Harry Truman Remembered

Figures 2 and 3 indicate that increases in government outlays to fight the Korean War in the early 1950s were accompanied by corresponding increases in tax revenues. Unlike World Wars I and II, the Korean War was financed almost exclusively by taxes rather than by issuing interest-bearing debt and base money.[17] President Harry Truman's decision to fight the Korean war with a balanced budget was partly a consequence of his personal experience as bondholder during World War I as well as his desire to avoid a third bout of postwar inflation. According to historian Robert Donovan (1996, p. 329)

> Truman was dead set against the thought of tampering with government bonds, especially because some that he had bought while in the army plunged in value in the

[17] Also see Goldin (1980), Ohanian (1997), Rockoff (2012), and Hall and Sargent (2021).

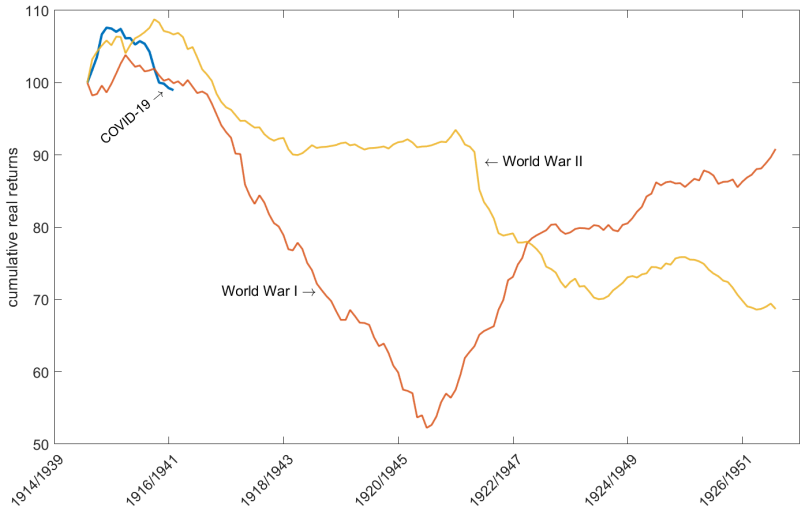


Figure 9: Real Values of $100 Portfolio of Treasury Securities Invested at Starts of Three Wars

This figure reports the cumulative real values coming from continually reinvesting in a value-weighted re-balanced portfolio of all outstanding US Treasury securities of an initial investment of $100 at the start of each war. Ticks on the x-axis correspond to January for the 1914 to 1926 period and March for the 1939 to 1951 period. For the COVID-19 war, the series begins January 2020 and ends June 2021.

> depression of 1920-21. It became an article of faith with him that if a person bought a government bond for $100, that person should be able to redeem it for $100.

On February 2, 1951, in his *Special Message to the Congress Recommending a "Pay as We Go" Tax Program*, President Harry Truman argued

> During World War II, taxes were not high enough, and the Government was forced to borrow too much. As a result, when controls were taken off after the war, prices skyrocketed and we paid in inflation for our failure to tax enough. The value of people's savings was cut down by the higher prices they had to pay.

8 Questions and Qualifications

Will US federal bonds deliver returns that approximate the low levels observed after the two twentieth century World Wars? Maybe, but there are important differences between the situation today and those earlier periods. We focus here mainly discussion on contrasting the market for Treasury securities today and during the post-World War II years. We list four pertinent differences.

1. The maturity structure of the debt is much shorter today than it was after World War II.

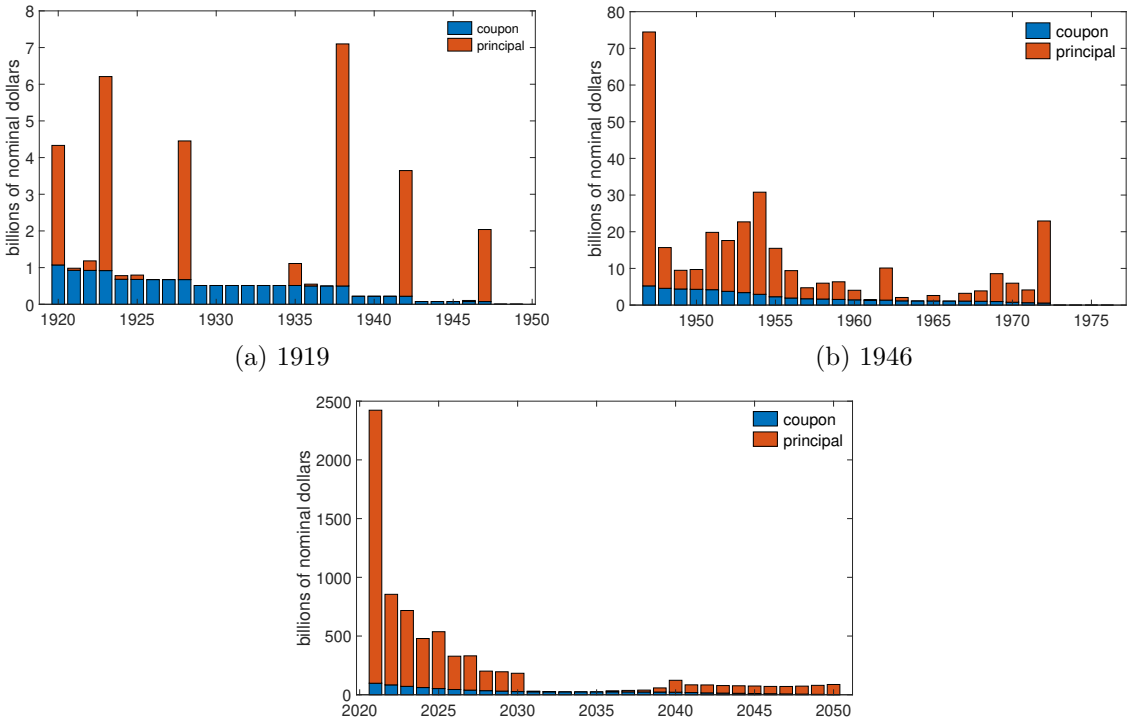
In figure 10, we plot the debt-service profile of Treasury debt at the end of 1919, 1946, and 1920. Each panel reports the number of dollars the Treasury has promised to pay its creditors in each year for the subsequent 30 years. We decompose promised payments into coupons (stacked blue bars) and principal (stacked red bars). Today, the profile is much smoother and more weighted to the short-end than at the end of World Wars I and II.

2. During and after World War II, much federal debt held by private investors consisted of longer-term securities (i.e., Treasury Notes and Bonds), while the Federal Reserve's holdings were concentrated in shorter-term securities (i.e., Treasury Bills and Certificates of Indebtedness). Today, the reverse is true.

3. During and after World War II, nonmarketable bonds (e.g., savings bonds and notes) formed much larger shares of private investors' holdings than now. Today most nonmarketable debt is held by the Social Security Trust Fund and other government retirement accounts.

4. During World War II, the Treasury faced less competition for funds than it now does. There were few consumer goods for sale and few alternative investment opportunities outside of Treasury securities. Investing abroad was not an option. There was also social pressure to purchase Treasury bonds. Today, private investors are free to buy a much wider range of domestic and foreign securities.

After World War II, losses that the lifting of price controls and the subsequent inflation imposed on holders of federal bonds fell primarily on private investors. Today, a similar-sized inflation would probably hit the Fed's balance sheet and the Social Security Trust Fund much harder. To analyze that risk and its consequences when the Fed pays interest on excess reserves as it now does, it will help us to adopt a two-budget constraint framework like that of Bassetto and Messer (2013).



(a) 1919

(b) 1946

(c) 2020

Figure 10: US Treasury Debt Service Profiles

Each panel reports the number of dollars the Treasury has promised to pay its creditors in each year for the subsequent 30 years. Promised payments are decomposed into promised coupon payments (stacked blue bars) and principal payments (stacked red bars).

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A Data Sources

- Nominal and Real GDP are from `www.measuringworth.com` from 1900 to 1947 and the BEA: National Income and Product Accounts thereafter.
- Figure 1:
  - Activity Duty Military Personnel from 1900 to 2005 are from Table 2-11 of *Selected Manpower Statistics: Fiscal Year 2005* Statistical Information Analysis Division, Defense Manpower Data Center, Department of Defense. Data from 2005 to the present are from `https://dwp.dmdc.osd.mil/dwp/app/dod-data-reports/workforce-reports`

- Insured Unemployment is from FRED[18]
- Population is total population including Armed Forces overseas from the Census Bureau.

- Figures 2 and 3
  - Federal expenditures and revenues from 1900 to 1940 are from the *Annual Report of the Secretary of the Treasury on the State of the Finances.*[19] The numbers we use are summarized on pages 642 - 650 of the 1940 Annual Report.[20] Federal expenditures and revenues from 1940 to 2011 are from the Office of Management and Budget (OMB).[21]
  - From 2011 to 2021 Monthly Receipts, Outlays, Reduction of Operating Cash and Funding by Other Means are from the *Monthly Treasury Statement.*[22] Interest on Treasury Debt Securities (Gross) and Interest Paid to Government Accounts are from the US Treasury Report: *Interest Expense on the Debt Outstanding.*[23]
  - The White House forecasts for 2021-2031 are from the Congressional Budget Office Report 57358: *An Analysis of Certain Proposals in the President's 2022 Budget.* 2021[24]

- Figures 4, 7, 9, 10, and Tables 1 and 2
  - For 1900-1960 the price and quantity data of outstanding Treasury securities are from Hall et al. (2018)
  - For 1960-2021 the price and quantity data are from the CRSP US Treasury Database and the US Treasury *Monthly Statement of Public Debt.*[25]
  - Federal Reserve Holdings of Treasury securities are from the Federal Reserve System Open Market Account (SOMA).[26]
  - Foreign Holdings of US Treasury Securities
    - for 1939 to 1999 are from the Department of the Treasury's *Treasury Bulletin.*[27]
    - for 2000 to 2021 are from the Department of the Treasury's *Treasury International Capital (TIC) System.*[28]

[18] See `https://fred.stlouisfed.org/series/CCSA`.
[19] See `http://fraser.stlouisfed.org/publication/?pid=194`.
[20] See `http://fraser.stlouisfed.org/docs/publications/treasar/AR_TREASURY_1940.pdf`.
[21] See `http://www.whitehouse.gov/omb/budget/Historicals`.
[22] See `https://www.fiscal.treasury.gov/reports-statements/mts/`.
[23] See `https://fiscaldata.treasury.gov/datasets/interest-expense-debt-outstanding`.
[24] See `https://www.cbo.gov/publication/57358`..
[25] See `http://www.crsp.org/products/research-products/crsp-us-treasury-database` and `https://www.treasurydirect.gov/govt/reports/pd/mspd/mspd.htm`.
[26] See `https://www.newyorkfed.org/markets/soma-holdings`.
[27] See `https://fraser.stlouisfed.org/title/407`.
[28] See `https://home.treasury.gov/data/treasury-international-capital-tic-system`.

  - Federal Reserve credit is the sum of bills discounted, bills bought, United States Government securities bought outright and discounted, deposits in foreign banks, industrial and commercial loans, municipal warrants, and Federal Reserve bank float. The source of these data are the tables of assets and liabilities of the twelve Federal Reserve Banks reported in each issue of the *Federal Reserve Bulletin*.
  - For federal expenditures and receipts, see the sources cited above.

- Figures 5 and 6
  - The tables of assets and liabilities of the twelve Federal Reserve Banks reported in each issue of the *Federal Reserve Bulletin*.

- Figure 8
  - Consumer Price Index for All Urban Consumers from FRED.[29]

[29] See `https://fred.stlouisfed.org/series/CPIAUCNS`.