Three World Wars: Fiscal-Monetary Consequences*

George J. Hall† Thomas J. Sargent‡

March 10, 2022

Abstract

Directed by a consolidated government budget constraint, we compare US monetary-fiscal responses to World Wars I and II and the War on COVID-19.

KEYWORDS: COVID-19, inflation, unpleasant monetarist arithmetic

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, 1923, *A Tract on Monetary Reform*, pp. 62.

1 Introduction

This paper describes how the US government made "the public pay for" surges in expenditures associated with three world wars. We apply an approach of Becker (1962) by focusing exclusively on a consolidated government budget constraint and ignoring other parts of macroeconomic models.[1] Unlike Bassetto (2002), Davig et al. (2011), Leeper et al. (2013), Bi et al. (2013), Leeper

*We thank William Berkley for supporting our research. Hall thanks the Theodore and Jane Norman Fund for financial support. We thank Mark Aguiar, Manuel Amador, Marco Bassetto, Ramon Marimon, and Carolyn Sargent for helpful criticisms of earlier drafts. We thank Robert Reese, William Roberds, and Manjola Tase for answering our questions about data and institutions.

†Brandeis University, E-mail: ghall@brandeis.edu.

‡New York University, E-mail: thomas.sargent@nyu.edu.

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

et al. (2021), Sargent and Wallace (1981, 1985), and other users of "fiscal theories of price levels", we assume nothing about demand functions for base money and government bonds or about Central Bank and Treasury decision rules. Instead, emulating Friedman (1952) and Hall and Sargent (2021), we assemble time series of Treasury accounts and Federal Reserve balance sheets, and, in light of consolidated federal government budget constraints, watch for patterns, especially during and after big wars.[2] We focus on similarities and differences between the US government's "War on COVID-19" and two twentieth century world wars. The US "War on COVID-19" shares these features with those two world wars:

- Negative labor supply shocks, i.e., converting civilian workers to soldiers during the twentieth century world wars, and lockdown mandates that diverted 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
- Surges in federal government expenditures mostly financed by issuing interest-bearing debt and base money
- Federal Reserve support of federal bond prices and an expanded Fed balance sheet

We don't yet know whether the War on COVID-19 will share the following trait with those two twentieth century world wars:

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

We sidestep monetary-fiscal policy coordination issues studied by Sargent and Wallace (1981, 1985). Organizing our entire analysis around a consolidated government budget constraint prevents us from isolating struggles between a Treasury and a Central Bank that can emerge when a Central Bank pays interest on excess reserves, as the Federal Reserve has since 2008. Bassetto and Messer (2013) analyzes such sources of stress by disintegrating the consolidated budget constraint used in this paper into separate budget constraints for a Treasury and a Central Bank. Those two budget constraints are linked through transfers of monopoly profits (seigniorage revenues) that a Central Bank ordinarily makes to a Treasury and reverse transfers that a Treasury occasionally sends back to the Central Bank in order to repair a Central Bank's balance sheet when it has suffered portfolio losses after increases in long-term nominal interest rates. A Fed portfolio strategy that, like quantitative easing (QE), is financed by issuing bank reserves on which the Fed promises to pay interest exposes the Fed to a risk of going hat-in-hand to the Congress and Treasury to ask for funds to make those payments. By reassigning lines of authority between the Federal Reserve and the Treasury, that risk subverts the Fed's independence. It would be fruitful

[2] A closely related research strategy is deployed in various chapters of Kehoe and Nicolini (2021).

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) and Del Negro and Sims (2015). Such an analysis could shed light on how the presence of the interest-on-reserves policy combined with aggressive QE deployed during the War on COVID-19 might disrupt patterns that prevailed when the Fed did not pay interest on reserves during the two twentieth century world wars.

1.1 Twentieth Century World Wars

Twentieth century world wars permanently affected fiscal policies and institutional arrangements for implementing them. Many of those effects were not anticipated by the 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" Sargent and Wallace (1981) case. But that law leaves intact another pillar of those theories: the consolidated government budget constraint.[3]

Twentieth century world wars fostered what Germans called "War Socialism" in the form of government commands and controls, relaxations of anti-trust rules, price controls, government subsidies of maritime insurance and shipbuilding, rationing, forced saving, and more. Kennedy (1980) described US collectivist measures implemented during WWI. Their experiences as public officials during WWI shaped policies that Presidents Hoover and Roosevelt would later deploy in response to the 1929-1933 Depression, a national emergency that both presidents likened to WW I. Rothbard (2017, chs. 12-13) described how John Dewey, Walter Lippman, and Richard T. Ely thought that World War I presented opportunities to expand the economic role of the federal government. Consequences of their efforts are recorded in Federal Reserve balance sheets and federal government budgets.

1.2 Reader's Guide

Section 2 describes US government responses to COVID-19. 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 all three world wars, taxes increased much less than expenditures, so new issues of interest-bearing debt and non-interest bearing money were the government's primary sources of revenues. Although postwar federal expenditures as percents of GDP declined from their war time levels, they stayed permanently higher than they had been before both twentieth century world wars. The Federal Reserve supported markets for Treasury securities during all three wars. Section 4 describes adjustments that we make to the government's records on debt and interest payments to align them with macroeconomic theory. Section 5 employs a

[3]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).

consolidated government budget constraint to decompose changes in federal revenues during the three wars. We confirm an impression conveyed graphically in section 3, namely, that all three wars were financed chiefly by issuing interest-bearing debt and base money. While World Wars I and II were financed primarily by issuing interest-bearing debt, at first glance the government's response to COVID seems to have been financed primarily by issuing base money. But much of that additional base money took the form of banks' deposits at the Fed that should actually be classified as interest-bearing government debt because since October 2008 the Fed has paid interest on those deposits. This motivates an adjustment to the outstanding stock of interest-bearing debt that we describe in sections 4 and 5. Section 6 shows that the price level rose dramatically during and after both twentieth century world wars. Real returns on federal bonds mirrored these price level changes: bonds gave negative real returns in the twelve years after the starts of both twentieth century world wars. Section 7 tells a story about how returns that WWI US Army Captain Harry Truman had earned on his Liberty bonds permanently affected his attitudes about war finance. For the two twentieth century world wars, section 8 decomposes postwar changes in debt-GDP ratios into parts due to GDP growth, inflation, federal net-of-interest surpluses, and nominal returns on Federal securities. Section 9 revisits Harry Truman's concerns about paying low real returns on government bonds. Changes in the structure of markets for federal bonds 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. Section 10 concludes.

2 COVID-19

COVID-19 came to the US in January 2020. By March 4, 2022, the virus had killed 955,000 Americans. It strained health care systems. Governments at all levels responded with expenditures and commands. In mid-March 2020, state governments implemented shelter-in-place policies and forced non-essential businesses to close. Layoffs rose and new hiring fell. GDP fell 9.5% in the second quarter of 2020. The unemployment rate was 14.8% in April 2020, and as figure 1 shows, 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 had ever been observed since the start of this data series in the early 1970s. 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 December 2021, the US federal government responded to COVID-19 by authorizing over $4.8 trillion in additional spending. That amounted to 21.4% of a year's GDP.[4] First, 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

[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, a negligible fraction of 1919 US GDP of $79 billion. See Glass (1919, pp. 533-535,541).

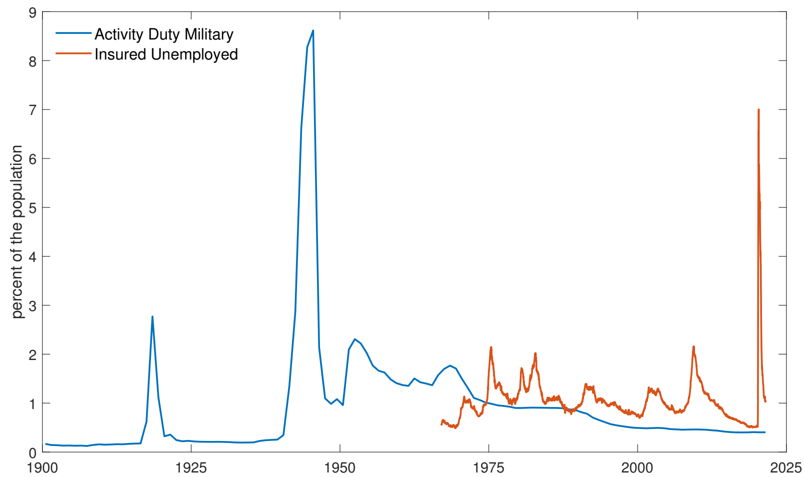


Figure 1: Active Duty Military and Unemployed Persons Receiving Insurance as Percentages of Total Population: 1900-2021

expanded unemployment benefits, started a Paycheck Protection Program[5], and presented one-time payments of $1,200 to persons who earned under $75,000. Second, in December 2020, President Trump signed the Consolidated Appropriations Act, 2021, which included an additional $900 billion of COVID-related spending. Third, in March 2021, President Biden signed the American Rescue Plan authorizing $1.9 trillion in further COVID-related spending. Finally, in addition to direct COVID-related spending, in November 2021, President Biden signed the Infrastructure Investment and Jobs Act which authorized over $500 billion in new spending in excess of normal infrastructure appropriations and aimed to raise $50 billion in new revenue over the next ten years.

3 Revenues, Outlays, Debt, and Fed Credit

In figure 2, we plot 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 forecasts based on Congressional Budget Office (CBO) projections of outlays and revenues.

- Outlays spiked 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 and tax revenues remained elevated, letting the government ran a primary surplus for many years. These patterns are consistent

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

with the tax-smoothing responses to *temporary* government spending surges called for in Barro (1979).

- Permanent increases in federal expenditures as fractions of GDP followed World Wars I and II. The Biden Administration wants this also to occur when the COVID-19 pandemic ends.

- The federal government's fiscal responses to the Great Recession of 2008 and the Great Depression of the 1930s were similar as fractions of GDP.

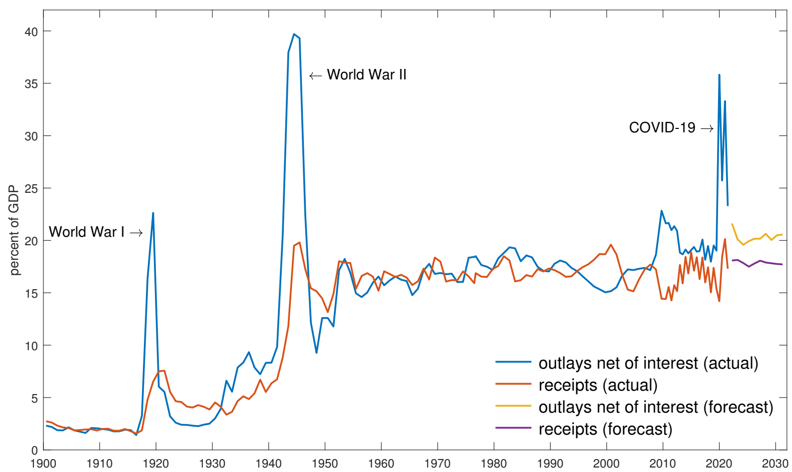


Figure 2: Outlays and Receipts: 1900-2031

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 2022-2031 are computed using CBO projections.

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

- At the end of December 2021, of \$29.6 trillion (measured at its par value) of total debt outstanding, the Federal Reserve owned 19% (\$5.6 trillion), government accounts and trust funds owned 22% (\$6.5 trillion), foreign investors owned 26% (\$7.7 trillion), and domestic private investors owned 33% (\$9.8 trillion).

- Immediately prior to COVID-19, the Federal Reserve owned 10% of the Treasury debt.

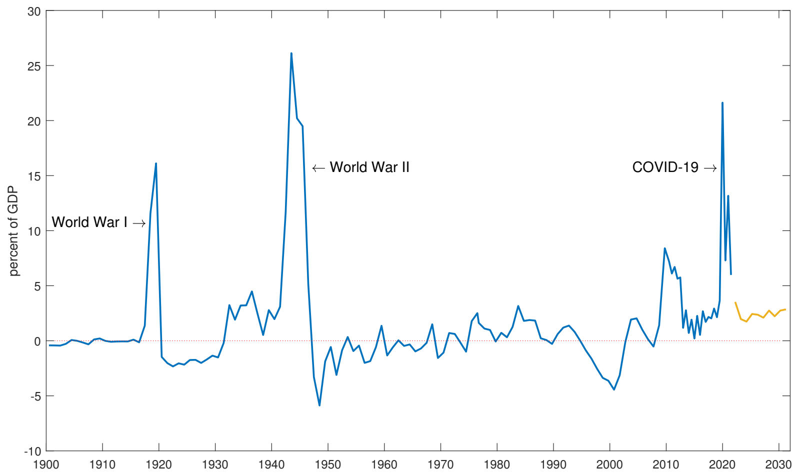


Figure 3: Primary Deficit: 1900-2031

1900-2010 annual by fiscal year; 2011-present monthly data aggregated to 6-month periods. 2022-2031 are computed using CBO projections.

- Between December 2019 and December 2021, the par value of Treasury debt increased by \$6.4 trillion, and the debt/GDP ratio rose from 107.0% to 123.4%. The largest purchasers of this new debt were the Federal Reserve, which bought 51% of the new debt, and domestic private investors, who bought 28%.
- Before World War I, private investors held nearly all Treasury debt.
- The Federal Reserve bought Treasury debt during both twentieth century world wars.

Deficits not financed by issuing interest-bearing bonds are financed by issuing non-interest bearing debt, sometimes called "base money" because it can serve as reserves for regulated banks. We call this Federal Reserve Credit and measure it by the sum of Bills Discounted, the Market Value of Treasury Debt Held by the Fed, and the private assets held by the Fed.

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

- During World War I, the Fed directly purchased only 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. To make those loans, local banks borrowed funds from the Fed's discount window. The Fed also lent at preferred discount rates to banks that used the funds to purchase Treasury securities that the Fed then accepted as collateral. See the tan area

[6] In the online appendix, we plot the Fed balance sheet during times of peace. They testify to portfolio shares being much smoother and predictable over time during peace times than during big wars.

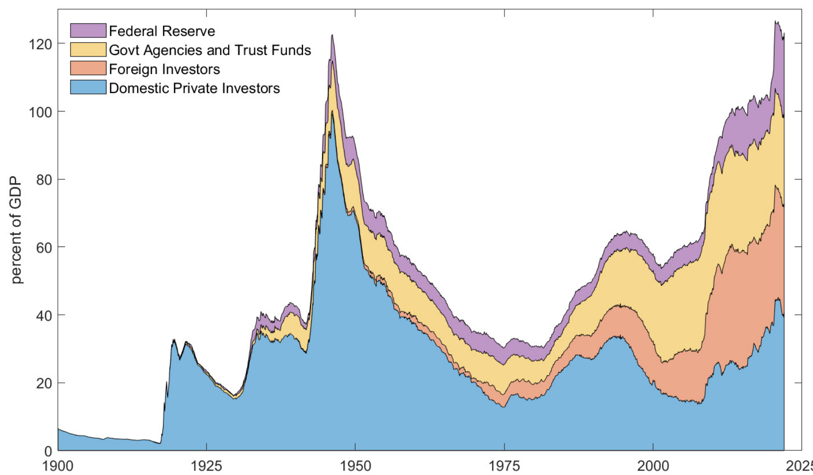


Figure 4: Par Value of US Treasury Debt by Ownership as a Percent of GDP: 1900 to 2021

	World War I		World War II		COVID-19	
	1914:5	1918:12	1939:9	1945:12	2019:12	2021:12
Federal Reserve	$0	$0.3115	$2.80	$19.41	$2,303.5	$5,580.0
	+0.312		+16.61		+3,276.5	
Gov't Agencies and Trust Funds	0	0.1070	6.55	31.88	6,030.9	6,473.5
	+0.107		+25.33		+442.6	
Foreign Investors	–	–	–	2.40	6,844.2	7,739.4
					+895.2	
Domestic Private Investors	1.1893	20.6574	31.51	224.42	8,045.2	9,824.3
	+19.468		+192.91		+1,779.1	
Total	$1.1893	$21.0759	$40.86	$278.11	$23,223.8	$29,617.2
	+19.887		+237.25		+6,393.4	

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.

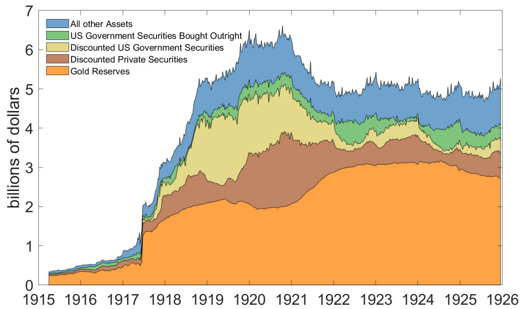
of panel 5a. The Fed discounted and held as collateral up to $2 billion in federal debt – roughly 10% of the new debt – through this program. Thus, during this period, up to 10% of the Treasury debt reported to be held by domestic private investors (and colored blue in figure 4) was actually held by the Fed, so the purple area in figure 4) understates the Fed's holding.[7]

- During World War II, the Fed purchased 7% of new debt. See the green area of panel 5c. To protect investors of marketable securities from rising interest rates and declining bond prices, starting in 1942 the Federal Reserve fixed interest rates on Treasury securities. As a consequence of the Fed's 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, so the Fed served as "buyer of last resort" for 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]

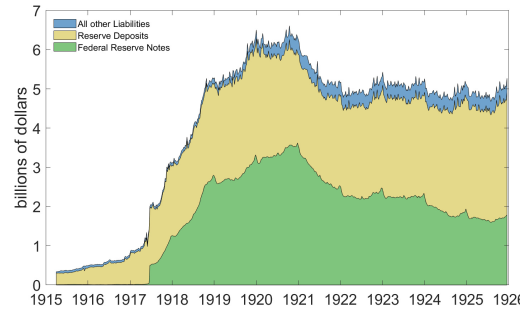
- During the COVID-19 pandemic, from December 2019 to December 2021, the Fed balance sheet grew from $4.2 to $8.8 trillion; $3.3 trillion of the increase was due to the Fed's purchases of US Treasury debt, the green area of panel 5e. An additional increase of $1.2 trillion was largely due to the Fed's support of private financial markets. The Fed's mortgage backed securities holdings increased from $1.4 to $2.6 trillion, contained within the brown area of panel 5e. Two notable differences between 2004-2021 and earlier periods are the large Treasury deposits with the Federal Reserve and the growth in reverse repurchase agreements, the blue and red areas in panel 5f. The large gap between the government's borrowing and its spending indicates how the Treasury initially retained substantial "cash-on-hand."

In all three wars, the Federal Reserve financed its support for the Treasury market by increasing the monetary base. From December 2019 to December 2021, the monetary base increased from $3.40 to $6.23 trillion. Of this $2.8 trillion increase, Federal Reserve notes in circulation increased $0.4, and reserve deposits increased $2.4 trillion.

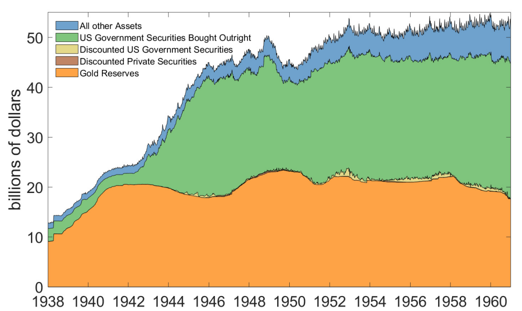
[7] For more about this program and its political consequences, see Hall and Sargent (2019).
[8] See Garbade (2012, pp. 342-344) and Hall and Sargent (2021, pp. 859-862) for more about this.



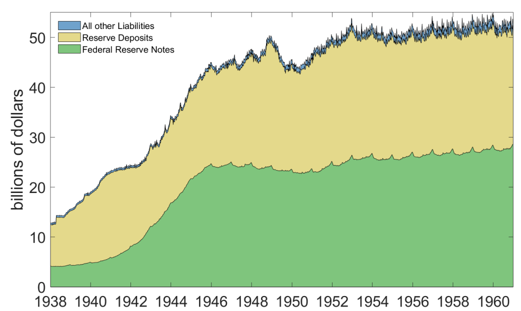
(a) Assets: 1915-1925



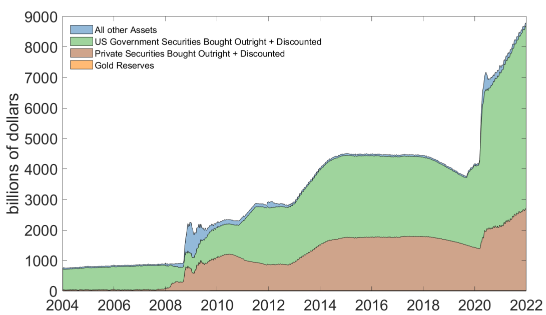
(b) Liabilities: 1915-1925



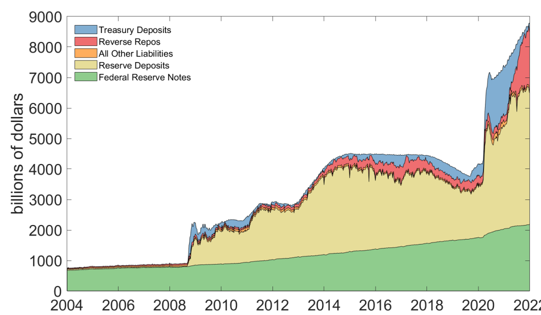
(c) Assets: 1938-1960



(d) Liabilities: 1938-1960



(e) Assets: 2004-2021



(f) Liabilities: 2004-2021

Figure 5: Federal Reserve Balance Sheets During Three Wars

4 Adjustments to Fiscal Accounts

We have adjusted the US Treasury's accounts to align with macroeconomic theory. Specifically, we adjust the federal government's measures of debt outstanding and interest payments to its creditors. We make two 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 measure Treasury debt by its market value rather than its par value.[9]

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 value answers the question: how much must the government pay if it were to repurchase the entire portfolio of privately-held debt at current market prices?

Figure 6 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, they sometimes differ. Since December 2018, market values have exceeded par values. From December 2019 to December 2021, the market value of

- total Treasury debt outstanding increased \$6.6 trillion from \$24.00 to \$30.60 trillion,

- the sum of domestic privately held and foreign holdings increased \$2.5 trillion from \$15.22 to \$17.72 trillion,[10]

- Federal Reserve holdings increased \$3.7 trillion from \$2.66 to \$6.36 trillion, and

- Government Account holdings increased \$0.4 trillion from \$6.12 to \$6.51 trillion.

Figure 5 is full of information about how the Fed responded to stresses that arrived with big wars. Here we'll just focus on the beginning of the War on COVID-19. In addition to a huge jump and subsequent accelerated rate of increase of total Fed liabilities ignited by President Trump's signing of the CARES Act in March 2020, panel 5f indicates alterations over time in the composition of those liabilities. Initially bank reserves (tan) and Treasury deposits (blue) jumped. For about a year after March 2020, bank reserves grew fast as the Treasury gradually drew down and spent its deposits at the Fed. But in March 2021, growth in bank reserves slowed markedly while reverse repurchase agreements (RPPs) (red) accelerated rapidly. It is appropriate to view RPPs as reserve accounts at the Fed. These grew fast after March 2021 because the Fed

[9] In Statistical Release H4.1, the Federal Reserve adjusts face values of its holdings of Treasury securities and private assets for both premiums and discounts (i.e., estimated differences between purchase prices and face values).

[10] We lack sufficiently detailed data on foreign holdings to compute their market values separately from domestic private investors.

opened such accounts for money market mutual funds. Proposals for the Fed to trade reverse repos had been discussed by Federal Reserve staff members as early as 1963,[11] but until March 2021 the Fed had mostly refrained from making those trades. In March 2021, the Fed opened the reverse repo spigot to money market mutual funds presumably in order to arrest disturbances in the market for repurchase agreements that had threatened to send repo rates into negative territory. Negative repo rates would have adversely affected money market mutual funds, a part of the US shadow banking system that the Fed cares about. The Fed pays interest on RPPs, but at a lower rate than on bank reserves.

In October 2008, the Federal Reserve began paying interest on reserve deposits, effectively making them perfect substitutes for interest-bearing Treasury debt. To acknowledge that change in Fed operating procedures, the green line in figure 6 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. Counting reserves at the Fed and the Fed's reverse repo positions as interest-bearing debt increases the ratio of privately-held federal debt to GDP from 72.7% to 97.3% as of December 31, 2021. Because the Fed used some of 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 6 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.

[11] See Garbade (2021, p. 361) and Meltzer (2009, pp. 374 and 464)

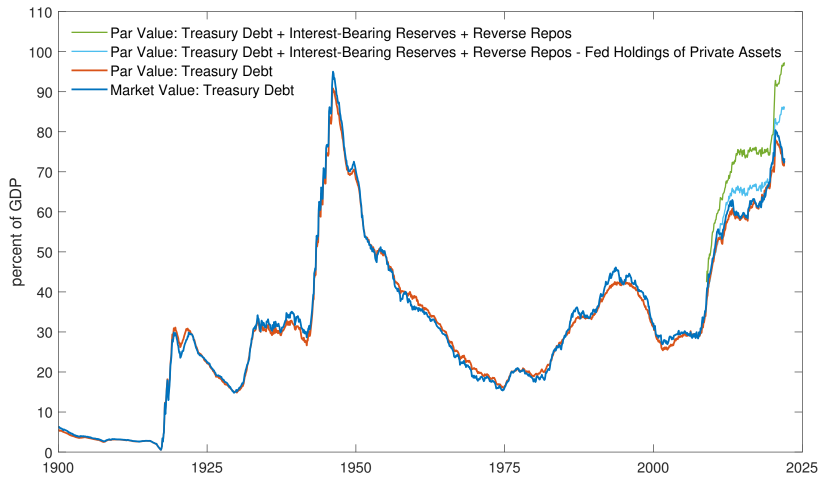


Figure 6: Par and Market Values of US Federal Debt Held by Domestic Private Investors and Foreign Investors as Percents of GDP: 1900 to 2021

From October 2008 to December 2021, the green line plots the sum of the par value of privately-held Treasury debt and interest-bearing reserves and reverse repos 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.

5 Government Budget Arithmetic

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

$$G_t + r^B_{t-1,t}B_{t-1} + (A_t - A_{t-1}) = T_t + (B_t - B_{t-1}) + r^A_{t-1,t}A_{t-1} + (M_t - M_{t-1}) + OM_t \qquad (1)$$

where

$$
\begin{aligned}
G_t &= \text{Government outlays (net of official interest payments} \\
B_{t-1} &= \text{Nominal market value of interest bearing government debt held by private} \\
&\quad\;\; \text{investors at the end of } t-1 \\
r^B_{t-1,t} &= \text{Nominal value-weighted holding period return on government debt between } t-1 \text{ and } t \\
A_t &= \text{Private assets purchased by the Federal Reserve} \\
r^A_{t-1,t} &= \text{Nominal holding period return on Fed-held private assets between } t-1 \text{ and } t \\
T_t &= \text{Tax receipts} \\
M_t &= \text{Federal Reserve credit} \\
OM_t &= \text{Funding by Other Means}
\end{aligned}
$$

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.

Dividing each term in equation (1) by nominal GDP and rearranging yields:

$$\frac{G_t}{Y_t} + \left(r^B_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} - r^A_{t-1,t}\frac{A_{t-1}}{Y_{t-1}}\right) + \left(\frac{A_t}{Y_t} - \frac{A_{t-1}}{Y_{t-1}}\right) = \frac{T_t}{Y_t} + \left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}}\right) + \frac{M_t - M_{t-1}}{Y_t}$$
$$+\frac{OM_t}{Y_t} + g_{t-1,t}\frac{B_{t-1} - A_{t-1}}{Y_{t-1}} + \pi_{t-1,t}\frac{B_{t-1} - A_{t-1}}{Y_{t-1}} + (\pi_{t-1,t} + g_{t-1,t})\left(r^B_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} - r^A_{t-1,t}\frac{A_{t-1}}{Y_{t-1}}\right) \quad (2)$$

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

Following Hall and Sargent (2021), we decompose wartime increases in federal revenue by computing deviations from peacetime baselines values for each term in equation (2) and summing these deviations between the start and the end of each war. We describe this decomposition in section 1 of the appendix.

Columns 1, 2, and 3 of table 2 report spending from the left side of equation (2). Columns 5 and 6 report wartime changes in tax revenues and debt relative to prewar baselines. Columns 7-9 report wartime changes in money growth, real GDP growth, and inflation. Column 10 reports the sum of changes in other means, the cross product, and a sum of residuals.[12] For each war, entries in the first row are percents of GDP and we sum over years. Entries in columns 5-10 sum to column 4; for example, the increase in government spending for World War I over the two years 1917-1918 was 36.93% of a single year's GDP. Net payouts to bondholders during the war were 0.30% of a year's GDP, and the Fed purchased private assets worth 0.16% of a year's GDP bringing the total cost of the war to 37.39%. The numbers in the second row are percentages of the sum of war-related government spending, net payouts to bondholders and asset purchases (column 4) accounted for by each term on the right side of equation (2).

How did the government pay for these outlays? For World War I, the answer is:

- 20.8% taxes, 74.3% growth in interest-bearing debt, 6.9% money growth, and -2.0% from the remaining terms.

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

War Start - End (US entry -)	(1) government spending	(2) payouts on net debt	(3) asset purchases	(4) (1)+(2) +(3)	(5) tax revenue	(6) debt growth	(7) money growth	(8) GDP growth	(9) inflation	(10) Other
World War I										
1914:7 - 1918:11	36.11	0.43	0.39	36.92	6.83	26.76	3.41	0.48	1.12	-1.67
					18.5	72.5	9.2	1.3	3.0	-4.5
(1917:4 -)	36.93	0.30	0.16	37.39	7.76	27.79	2.59	0.03	0.68	-1.46
					20.8	74.3	6.9	0.1	1.8	-3.9
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 - 2021:12	21.37	0.22	5.85	27.45	0.95	-0.59	25.16	1.02	3.03	-2.12
reserves $\subset M$					3.5	-2.2	91.7	3.7	11.0	-7.7
2020:1 - 2021:12	21.37	0.17	5.85	27.40	0.95	18.36	5.07	1.48	3.99	-2.45
reserves $\subset B$					3.5	67.0	18.5	5.4	14.6	-8.9

Table 2: Decomposition of Wartime Revenues from Equation (2)

For each war, the elements in first row are in percent of GDP. Columns 5-10 sum to column 4. The numbers in the second row are percentages of the sum of war-related spending, net debt payments and purchases of private assets (column 4) accounted for by each term on the right side of equation (2). Column 10 is the sum of other means, the cross product, and a residual. See the appendix for the definition of M.

For World War II, the answer is:

- 30.2% taxes, 46.0% growth in interest-bearing debt, 10.1% money growth, and 13.7% from the remaining terms.

For the War on COVID-19, so far, the federal government has spent slightly over 1/5 of a year's GDP to fight COVID-19. Relative to the size of the economy, the US government has already spent a little more than half of what it spent fighting World War I. On top of these outlays, the Federal Reserve has increased its holding of private assets, largely mortgage-backed securities, by 5.85% of a year's GDP. For COVID-19, we decompose revenues in two ways. In our first decomposition, we count reserve balances at the Federal Reserve as part of base money.[13] In this case, the revenue decomposition is:

- 3.5% taxes, -2.2% growth in interest-bearing debt, 91.7% money growth, and 7.0% from the remaining terms.

Our second decomposition acknowledges that the Federal Reserve has paid interest on reserve deposits since 2008 and issued more reverse repurchase agreements. When we count these reserves and reverse repos as interest-bearing federal debt and subtract them from our measure of Fed credit, the revenue decomposition for the COVID-19 War becomes:

- 3.5% taxes, 67.0% growth in interest-bearing debt, 18.5% money growth, and 11.1% from the remaining terms

This adjustment re-allocates roughly 70% of the revenues from money growth to interest bearing debt growth. It has no impact of the share of revenue from explicit taxation.

These decompositions confirm indications from figures 2, 4, and 5. During all three wars, the federal government financed its expenditures primarily by issuing interest-bearing debt and non-interest bearing money rather than by increasing taxes. In the First and Second World Wars, the federal government relied chiefly on interest-bearing debt to raise revenue. So far during the War on COVID-19, if the fact that the Fed now pays interest on bank reserves and reverse repos does not convince you to reclassify reserves and repos as bonds instead of money, then money growth has been government's main source of revenue.[14] By diluting the real value of the outstanding debt, inflation has already contributed over 10% of total government revenue collected during the COVID-19 War.

From the relative increases in debt holdings in table 1, the finding from our first COVID-19 decomposition that -2.2% of total costs was financed by interest-bearing debt may seem low. As

[13]We construct our measure of Fed credit from the asset side of the Fed's balance sheet rather than the liability side. In the online appendix we report this decomposition measuring Fed credit from the liability side of the Fed's balance sheet.

[14]Drawing lines between "money" and "bonds" is always theoretically delicate, especially when reserves earn interest. See Friedman (1959) and Bassetto and Messer (2013).

table 1 shows, during the 24 months of the COVID-19 War, domestic and foreign private investors purchased \$1.8 trillion in newly issued Treasury debt (measured at par value). However during the 24 months prior to COVID, between December 2017 and December 2019, the federal government consistently ran primary deficits and private investor holdings of interest-bearing Treasury debt increased by \$2.5 trillion. Our first decomposition implies that all of the COVID-era increase in privately held debt would have occurred in the absence of the pandemic.

6 Bond Returns

All three wars were financed mainly by issuing interest-bearing bonds and base money. How well did bondholders do in the 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 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 7 compares natural logarithms of the US price level for the 12 years after the start of World War I with 12 year period after the start of World War II. For each war, we normalize the price level by the transformation $100 \times (\log P_t - \log P_{\text{start of war}})$, so a series records cumulative percentage changes in the price level after a war's start. The blue line reports the log of the price level for 24 months following the outbreak of COVID-19.

Figure 7 confirms how the price level rose during both twentieth century world wars. After World War I, the price level peaked in 1919 at more than 70% higher than its pre-war level. Although the price level fell during a deep but short 1920-1921 depression, ten years after the war it remained about 55% higher above its 1914 level.

During World War II, price and wage controls postponed price level increases. 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, as figure 8 shows.

Figure 8 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] During both twentieth century world wars, real values of a portfolio of Treasury bonds initially rose but soon fell as the price level rose. After World War I, rising interest rates drove bond prices down so that by June 30, 1920, long-term bonds traded 10 to 15% below their par

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

[16] The real value at month t is $100 \times \prod_{s=s_o}^{t} \frac{1+r_{s,s+1}}{1+\pi_{s,s+1}}$, where s_o is the month at the start of the war, $r_{s,s+1}$ 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 $s+1$. Units are start-of-war dollars.

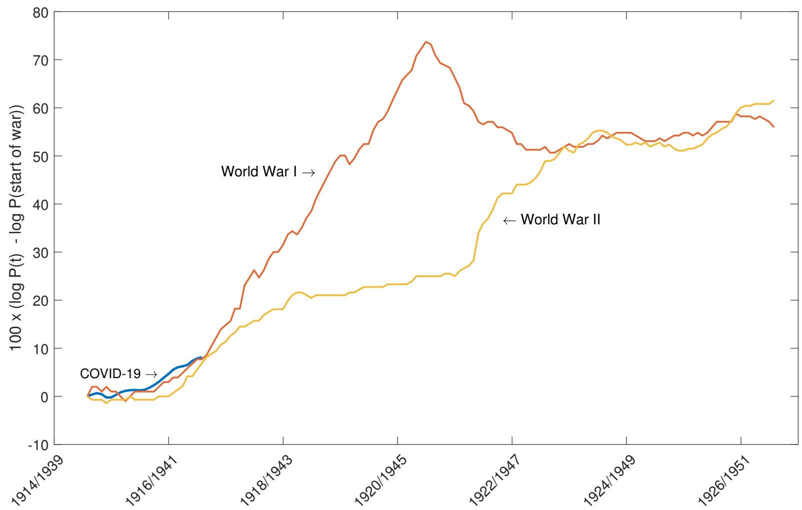


Figure 7: Natural Log of the Price Level During and After Each War

This figure displays $100 \times (log P_t - log P_{\text{start of war}})$, 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 December 2021.

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 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, World War II Treasury officials fixed bond yields. That kept nominal returns on the Treasury's portfolio 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.

Blue lines in figures 7 and 8 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 a bondholder during

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

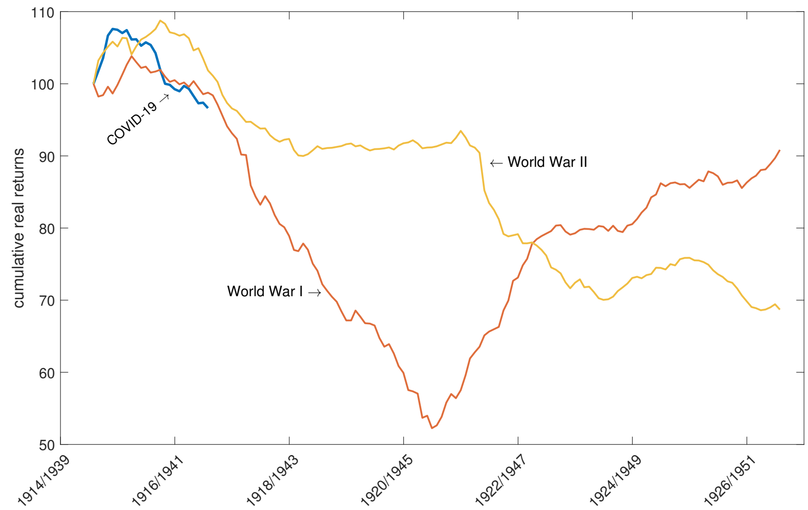


Figure 8: Real Values of $100 Portfolio of Treasury Securities Invested at Starts of Three Wars

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 December 2021.

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 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 Decomposing Postwar Changes in Debt-GDP Ratios

We rearrange equation (2) to decompose the evolution of the interest-bearing debt-GDP ratio into contributions made by nominal returns paid on Treasury securities, GDP growth, inflation,

	100 × Debt/GDP			Contributions					
War post-war period	(1) end of war	(2) 15 years postwar	(3) change	(4) nominal payouts $r_t \frac{B_{t-1}}{Y_{t-1}}$	(5) real gdp growth $g_t \frac{B_{t-1}}{Y_{t-1}}$	(6) inflation $\pi_t \frac{B_{t-1}}{Y_{t-1}}$	(7) primary deficit $\frac{G_t - T_t}{Y_t}$	(8) money growth $\frac{M_t - M_{t-1}}{Y_t}$	(9) other
World War I 1919-1934	28.6	31.4	2.8	15.7	-7.1	3.7	-11.9	-1.0	3.4
World War II 1945-1960	90.1	35.7	-54.4	14.3	-15.8	-38.9	-13.0	-0.3	-0.8

Table 3: Decomposition of Post-War Changes to the Debt/GDP Ratio from Equation (3)

a cross-term, the primary deficit and seigniorage:

$$\begin{aligned} \frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}} &= r_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} - g_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} - \pi_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} - r_{t-1,t}(\pi_{t-1,t} + g_{t-1,t})\frac{B_{t-1}}{Y_{t-1}} \\ &\quad + \frac{G_t - T_t}{Y_t} - \frac{M_t - M_{t-1}}{Y_t}. \end{aligned} \tag{3}$$

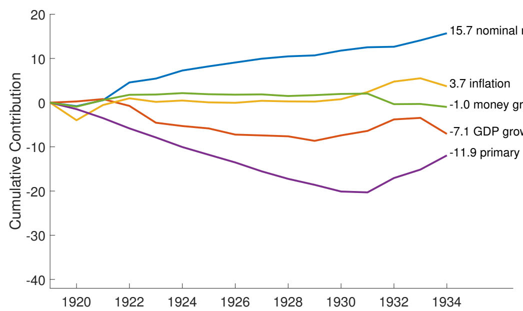
Note that we have set $A_t = 0$.

Columns 1 - 3 of table 3 report changes in the debt-GDP ratio over fifteen-year periods following the end of each war. In columns 4 - 9, we report our decomposition into components attributable to (i) nominal payments to bondholders, (ii) GDP growth, (iii) inflation, (iv) the primary deficit, (v) money growth, and (vi) the sum of the residual and the cross-term. Figure 9 displays the cumulative sum of the first five of these components.

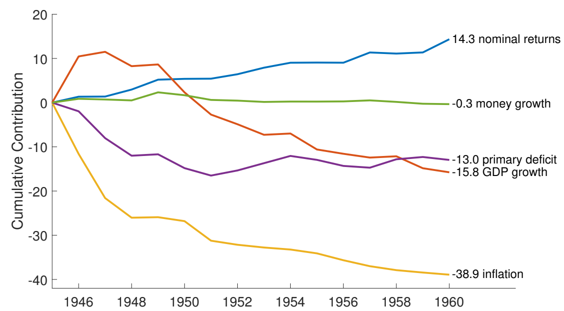
From 1919 to 1928, driven largely by primary surpluses and real GDP growth, the debt-GDP ratio fell from 28.6 to 20.2; but then from 1929 to 1934 as real GDP growth became negative and the federal government began to run primary deficits, the debt-GDP ratio rose to 31.4.

From 1945 to 1960, the debt-GDP ratio fell from 90.1 to 35.7. That reduction was attributable to inflation (71%), real GDP growth (29%), and primary surpluses (24%). These add to more than 100% because, offsetting these contributions, bondholders received 26% of the 54.4% decrease in the debt-GDP ratio.

Figure 9 visualizes how the table 3 decompositions accumulated gradually over 15 year time spans. We must wait for a corresponding panel for 15 years after the end of the War on COVID.

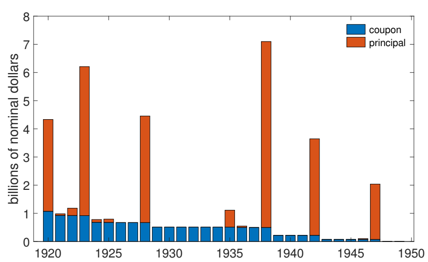


(a) Post World War I

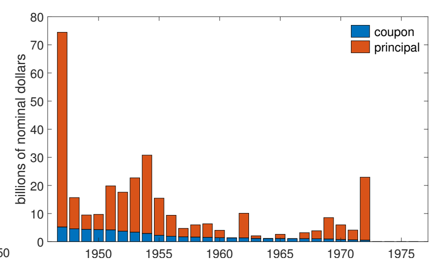


(b) Post World War II

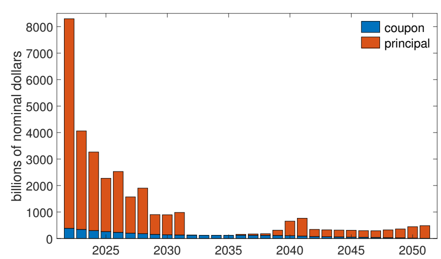
Figure 9: Cumulative Sums of Contributions to Postwar Debt-GDP Changes



(a) 1919



(b) 1946



(c) 2021

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).

9 Whither Bond Returns?

After the War on COVID-19, will US federal bonds provide private owners even lower real returns than they did after the two twentieth century world wars? Maybe, but four differences between now and then make it more difficult for the government to raise revenues by giving low returns to private bond holders.

1. The maturity of total federal debt outstanding 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 2021. 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 heavily weighted toward the short-end than it was at the ends of World Wars I and II. That means that a given rise in interest rates has less effect on the market value of federal debt.

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 held mostly 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. There were fewer consumer goods for sale and fewer 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 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 to adopt a two-budget constraint framework like those of Bassetto and Messer (2013) or Del Negro and Sims (2015).

10 Concluding Remarks

The words of Keynes with which we began this paper remind us that *someone* will ultimately pay for the US War on COVID-19. Table 2 measures how the US government made "the public pay for" war-time surges in expenditures in the ways that Keynes (1923, p. 62) delineated – taxes, sales of government bonds, and printing money. As percentages of total revenues, sources were:

	taxes	bonds	money
World War I	20.8	74.6	7.0
World War II	30.2	46.0	10.1
COVID-19	3.5	67.0	18.5

It is striking how little of the War on COVID-19 has thus far been financed by explicit taxation, even compared to World Wars I and II.[18] Harry Truman's advice about how to pay for a war has temporarily been ignored.

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[18] As we explained in section 4, the Fed's policy of paying interest on excess reserves since 2008 makes tenuous how our numbers separate money creation from debt issues during the War on COVID-19.

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