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DEBT AND TAXES IN EIGHT U.S. WARS AND TWO INSURRECTIONS

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Debt and Taxes in Eight U.S. Wars and Two Insurrections
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ABSTRACT

From decompositions of U.S. federal fiscal accounts from 1790 to 1988, we describe differences and patterns in how expenditure surges were financed during 8 wars between 1812 and 1975. We also study two insurrections. We use two benchmark theories of optimal taxation and borrowing to frame a narrative of how government decision makers reasoned and learned about how to manage a common set of forces that bedeviled them during all of the wars, forces that included interest rate risks, unknown durations of expenditure surges, government creditors' debt dilution fears, and temptations to use changes in units of account and inflation to restructure debts. Ex post real rates of return on government securities are a big part of our story.

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A war can ravage half a continent and raise no new issues in economic theory.

George Stigler

A fellow may do many a crazy thing and as long as he has no theory about it, we forgive him. But if there happens to be a theory behind his actions, everybody is down on him.

Gene Henderson in *Henderson the Rain King* by Saul Bellow

... the study of the past with one eye, so to speak, upon the present is the source of all sins and sophistries in history.

Herbert Butterfield, *The Whig Interpretation of History* (1931)

1 Introduction

This paper describes an extended exercise in pattern recognition; or is it pattern imposition? We construct and interpret accounts that measure fiscal choices and some of their consequences during and after 10 surges of government spending that were associated with eight major U.S. wars and two insurrections, seeking to spot similarities and differences across these surges. We don't pretend to "let the data speak for themselves"¹ and admit that our interpretations are shaped by the economic theories described in section 2 and an accounting scheme that we describe in section 3. The section 3 decompositions of government budgets are designed to make contact with the section 2 theories.

Wartime surges in government expenditures have always provoked debates about how to pay for them. Those debates inspired classic theoretical contributions about the optimal mix of debt and taxes and whether the mix matters at all. The origin of theories of optimal tax-borrowing policies in those debates is an element of our defense against a Butterfieldian charge of inappropriate presentism (interpreting the past from a perspective and with information not available to those who acted in history). Statesmen who made the tax and borrowing decisions studied here had purposes and theories in mind, intellectual forces that will be important parts of our story. Therefore, we are naturally ambivalent about whether our section 2 theories are to be viewed as normative (how things should be) or positive (how things are). We use the theories both ways because key historical actors sometimes used them as rationalizations of their proposals. A poster child for this point of view is the coincidence of recommendations of the Barro (1979) model with Secretary of Treasury Albert Gallatin's 1807 Report as well as subsequent actions of Gallatin and his successors.

¹If asked to do so they would have been silent.

We appreciate Gary Becker's 1962 view that constraints alone go a long way in explaining patterns in outcomes, regardless of decision makers' purposes or their rationality. When we spot differences across our 8 + 2 wartime expenditures, our theories naturally direct us to ask how much of these are to be explained by decision makers' purposes or their constraints or their understandings, i.e., their theories. We describe the expenditure surges sequentially and note decision maker's evolving understandings. Memories of how the Continental currency that had financed the War of Independence from Great Britain had eventually depreciated to one penny on the dollar prompted War of 1812 decision makers to take steps to avoid that outcome. Noncallable Federal bonds issued to pay for the Mexican War appreciated in value after the war when interest rates fell, creating *ex post* regrets that the bonds had not been bundled with call options, something that the Union would do early in the Civil War. Rising nominal interest rates after World War I delivered nominal capital losses to owners of the Liberty Bonds that had been used to finance the war, teaching Captain Harry Truman a lesson that he would remember when as President he insisted that the Treasury and Federal Reserve manage interest rates after World War II to prevent that from happening again. We recount many other instances of later statesmen learning from what came to be recognized as mistakes during past wars. Prevailing understandings evolved about how government securities should be designed and marketed; about types of taxes to be imposed; and about the roles of the legal restrictions such as price controls and portfolio restrictions recommended by Keynes (1940) and formalized by a theory of Bryant and Wallace (1984). Statisticians tell us that the *only* things we can learn about are parameters of a necessarily restricted *model*, so perhaps it is excusable that we see successive government authorities processing information about past government expenditure surges in order to modify and refine their theories. (See the words written by Secretary McAdoo in the first paragraph of section 6.5.)

This brings us to a difficulty that we want to acknowledge. As we watch policy makers over two centuries confronting their predicaments by combining their recollections of histories with their theories, we'll see them struggle over and over again with the same forces. These include roll-over risks associated with unanticipated changes in market conditions and interest rates that bedevil decisions about the maturity structure of debt to sell; issues about units of account in which to denominate coupon and principal payments; interactions between banking and fiscal policies; temptations to default; and issues forced on them by prospective government creditors incentives to delay supplying credit in anticipation of better terms in the foreseeable future.² We admit that the section 2 benchmark models that frame this paper omit or oversimplify almost all

²But notice how our Lucas-Stokey (1983) benchmark model refines our Barro (1979) model by allowing returns on government debt to be state-contingent, a feature that we'll use to interpret evidence on postwar returns to government creditors. There have been many subsequent refinements of this type of model. For example, Pouzo and Presno (2016) studies defaults to government creditors as a way to provide some state-contingency with interesting incentive effects.

of these forces, something that we'll try to keep in mind as we describe and interpret our 8 + 2 wartime expenditure surges in sections 4, 5, 6, and 7.

1.1 Reader's guide

Section 2 describes the two classic models of wartime finance that frame our analysis, one that we attribute to Gallatin (1837) and Barro (1979), the other to Lucas and Stokey (1983). We compare the composition of financing across wars extending from the American Revolution to Vietnam. Our analysis differs from previous studies in some important ways. Consistent with our benchmark theories, we measure government debt at its market value rather than its par value and we measure returns to bondholders in terms of *ex post* holding period returns instead of with the government's accounting measure of interest payments on its debt. In addition, we use GDP growth and inflation to help account the real debt burden relative to GDP.

In most wars, we see evidence of Gallatin-Barro tax smoothing (i.e., tax responding much less than one-for-one with spending), but only during the Civil War do we see a close approximation to the split between taxes and debt that the model recommends for a purely *temporary* expenditure surge. We also see negative wartime bond returns followed by positive postwar returns in the War of 1812, the Civil War, World War I and the Korean War as prescribed by the Lucas-Stokey model. But we note this model directs that bondholders should receive an immediate capital loss at the *outbreak* of a war. We observe that only in the Korean War. To implement that Lucas-Stokey recommendation there had to be a sufficiently large outstanding stock of debt at the time of the wartime surge in government spending. At the starts of several wars (e.g., the Mexican War, Civil War, World War I), the U.S. had little debt. So for these wars, the Lucas-Stokey action would not help the government's financial situation.³ In section 6 we discuss how Congress and Treasury secretaries experimented and innovated with various debt designs and management policies to induce potential investors to purchase bonds early in wars despite fears of wartime capital losses.

We detect some notable patterns. Over time, from the War of 1812 to the Vietnam War, the U.S. has financed a larger share of wartime spending with taxes and a smaller share with debt. Seignorage contributed a significant share of revenue in the Civil War, World War I, World War II and the Korean War. Over time, post-war real returns paid to bondholders have declined. After four majors wars, the War of 1812, the Civil War, World War I and World War II, average annual returns to bondholders were 12.0%, 8.5%, 5.5% and -1.4%, respectively. We decompose changes in the debt/GDP ratio. We find that the U.S. didn't simply grow out of its World War

³It is ironic that we only see these Lucas-Stokey start-of-war losses during the Korean War. President Harry Truman, was determined to ensure that returns on government debt was risk free – not state-contingent. For example, during the war he tried to make sure the Fed and Treasury kept the nominal yield curve fixed. However, he had limited control over the price level. Prices rose at the start of the Korean War generating the negative real returns.

II debt. While GDP growth certainly played an important role, other forces also contributed. Inflation eroded between one-third and one-half of the debt, and primary budget surpluses also contributed. From the War of 1812 to World War II, there was a democratization of U.S. Treasury debt. We emphasize two forces that drove this extension of the Treasury market from the nation's elite to broad range of investors: (i) as wars became more expensive, the Treasury wanted to raise more funds than banks and investment houses, particularly in the northeast, seemed eager to supply at prices acceptable to the Congress and Treasury; and (ii) Treasury secretaries and others viewed broad-based purchases of debt as an indicator of patriotic support for a war.⁴ While this expansion of Treasury ownership might have resulted in increased political support to service the debt, we find that as federal debt became more widely held, postwar returns fell.

After studying eight wars, we compare the funding of two insurrections: the American colonists' war of secession from the British Empire from 1775 to 1873 and the Confederate States of America's (CSA) failed attempt to secede from the United States in the early 1860s. Both rebel governments had limited access to taxation and thus funded their armed forces largely through debt and seignorage, but the timing of their issues of debt and money differed. The Continental Congress funded the first half of the American Revolution, from 1775 to 1780, almost exclusively through seignorage while it financed the second half by borrowing in the form of commissary and quartermaster certificates and other *ad hoc* I.O.U.s. Initially, the CSA financed their efforts with a greater mix of debt; as the war progressed the CSA relied more heavily on seignorage.

In section 8, we conclude this paper by offering qualifications involving the draft and other issues of fairness. We also note that while Treasury secretaries have viewed widespread purchases of debt as a sign of patriotic support for a war effort, contemporary op-ed writers and political scientists viewed higher taxes as a better way to signal broad-based support. Appendix A describes our accounting system while appendix B tells data sources.

2 Two Theories of War Finance

As benchmarks, we use two classic models of about how a government optimally finances wartime surges of government expenditures, one due to Barro (1979), the other to Lucas and Stokey (1983). Both models are about how a government ought to adjust tax collections and government borrowing in response to random government expenditure shocks. The models differ in how much fiscal shock absorbing is done by adjusting tax collections and how much is done by adjusting *ex post* returns to government creditors and quantities of government debt. In our Barro model, fiscal shocks permanently affect both tax collections and government debt but leave *ex post* returns on government debt unaffected. Whether tax collections or government debt adjusts more depends

⁴There were bumps along this road. For example, falling bond prices immediately after World War I soured many new investors on U.S. Treasuries. In response, in World War II the Treasury created non-marketable savings bonds and fixed the yield curve.

on how permanent are the shocks to government expenditures, with tax collections adjusting relatively more the more permanent are the shocks. So in the Barro model, a war that is expected to be short should be financed more by borrowing while a war expected to be long should be financed more by raising taxes. In our Lucas-Stokey model, regardless of how persistent they are, fiscal shocks leave government tax collections completely unaffected but affect *ex post* returns to government creditors.

Our Barro (1979) model assumes that a government can trade only risk-free one-period bonds each period, while our stripped down Lucas and Stokey (1983) model allows a government to trade a complete set of one-period Arrow securities. Interest rates are exogenous in both models.⁵ We make the models be as close as possible to each other by setting state-contingent prices in our Lucas-Stokey model so that the return on risk-free one-period debt is the same as it is in the Barro model.

In both models, a government seeks to minimize the intertemporal loss functional

$$L(\{T_t\}_{t=0}^{\infty}) = E\left[\sum_{t=0}^{\infty} \beta^t \ell(T_t)\right] | z_0 \tag{1}$$

where T_t is total tax collections at time t , $\ell(T_t) = T_t^2$, $\beta \in (0, 1)$ is a discount factor, and $E[\cdot | z_0]$, is a mathematical expectation conditional on a vector z_0 of information about future government expenditures that is available at time 0. Government expenditures $\{G_t\}_{t=0}^{\infty}$ are a scalar stochastic process that is a function of a Markov state z_t so that

$$G_t = G(z_t) \tag{2}$$

$$z_{t+1} \sim \phi(z_{t+1} | z_t) \tag{3}$$

where $\phi(z_{t+1} | z_t)$ is a Markov transition probability distribution defined on the time invariant state-space Z . In both models, an important role is played by the conditional expectation of the present value of future government expenditures PVG_t defined as

$$PVG_t = E \left[\sum_{j=0}^{\infty} \beta^j G_{t+j} \right] | z_t \tag{4}$$

$$= H(z_t) \tag{5}$$

⁵Barro assumed an exogenous interest rate just as we do, but Lucas and Stokey did not. They analyzed a closed economy in which government tax and debt management policies influenced equilibrium state-contingent prices. An important part of their theorizing was how a benevolent government optimally uses its knowledge of equilibrium private sector decision rules to manipulate state-contingent prices and associated *ex post* returns on its state-contingent debt. Our simplified Lucas-Stokey model completely shuts down that interest-rate manipulation motive and instead focuses on how the government takes advantage of the opportunity to trade securities whose payoffs are contingent on realizations of the government expenditure process.

where the function $H(z_t)$ satisfies the functional equation

$$\begin{aligned} H(z_t) &= G(z_t) + \beta \int H(z_{t+1})\phi(z_{t+1}|z_t)dz_{t+1} \\ &= G(z_t) + \beta E[H(z_{t+1})|z_t]. \end{aligned} \quad (6)$$

Our two models share the loss function (1) and are distinguished only by the budget constraints that confront the government at times $t \geq 0$. In our version of the Barro (1979) model, the government faces

$$T_t + a_t = R^{-1}a_{t+1} + G_t \quad (7)$$

where R is a gross rate of interest on one-period risk-free loans that following Barro we assume is constant over time and equal to β^{-1} . Here a_t is a risk free claim on time t goods that the government purchased at time $t - 1$ for $t \geq 1$ or was endowed with at time $t = 0$. At time t , the government purchases risk-free claims a_{t+1} of time $t + 1$ goods. Thus, government risk-free *debt* coming into period t is $-a_t$.

In our simplified Lucas and Stokey (1983) model, at time $t \geq 1$ the government faces the budget constraint

$$T_t + a_{t-1}(z_t) = G_t + \int q_t(z_{t+1}|z_t)a_t(z_{t+1})dz_{t+1} \quad (8)$$

where the density $a_{t-1}(z_t)$ represents a claim on time t goods contingent on the time t Markov state z_t that the government purchased at $t - 1$ and $q_t(z_{t+1}|z_t)$ is a pricing kernel that encodes a complete list of time t prices of one-period ahead Arrow securities. We assume that the pricing kernel is time-invariant and given by

$$q_t(z_{t+1}|z_t) = \beta\phi(z_{t+1}|z_t) \quad (9)$$

so that for $t \geq 1$ budget constraint (8) becomes

$$T_t + a_{t-1}(z_t) = G_t + \beta E[a_{t+1}|z_t] \quad (10)$$

and at time 0 is

$$T_0 + a_0 = G_0 + \beta E[a_1|z_0]. \quad (11)$$

where a_0 is an exogenous endowment of claims on time 0 goods owned by the government. Expression (9) for the pricing kernel tells how state-contingent prices discount the future through β and discount unlikely events through the conditional probability density $\phi(z_{t+1}|z_t)$.

The *ex post* gross return on the government's asset portfolio $a_t(z_{t+1})$, $z_{t+1} \in Z$ as a function

of the realized time $t + 1$ Markov state z_{t+1} is

$$R_t(z_{t+1}|z_t) = \frac{a_t(z_{t+1})}{\beta E(a_t(z_{t+1})|z_t)}. \quad (12)$$

The conditional expectation of the return on the government portfolio is then

$$ER_t(z_{t+1}|z_t)|z_t = \beta^{-1}, \quad (13)$$

which equals the one-period return on a risk-free claim on time $t + 1$ output in the Barro model.

2.1 Optimal Tax-Borrowing Plan: Barro's model

For Barro's model, a decision rule for collecting taxes that minimizes loss criterion (1) subject to the sequence of government budget constraints (7) is the following function of z_t and a_t

$$\begin{aligned} T_t &= (1 - \beta)[PVG_t + a_t] \\ &= (1 - \beta)[H(z_t) + a_t] \end{aligned} \quad (14)$$

that has the implication that tax collections follow a random walk

$$ET_{t+1}|z_t = T_t \quad (15)$$

and that government assets a_t are a unit root process that is cointegrated with government assets.⁶

2.2 Optimal Tax-Borrowing Plan: Lucas and Stokey's model

For our version of the Lucas-Stokey model, a decision rule for tax collections that minimizes criterion (1) subject to the sequence of budget constraints (8) completely smooths tax collections across time and states so that

$$T_t = T_0 \quad (16)$$

where a state-contingent asset-purchasing strategy supports this tax collection policy, namely,

$$a_{t-1}(z_t) = a(z_t, T_0) \equiv H(z_t) - \frac{1}{1 - \beta} T_0. \quad (17)$$

⁶See Ljungqvist and Sargent (2018, ch. 2) for analogous properties of a consumption-smoothing model that is isomorphic to the tax smoothing model.

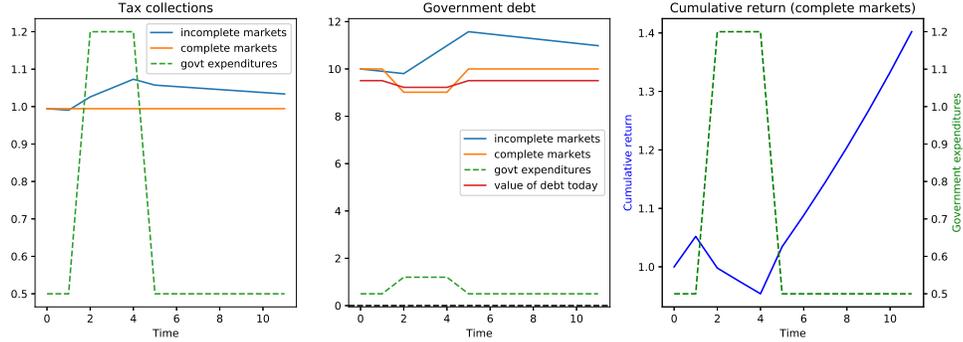


Figure 1: Tax smoothing in complete and incomplete markets economies.

2.2.1 Two state Markov example

Let's do an example in which z follows a two-state Markov chain in which state 1 denotes peace and state 2 denotes war. Let $G(1) = .5, G(2) = 1.2, P = \begin{bmatrix} .9 & .1 \\ .6 & .4 \end{bmatrix}$, and $\beta = .96$. *Ex post* returns on the government portfolio are described by a matrix $R = \begin{bmatrix} 1.052 & .949 \\ 1.084 & .977 \end{bmatrix}$ in which $R_{i,j}$ denotes the return when $s_{t+1} = j$ and $s_t = i$. Figure 1 shows outcomes for a realization of Markov states of two peace times followed by a three year war that commences in period 2 and ends after period 5 and is not followed by a subsequent war during the following periods in the sample. The orange line in the middle panel depicts $a_{t-1}(z_t)$ realized along the sample path, while the red line depicts $\beta E[a_t(z_{t+1})|z_t]$, today's value of the government's portfolio of Arrow securities that will pay off tomorrow. The panel on the right shows cumulative *ex post* gross returns on the government's portfolio of debts in our Lucas-Stokey model along a sample path. It displays negative gross returns during the war and positive gross returns during peace time.

2.2.2 Continuous state Markov example

Here we let the Markov state z_t be continuous and consist of $z_t = \begin{bmatrix} g_{1t} & g_{2t} \end{bmatrix}'$ where g_{1t} follows a random walk and g_{2t} is white noise:

$$G_t = g_{1t} + g_{2t} \quad (18)$$

where

$$\begin{aligned} g_{1,t+1} &= g_{1t} + \sigma_1 w_{1,t+1} \\ g_{2,t+1} &= \sigma_2 w_{2,t+1} \end{aligned} \quad (19)$$

where $w_{t+1} = \begin{bmatrix} w_{1,t+1} & w_{2,t+1} \end{bmatrix}' \sim \mathcal{N}(0, I)$. Thus, the shock $\sigma_1 w_{1,t+1}$ has permanent effects on government expenditures while the shock $\sigma_2 w_{2,t+1}$ has purely transitory effects. What do these government expenditure shocks do to tax collections and government debt according to our two benchmark models? For our Barro model, the optimal decision rules imply

$$\begin{aligned} T_{t+1} - T_t &= \sigma_1 w_{1,t+1} + (1 - \beta)\sigma_2 w_{2,t+1} \\ a_{t+1} - a_t &= -\sigma_2 w_{2,t+1} \end{aligned} \tag{20}$$

so that a permanent expenditure shock $\sigma_1 w_{1,t+1}$ leads to a permanent increase in tax collections by the amount of the shock and no increase in government debt, while a purely temporary shock $\sigma_2 w_{2,t+1}$ leads to a permanent increase in government debt in the amount of the shock and a permanent increase in tax collections of $(1 - \beta)$ times the amount of the shock, an increase that is just sufficient permanently to service the increase in interest payments on the government debt.

These outcomes indicate how the Barro model confirms Treasury Secretary Albert Gallatin's 1807 prescription that in the event of a war, tax rates should be set to ...

provide a revenue at least equal to the annual expenses on a peace establishment, the interest on the existing debt, and the interest on the loans which may be raised ... losses and privations caused by war should not be aggravated by taxes beyond what is strictly necessary.⁷

In the ‘‘pure Gallatin’’ case that the surge in government expenditures is thought to be temporary (a war is forecast to be short), the increase in government spending is nearly all financed by borrowing with taxes increasing by just enough to cover the interest expenses on new debt. In figure 2, we plot paths of taxes and debt in response to one-time purely transitory 50% increase in government spending. Most of the increase in government spending is absorbed through a permanent increase in debt, while the remaining part of the increase is absorbed through a permanent increase in taxes.

For our Lucas-Stokey model, tax collections are completely smoothed across time and Markov states, so $T_t = T_0$ for all $t \geq 0$. Calculating the fixed point of functional equation (6) yields the linear function

$$H(z_t) = (1 - \beta)^{-1} g_{1t} + g_{2t}$$

so that the government's optimal portfolio of state-contingent assets is

$$\begin{aligned} a_{t-1}(z_t) &= (1 - \beta)^{-1} g_{1t} + g_{2t} - \frac{1}{1 - \beta} T_0 \\ &= (1 - \beta)^{-1} (g_{1,t-1} + \sigma w_{1,t}) + \sigma_2 w_{2t} \end{aligned} \tag{21}$$

⁷See page 360 of Gallatin (1837).

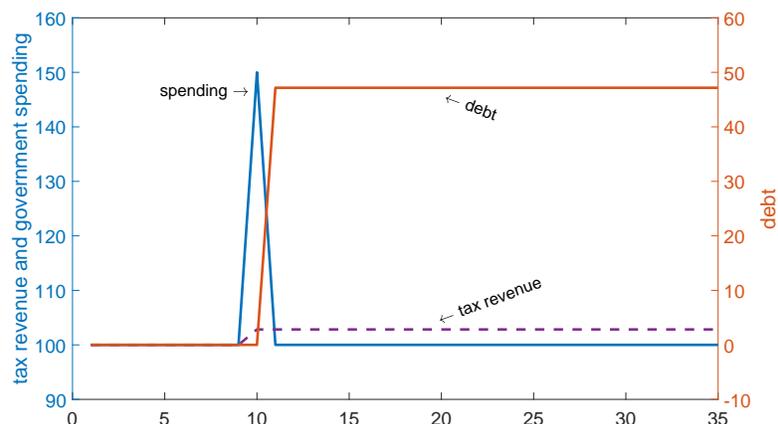


Figure 2: The Response of Taxes and Debt to a Temporary Increase in Government Spending in the Gallatin-Barro Model

The right side of the second line is a compact description of the shock-contingent date $t + 1$ payoffs that at time t the government purchases to insure itself against the two fiscal shocks.

2.3 U.S. government debt: risk-free or state-contingent?

In sections 4 and 5 below, we will use patterns presented in our benchmark models as guides for organizing and interpreting observed spending, taxes, debt, and *ex post* returns during and after eight wars. Most debt issued by the U.S. Treasury was not explicitly state-contingent debt.⁸ But by accepting or engineering changes in price levels, capital tax rates, and interest rates, a government can deliver *ex post* state-contingent returns on its debt. Until World War II, the U.S. government encouraged money- and bond-holding in the face of wartime inflations by promising postwar deflations. Bordo and Kydland (1995) argued that, as administered between 1880 and 1914, the gold standard facilitated making returns on a government’s debt state-contingent. During calm periods, governments on the gold standard pegged their currencies to gold. But during a wartime fiscal emergency, gold convertibility could be suspended with the understanding that after the war convertibility at the original par would be resumed. During a war, a government could issue paper money and sell bonds to meet temporary spending demands, generating wartime inflation. But to do that, a government had to sustain prospects that it would preside over a postwar deflation that would allow it eventually to redeem those wartime debts in gold.

⁸Call and exchange options are notable explicit state-contingencies. Sections 6.3 and 6.5 describe call options in Civil War era 5-20 bonds and exchange options in the early Liberty Loans issued during World War I.

3 Government Budget Constraint

In the section 2 benchmark models, a government issues only one-period interest bearing debt. To connect those models with the full range of maturities of U.S. Treasury securities and the monetary base, let $B_{t-1} = \sum_{j=1}^n B_{t-1}^j$ be the total nominal value of interest bearing government debt at $t - 1$, where B_{t-1}^j is the nominal value of zero coupon bonds of maturity j at $t - 1$. The government budget constraint at time t is

$$B_t = B_{t-1} + r_{t-1,t}B_{t-1} + G_t - T_t - (M_t - M_{t-1}) \quad (22)$$

where G_t is the dollar value of government purchases, T_t is the dollar value of taxes net of transfers, and M_t is the stock of non-interest bearing government debt called base money. Let $r_{t-1,t}^j$ be the net *nominal* return between $t - 1$ and t on nominal zero-coupon bonds of maturity j , so the equality

$$\sum_{j=1}^n r_{t-1,t}^j B_{t-1}^j = r_{t-1,t} \sum_{j=1}^n B_{t-1}^j \quad (23)$$

implicitly defines the value-weighted net nominal return $r_{t-1,t}$ on interest-bearing nominal government bonds from $t - 1$ to t . As we explain in Appendix A, the U.S. Treasury's series *Interest Expense on the Debt Outstanding* is an accounting measure, not a value-weighted holding period return on the debt. Consistent with our theory, in our calculations we use the value-weighted holding period return on the portfolio of the Treasury debt to record the returns to bondholders.

To align our measurement of debt to theory, we make two adjustments to the U.S. Treasury's record of total public debt outstanding. First, we net out holdings by the Federal Reserve and Government Agencies and Trust Funds. Thus, we include only government debt held by private investors. In figure 3, we decompose the par value of the total public debt outstanding as a share of GDP from 1776 to 2018 into these three ownership classes. Prior to World War I, nearly all debt was held by private investors. At the end of 2018, of the nearly \$22 trillion (measured at its par value) in total debt outstanding, 26% was held in government accounts and trust funds and 10% was held by the Federal Reserve. Second, we measure Treasury debt by its market value rather than its par value. In Appendix A we explain how the market value of the government debt is related to its par value. The market value takes into account differences between interest rates and coupon rates at the time the debt is issued as well as changes in interest rates and repayment probabilities since the debt was issued; it answers the question: how much would the government pay if it were to repurchase the entire portfolio of privately-held debt at current market prices? In figure 4, we plot the par value of the debt in red and market value of the debt in blue from 1776 to 2018. While the two series track each other closely over time, each series has exceeded the other at various times.

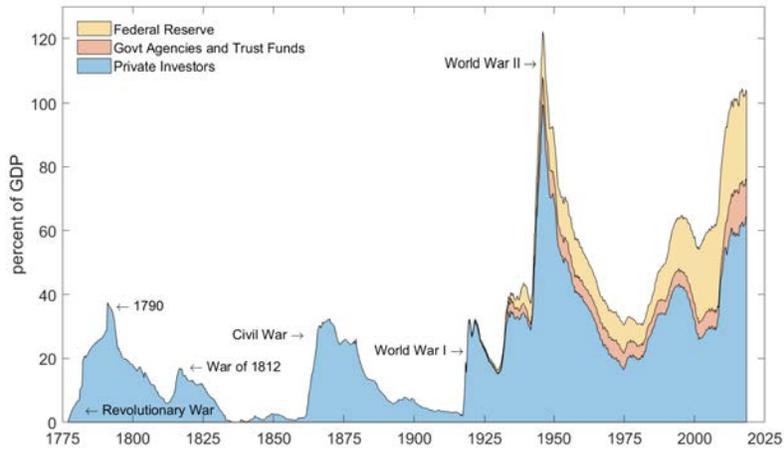


Figure 3: Par Value of U.S. Treasury Debt by Ownership as a Percent of GDP: 1776 to 2018

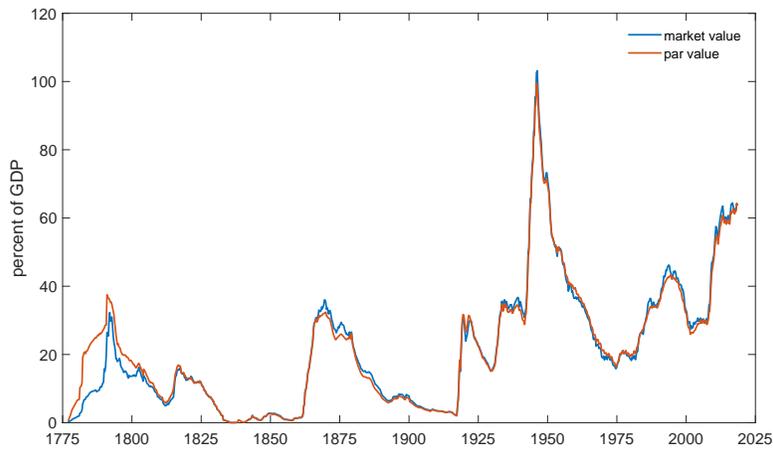


Figure 4: Par Value and Market Value of U.S. Treasury Debt Held by Private Investors as a Percent of GDP: 1776 to 2018

3.1 Decomposing Wartime Changes in Revenue

Dividing each term in equation (22) by nominal GDP, Y_t , and rearranging terms yields

$$\begin{aligned} \frac{G_t}{Y_t} + r_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} &= \frac{T_t}{Y_t} + \left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}} \right) + \frac{M_t - M_{t-1}}{Y_t} + g_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} \\ &+ \pi_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} + r_{t-1,t} (\pi_{t-1,t} + g_{t-1,t}) \frac{B_{t-1}}{Y_{t-1}} \end{aligned} \quad (24)$$

where $g_{t-1,t}$ denotes the growth rate of real GDP, and $\pi_{t-1,t}$ denotes the inflation rate. The two terms on the left side are government purchases and transfers as a share of GDP and interest payments on government debt as a share of GDP, respectively. The first three terms on the right side record sources of government revenue as shares of GDP: taxes, new borrowing and money creation. 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.

Consider a ‘‘peacetime baseline’’ version of equation (24):

$$\begin{aligned} \left(\frac{G}{Y} \right)^{base} + \left(r_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} &= \left(\frac{T}{Y} \right)^{base} + \left(\frac{B}{Y} - \frac{B_{-1}}{Y_{-1}} \right)^{base} + \left(\frac{M - M_{-1}}{Y_{-1}} \right)^{base} + \left(g_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} \\ &+ \left(\pi_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} + \left(r_{-1,0} (\pi_{-1,0} + g_{-1,0}) \frac{B_{-1}}{Y_{-1}} \right)^{base}. \end{aligned} \quad (25)$$

Subtracting equation (25) from equation (24):

$$\begin{aligned} \frac{G_t}{Y_t} - \left(\frac{G}{Y} \right)^{base} + \left[r_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} - \left(r_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} \right] &= \left[\frac{T_t}{Y_t} - \left(\frac{T}{Y} \right)^{base} \right] \\ &+ \left[\left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}} \right) - \left(\frac{B}{Y} - \frac{B_{-1}}{Y_{-1}} \right)^{base} \right] \\ &+ \left[\frac{M_t - M_{t-1}}{Y_t} - \left(\frac{M - M_{-1}}{Y_{-1}} \right)^{base} \right] \\ &+ \left[g_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} - \left(g_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} \right] + \left[\pi_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} - \left(\pi_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} \right] \\ &+ \left[r_{t-1,t} (\pi_{t-1,t} + g_{t-1,t}) \frac{B_{t-1}}{Y_{t-1}} - \left(r_{-1,0} (\pi_{-1,0} + g_{-1,0}) \frac{B_{-1}}{Y_{-1}} \right)^{base} \right]. \end{aligned} \quad (26)$$

For each war, we sum equation (26) from the beginning to the end of a war.

$$\begin{aligned}
\underbrace{\sum_{t=T_1}^{T_2} \left[\frac{G_t}{Y_t} - \left(\frac{G}{Y} \right)^{base} \right]}_{\text{government spending}} &+ \underbrace{\sum_{t=T_1}^{T_2} \left[r_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} - \left(r_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} \right]}_{\text{nominal return on debt}} = \underbrace{\sum_{t=T_1}^{T_2} \left[\frac{T_t}{Y_t} - \left(\frac{T}{Y} \right)^{base} \right]}_{\text{explicit tax revenue}} \\
&+ \underbrace{\sum_{t=T_1}^{T_2} \left[\left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}} \right) - \left(\frac{B}{Y} - \frac{B_{-1}}{Y_{-1}} \right)^{base} \right]}_{\text{interest-bearing debt growth}} \\
&+ \underbrace{\sum_{t=T_1}^{T_2} \left[\frac{M_t - M_{t-1}}{Y_t} - \left(\frac{M - M_{-1}}{Y_{-1}} \right)^{base} \right]}_{\text{money growth}} \\
&+ \underbrace{\sum_{t=T_1}^{T_2} \left[g_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} - \left(g_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} \right]}_{\text{debt dilution via real GDP growth}} + \underbrace{\sum_{t=T_1}^{T_2} \left[\pi_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} - \left(\pi_{-1,0} \frac{B_{-1}}{Y_{-1}} \right)^{base} \right]}_{\text{debt default via inflation}} \\
&+ \underbrace{\sum_{t=T_1}^{T_2} \left[r_{t-1,t} (\pi_{t-1,t} + g_{t-1,t}) \frac{B_{t-1}}{Y_{t-1}} - \left(r_{-1,0} (\pi_{-1,0} + g_{-1,0}) \frac{B_{-1}}{Y_{-1}} \right)^{base} \right]}_{\text{cross-term}} \tag{27}
\end{aligned}$$

where T_1 is the first year of the war or the first year of U.S. involvement, and T_2 is the final year of the war.

Table 1 reports the decomposition. In columns (1) and (2) of table 1, we report spending on the left side of equation (27). In columns (4) and (5), we report the wartime change in tax revenue and debt relative to the prewar baseline. In columns (6)-(8), we report wartime changes in money growth, real GDP growth, and inflation.⁹ The final two columns report changes in the cross term and a sum of residuals. For each war, entries in the first row are percents of GDP, and values in columns (4)-(10) sum to column (3). The units are percents of GDP and we sum over years; so, for example, the total cost of the Civil War over four years was 33% of a single year's GDP. The numbers in the second row are percentages of the sum of war-related government spending and returns to bondholders (column (3)) accounted for by each term on the right hand side of equation (27).

Consider columns (4) and (5). If the net real interest rate r is 6% (so $\beta = 1/1.06$ in the section

⁹During the War of 1812 and the Mexican War we assume that the federal government issued no fiat currency. For the War of 1812, we treat U.S. Treasury Notes as interest bearing debt rather than currency. Though these notes were never declared legal tender, they had several money-like attributes such as small denominations and a small-rectangular shape. In January 1812, Albert Gallatin wrote to Congress, "Treasury notes, bearing interest, might to a certain extent be issued, and to that extent diminish the amount to be directly borrowed. The advantage they would have would result from their becoming a part of the circulating medium, and taking, to a certain degree, the place of bank-notes."

2 benchmark models), and wartime spending shocks are purely temporary, then the policies in equations (20) imply that a government that engages in Gallatin-Barro tax smoothing will finance 94% of its war costs with debt and the remaining 6% with taxes. The Barro model also implies that the share of a government spending shock that is absorbed by taxes increases with the persistence of the shock. For each war, in the second row of columns (4), (5) and (6) we report percentages of total war costs (column (3)) funded by taxes, debt, and money creation. These percentages are shaded light blue. Only the decomposition for the Civil War is in line with Gallatin-Barro tax smoothing of a purely temporary expenditure shock: 6.8% from increased taxation, and 91% altogether from increased debt, money growth, and inflation.

The table reveals the striking pattern that the share of the war costs financed with taxes increased from -32.9% in the War of 1812 to 40.8% in the Vietnam War.¹⁰ Accordingly, the share financed with debt decreased from 148.5% in the War of 1812 to 12.9% in the Vietnam War. The exception to these patterns was the Spanish-American War, the shortest (fighting lasted only three months) and least costly of the eight wars.

If a government uses Lucas and Stokey tax smoothing, then all unexpected increases in government spending should be absorbed by wartime decreases in returns to government creditors. Column (2) reports the increase in nominal payments to bondholders. Column (8) reports the increase in inflation. With the exception of the Mexican War and the Korean War, the contribution of inflation is greater than the contribution of the nominal return on the debt, consistent with bond holders earning negative wartime real returns.

During World War II, the Treasury and the Federal Reserve pegged the yield curve. While government creditors received positive nominal returns during the war, those returns were set so that wartime real returns were *below* those that government creditors received during the five years prior to the war.

Clark (1931), Goldin (1980), Edelstein (2000), Rockoff (2012) and Zielinski (2016) present alternative decompositions of U.S. war finances. Our accounts differ from theirs in two ways. First, these previous authors attributed increases in specific items in the federal government’s budget to the war; we instead attribute to the war all deviations from a prior trend of components of the government budget constraint. During wars, expenditures on non-military items also increased. Second, we take into account GDP growth and inflation. For some wars, our results align with the calculations in those previous studies. For example, for World War I, Goldin (1980, Table 1, p. 938) finds that the total cost of the war was 41% of one year of GNP, and that taxes financed 24% of the cost while debt and money creation financed the remaining 76%; we estimate that the cost was 37% of one year of GDP, and that taxes financed 21% and debt and money growth financed 82% of the cost.

¹⁰During the 19th century, the main source of tax revenue was tariffs. See figure 7. During both of these wars, tariff revenue as a share of GDP fell. During the War of 1812, the U.S. went to war against its primary trading partner. During the Mexican War, the “Walker tariff” of 1846 lowered import duties across a wide range of goods.

For four other wars, the differences highlight the distinction between the two methodologies.

- For the War of 1812, Goldin (1980) finds that 21% of the war was financed by taxes while we find that since tax revenue fell relative the peacetime baseline, making our estimate of the contribution from taxes negative.
- For World War II, we find that 11.5% of the war was “paid for” through real GDP growth and devaluation of the debt through inflation.
- For the Korean War, Goldin (1980), Ohanian (1997), Edelstein (2000), and Rockoff (2012) estimate that, consistent with President Truman’s stated policy, the war was 100% tax financed. Indeed, the quantity of debt outstanding did remain virtually unchanged during that war. Further President Truman ran a balanced budget during the Korean War, with taxes rising sufficiently to cover the increase in spending. But prior to the war, the government ran a primary *surplus* and was paying down the debt incurred during World War II. The budget constraint decomposition reported in table 1 and the spending and revenue prewar averages in table 3 records that Truman’s financing of the Korean War eliminated the primary surplus and deferred the post-World War II paydown of the debt. We compute that debt and money growth financed 45.5% of the costs because the Korean War halted this debt paydown. That is, although the debt/GDP ratio fell during the war, this ratio was higher in 1954 than it would have been had the war not occurred.
- Edelstein (2000) argues that the Vietnam War was paid in part by a decrease in non-defense spending. Our decomposition is not designed to capture this.

War Start - End (U.S. entry -)	(1) government spending	(2) return on debt	(3) (1)+(2)	(4) tax revenue	(5) debt growth	(6) money growth	(7) GDP growth	(8) inflation	(9) cross term	(10) residual
War of 1812 1812:6 - 1815:2	7.34	-0.20	7.14	-2.35 -32.9	10.60 148.5	0.00 0.0	-0.16 -2.2	0.06 0.8	-0.39 -5.5	-0.62 -8.7
Mexican War 1846:5 - 1848:2	2.26	0.20	2.47	-0.06 -2.4	2.72 110.4	0.00 0.0	-0.06 -2.5	-0.01 -0.5	-0.00 -0.1	-0.12 -4.8
Civil War (Union) 1861:4 - 1865:4	31.04	2.10	33.14	2.26 6.8	19.74 59.6	6.49 19.6	1.08 3.2	3.95 11.9	0.40 1.2	-0.77 -2.3
Spanish-American War 1898:4 - 1898:8	0.78	0.11	0.90	0.45 50.0	-0.26 -28.9	0.07 7.3	0.67 74.3	0.13 14.6	0.03 3.2	-0.18 -20.4
World War I 1914:7 - 1918:11 (1917:4 -)	36.11	0.43	36.54	6.83 18.7	26.76 73.2	3.41 9.3	0.52 1.4	1.22 3.4	0.03 0.1	-2.24 -6.1
World War II 1939:9 - 1945:8 (1941:12 -)	129.50	0.10	129.60	7.76 20.8	27.79 74.6	2.59 7.0	0.05 0.1	0.76 2.1	0.00 0.0	-1.73 -4.6
Korean War 1950:6 - 1953:6	15.43	-0.71	14.73	49.91 38.5	54.78 42.3	11.32 8.7	15.42 11.9	9.62 7.4	0.26 0.2	-11.71 -9.0
Vietnam War 1964:8 - 1973:6	5.53	-2.13	3.41	35.80 30.2	54.53 46.0	11.96 10.1	8.99 7.6	6.05 5.1	0.43 0.4	0.71 0.6

Table 1: Decomposition of Wartime Revenue from Equation (27)

For each war, the elements in first row are in percent of GDP. Columns (4)-(10) 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 hand side of equation (27).

3.2 Decomposing Postwar Changes in the Debt/GDP Ratio

By rearranging equation (24), we decompose the evolution of the interest-bearing debt/GDP ratio into contributions made by nominal returns paid on Treasury securities, GDP growth, inflation, a cross-term, the primary deficit and seignorage.

$$\begin{aligned} \frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}} &= r_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} - g_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} - \pi_{t-1,t} \frac{B_{t-1}}{Y_{t-1}} \\ &\quad - r_{t-1,t}(\pi_{t-1,t} + g_{t-1,t}) \frac{B_{t-1}}{Y_{t-1}} + \frac{G_t - T_t}{Y_t} - \frac{M_t - M_{t-1}}{Y_t} \end{aligned} \quad (28)$$

In columns (1) - (3) of table 2 we report the change in the debt-GDP ratio over the fifteen year period following the end of the each war.¹¹ For each war, in columns (4) - (10) of the first row, we report components attributable to (i) nominal interest payments, (ii) GDP growth, (iii) inflation, (iv) the primary deficit, (v) the cross-term, (vi) money growth, and (vii) a residual. Hence the elements in columns (4) - (10) sum to column (3). Entries in the second row are percentages changes in the debt/GDP ratio accounted for by each component.

Except for Vietnam, the federal government reduced the debt/GDP ratio during the 12-15 year postwar period after every war, contrary to recommendations of the Gallatin-Barro and Lucas-Stokey models.

For each war, we highlight in light blue the largest contribution, in absolute value. For the first six wars, from the War for Independence to World War I, the value of the U.S. dollar was set by a bimetallic or gold standard. We see that after each of these wars, the largest forces *reducing* the debt/GDP ratio were primary surpluses followed by real GDP growth. Positive nominal returns to bondholders dampened these reductions, while changes in the price level went both ways. After the 1790 refunding of the War for Independence debt, the Mexican War and the Spanish-American War, inflation helped diminish the value of the debt relative to GDP. But after the War of 1812, the Civil War, and World War I – three wars that brought large inflations, postwar deflations increased values of debt relative to GDP and delivered high real returns to government creditors.¹²

Relative contributions changed during the three most recent wars.¹³ In contrast to the pre-World War II period, for World War II, the Korean War and the Vietnam War, primary surpluses were not the largest force pushing down the debt/GDP ratio postbellum, inflation and real GDP growth having been more important. In particular, in the 24 months after the lifting of the World

¹¹Because our data begin in 1790, in the first row of table 2 we include the 15-year period after Treasury Secretary Hamilton's refunding of the Revolutionary War debt.

¹²See figure 10 later in this paper for evidence of the sharp price level increases during these three wars and Hall and Sargent (2019, pp. 34-38) for an analysis of the post-World War I debt paydown.

¹³Hall and Sargent (2011) provides a more complete accounting of the contributions to the evolution of the debt/GDP ratio made by inflation, growth, and nominal returns paid on debts of different maturities for the post-World War II period.

War II price controls in June 1846, the price level rose 46%, effectively inflating way nearly half the value of the debt.¹⁴

In the years following the Korean and Vietnam Wars, the government ran primary deficits that helped increase the debt/GDP ratio. After the Korean War, these modest deficits were more than offset by inflation and GDP growth so that the debt/GDP declined. In the early 1980s Fed Chairman Paul Volker’s conquest of the persistent 1970s inflation generated high returns to government bondholders that helped push propel the debt/GDP ratio higher in the post-Vietnam period.

4 Expenditures and Tax Revenue

In the section 2 benchmark models, responses of tax collections and government debt to an unanticipated increase in government spending depend on the persistence of the government spending process. In the Barro model, a permanent shock is fully tax financed while a purely temporary shock is largely debt financed. See equations (20). In our version of a Lucas and Stokey model, permanent shocks to government spending generate much larger (i.e., by a factor of $(1 - \beta)^{-1}$) capital gains and losses to government bondholders than do purely transitory shocks. See equations (21).

In figure 5, we plot U.S. federal government receipts and expenditures from 1775 to 2018. For the Civil War, World War I and World War II, we see that during the war, government spending rose while taxes increased much less. After the wars, government spending fell while tax revenues remained elevated, so that the government ran a primary surplus for many years. These patterns are consistent with the optimal tax-smoothing response to a *temporary* government spending shock illustrated in figure 2. However, large U.S. wars have been followed by enduring changes in the size and composition of government spending and taxation. These three wars were followed by permanent rises in federal expenditures as fractions of GDP.¹⁵

To view the long-run impact of wars on spending in more detail, figures 6 and 8 plot expenditure categories defined by the federal government. In figure 6, federal spending from 1791 to 1940 is the sum of the categories Civil, Pensions, and War+Navy.¹⁶ Figure 8 splits spending into four categories: national defense, human resources, physical resources, and other.¹⁷ Figure 6 reveals that spending stayed higher after the War of 1812, the Civil War, and World War I, but the cate-

¹⁴See figure 10f below.

¹⁵Rothbard (2017, chs. 12-13) describes what he thinks were forces contributing to this outcomes after World War I.

¹⁶The category Civil includes spending on the Treasury-defined category, Indians.

¹⁷As defined by the OMB, Human Resources include Education, Training, Employment, and Social Services, Health Medicare, Income Security, Social Security, and Veterans Benefits; Physical Resources include Energy, Natural Resources and Environment, Commerce and Housing Credit, Transportation and Community and Regional Development; Other includes International Affairs General Science, Space, and Technology, Agriculture, Administration of Justice, and General Government.

War postwar period	100 × Debt/GDP			Contributions						
	(1) end of war	(2) 15 years postwar	(3) change	(4) nominal returns	(5) real gdp growth	(6) inflation	(7) primary deficit	(8) cross term	(9) seignorage	(10) residual
War for Independence 1791-1806	33.3	9.6	-23.8	11.3 47	-15.4 -65	-7.6 -32	-17.3 -73	-1.0 -4	-	6.3 26
War of 1812 1815-1830	11.6	3.4	-8.2	10.5 128	-5.6 -68	4.9 60	-19.4 -237	0.1 1	-	1.3 16
Mexican War 1848-1860 [†]	2.7	1.2	-1.5	0.8 53	-0.9 -60	-0.1 -7	-1.5 -100	-0.1 -7	-	0.3 20
Civil War (Union) 1865-1880	22.1	15.6	-6.5	21.4 329	-14.5 -223	13.5 208	-29.5 -454	0.1 2	1.2 18	1.3 20
Spanish-American War 1898-1913	4.6	2.2	-2.4	0.9 38	-1.2 -50	-1.1 -46	-1.9 -79	-0.1 -4	0.8 33	0.1 4
World War I 1919-1929 [‡]	28.6	20.2	-8.4	12.5 149	-6.4 -76	2.4 29	-20.3 -242	0.3 4	2.0 24	1.0 12
World War II 1945-1960	90.1	35.7	-54.4	14.3 26	-15.8 -29	-38.9 -71	-13.0 -24	-0.6 -1	-0.3 -1	-0.2 0
Korean War 1953-1968	49.9	21.8	-28.1	14.0 50	-20.3 -72	-10.8 -38	4.0 14	-0.8 -3	-5.8 -21	-8.5 -30
Vietnam War 1973-1988	16.4	34.7	+18.3	32.3 177	-12.2 -67	-19.2 -105	19.7 108	-2.7 -15	-6.0 -33	6.3 35

Table 2: Decomposition of Post-War Changes to the Debt/GDP Ratio from Equation (28)

[†] 12 years, [‡] 10 years

Note: For each war, the elements in the first row are in percent of GDP. Treasury debt is its end-of-year market value net of holdings of the Federal Reserve and government accounts and the balance in the Treasury. Columns (4) - (10) sum to column (3). The elements in the second row are the percentages in changes in the debt/GDP ratio accounted for by each contribution.

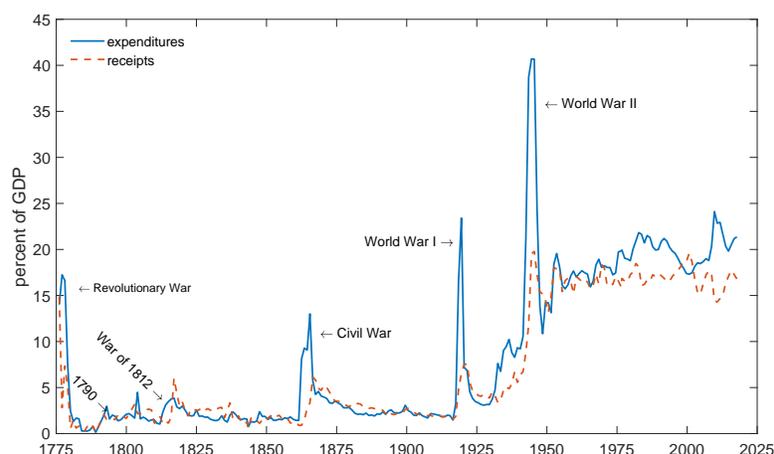


Figure 5: U.S. Federal Government Expenditures and Receipts: 1775 to 2018.

gories that increased differed. As a share of GDP, spending on the military remained permanently higher after the War of 1812. After the Civil War, there was a persistent increase in pension payments to Union veterans and their families, while after World War I, it was the Civil category, which included non-transfer domestic spending, that stayed permanently higher.¹⁸ Comparing figures 6 and 8 illustrates the enormous and permanent increase in government spending that occurred during World War II as government spending rose from under 10% of GDP before the war to 20% of GDP after the war.

In figures 7 and 9, we decompose federal tax revenue into various government defined categories. Prior to the Civil War, despite periodic attempts to diversify its revenue stream, the Treasury's primary revenue source was customs (i.e., tariff) revenue. During the Civil War, the federal government introduced a new set of internal taxes, including a personal income tax. Although many internal taxes (including the income tax) were removed shortly after war, during the 50 years between the Civil War and World War I, Treasury revenue was roughly evenly split between customs and internal revenue. Principal sources of these internal revenue were taxes on liquor and tobacco. Internal revenue, especially from the income tax, surged during the Civil War, World War I and World War II. Since the re-introduction of the income tax in 1914 and rises in income tax rates during World War I, internal revenues have been the primary sources of revenue for the Treasury. The Revenue Act of 1942, enacted shortly after the U.S. entered World War II, created today's system of personal and corporate income taxes.

Debts incurred during the War for Independence, the War of 1812, and Mexican War were serviced with customs revenue. Debts incurred during the Civil War and Spanish-American War were serviced with a combination of customs revenue and taxes on liquor and tobacco. Debts

¹⁸Between 1917 and 1922, the federal government advanced \$9.5 billion to 11 Allied countries. Although at the time the Treasury viewed these advances as loans, they were recorded as Civil expenditures. As Hall and Sargent (2019) report, by the early 1930s most of these foreign loans became gifts.

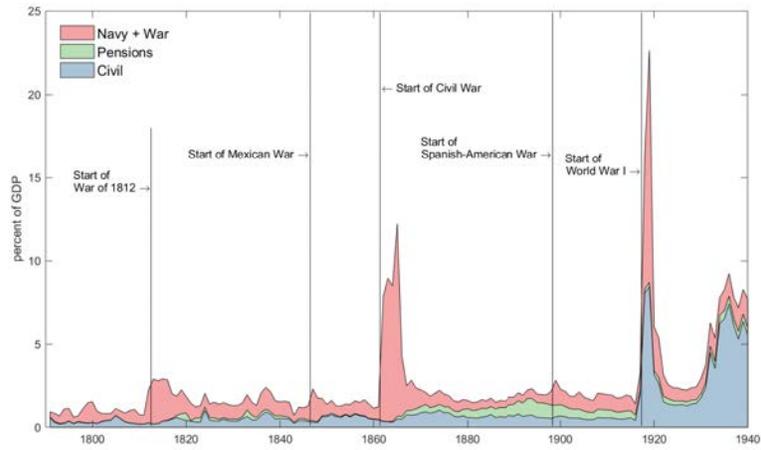


Figure 6: Composition of Federal Expenditures: 1791 to 1940

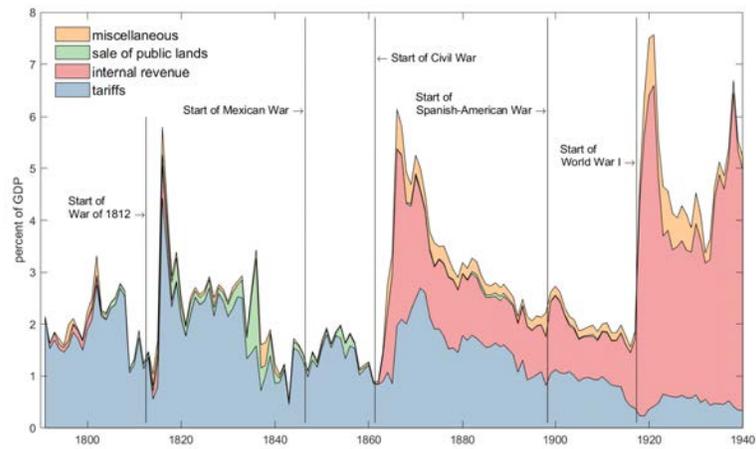


Figure 7: Composition of Federal Receipts: 1791 to 1940

N.B. The scales of the y-axes differ across figures 6 and 7.

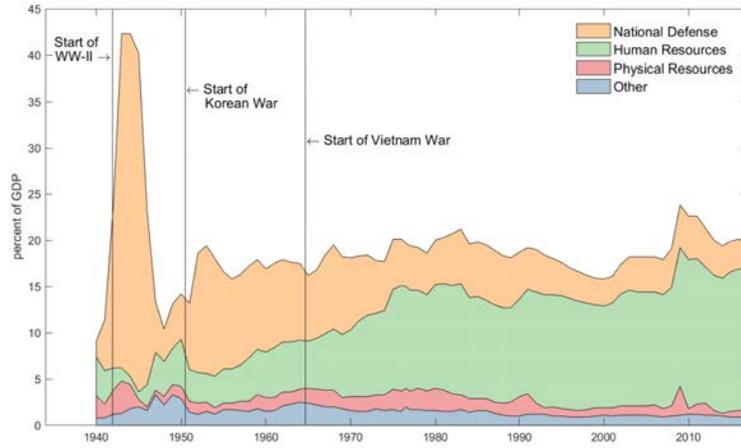


Figure 8: Composition of Federal Expenditures: 1940 to 2018

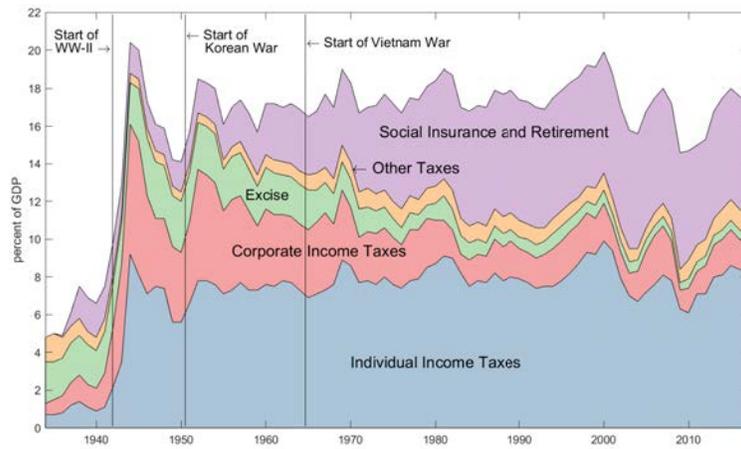


Figure 9: Composition of Federal Receipts: 1934 to 2018

N.B. The scales of the y-axes differ across figures 8 and 9.

incurred during World War I, World War II, the Korean War and the Vietnam War were serviced largely with corporate and personal income tax revenue.

To supplement these figures with numbers, in table 3 we report average spending and revenue as shares of GDP for the prewar, war and postwar periods for each of the eight wars. With the exception of the Civil War and World War II (both of which were preceded by an aggregate economic downturn), tax revenue exceeded government spending prior to the start of the war so that the government was running primary surpluses. During the War of 1812 and the Mexican War, T/Y fell relative to their prewar ratios as tariff revenues dropped. For the other six wars, consistent with tax smoothing, T/Y rose by less than the increase in G/Y . During the Korean War and the Vietnam War, wartime tax revenue exceeded government expenditures, but surpluses fell relative to their prewar averages. Finally note that, except for the Spanish-American War, government spending (net of interest payments) and tax revenue as shares of GDP were higher on average for the ten years after the war than they were for the five years prior to the start of the war.

For the 11 major wars in U.S. history, Edwards (2014) estimates that for every \$1 increase in spending during the war, the U.S. federal government spent another \$0.50 (in present value) over the following 80 years on transfer payments and in-kind benefits given to veterans and their spouses and other survivors. We can match Edward's ratio of wartime/postwar spending in the Barro model by setting $\beta = .95$ and specifying that $\{G_t\}$ is a first-order autoregressive process $G_{t+1} - \bar{G} = \rho(G_t - \bar{G}) + \sigma w_{t+1}$ with $\rho = 0.35$; in this case, equation (14) prescribes that 93% of wartime expenditures should be debt financed with the remaining 7% tax financed. Allowing for a realistic degree of persistence in the government spending process qualifies Albert Gallatin's rule only modestly.¹⁹

5 Returns to Bondholders

Changes in the price level and interest rates are ways a government can deliver state-contingent returns. A black line in each panel of figure 10 reports the natural log of the price level for the 20 years following the start of each war. For each war, we normalize the price level by the transformation $100 \times (\log P_t - \log P_{\text{start of war}})$, so the series records cumulative percentage changes in the price level after the war's outbreak. The figures present faded lines that facilitate quick cross-war comparisons within a single panel. In each panel, faded lines are normalized price level series for the War of 1812 (orange), the Civil War (purple), World War I (blue), and World War II (red).

A black line in each panel of figure 11 reports cumulative real values coming from continually

¹⁹The reader can experiment with other specifications for the $\{G_t\}$ process by using the Python code in the quantecon lecture https://python.quantecon.org/smoothing_tax.html together with the accompanying Jupyter notebook.

War	Start - End (U.S. entry -)	Fiscal Years [†]	G/Y			T/Y		
			prewar	war	postwar	prewar	war	postwar
War of 1812	1812:6 - 1815:2	1812-1815	0.88	2.72	1.82	1.95	1.37	3.14
Mexican War	1846:5 - 1848:2	1847-1849	1.18	1.94	1.51	1.31	1.29	1.66
Civil War (Union)	1861:4 - 1865:4	1861-1865	1.58	7.79	2.50	1.42	1.87	4.72
Spanish-American War	1898:4 - 1898:8	1898-1899	2.15	2.55	1.98	2.20	2.42	2.14
World War I	1914:7 - 1918:11	1915-1919	1.88	9.10	3.17	1.94	3.30	5.03
	(1917:4 -)	1917-1919	1.76	14.07	3.17	1.80	4.39	5.03
World War II	1939:9 - 1945:8	1940-1946	8.21	25.43	14.00	5.52	12.89	15.86
	(1941:12 -)	1942-1946	8.31	31.97	14.00	6.15	15.43	15.86
Korean War	1950:6 - 1953:6	1951-1953	13.79	15.70	15.84	15.07	16.91	16.52
Vietnam War	1964:8 - 1973:6	1965-1973	16.13	16.45	18.29	16.67	16.65	17.35

Table 3: Average government spending net of interest payments and tax receipts as a percent of GDP for the five years prior to each war, for the war period, and for the ten years following the war.

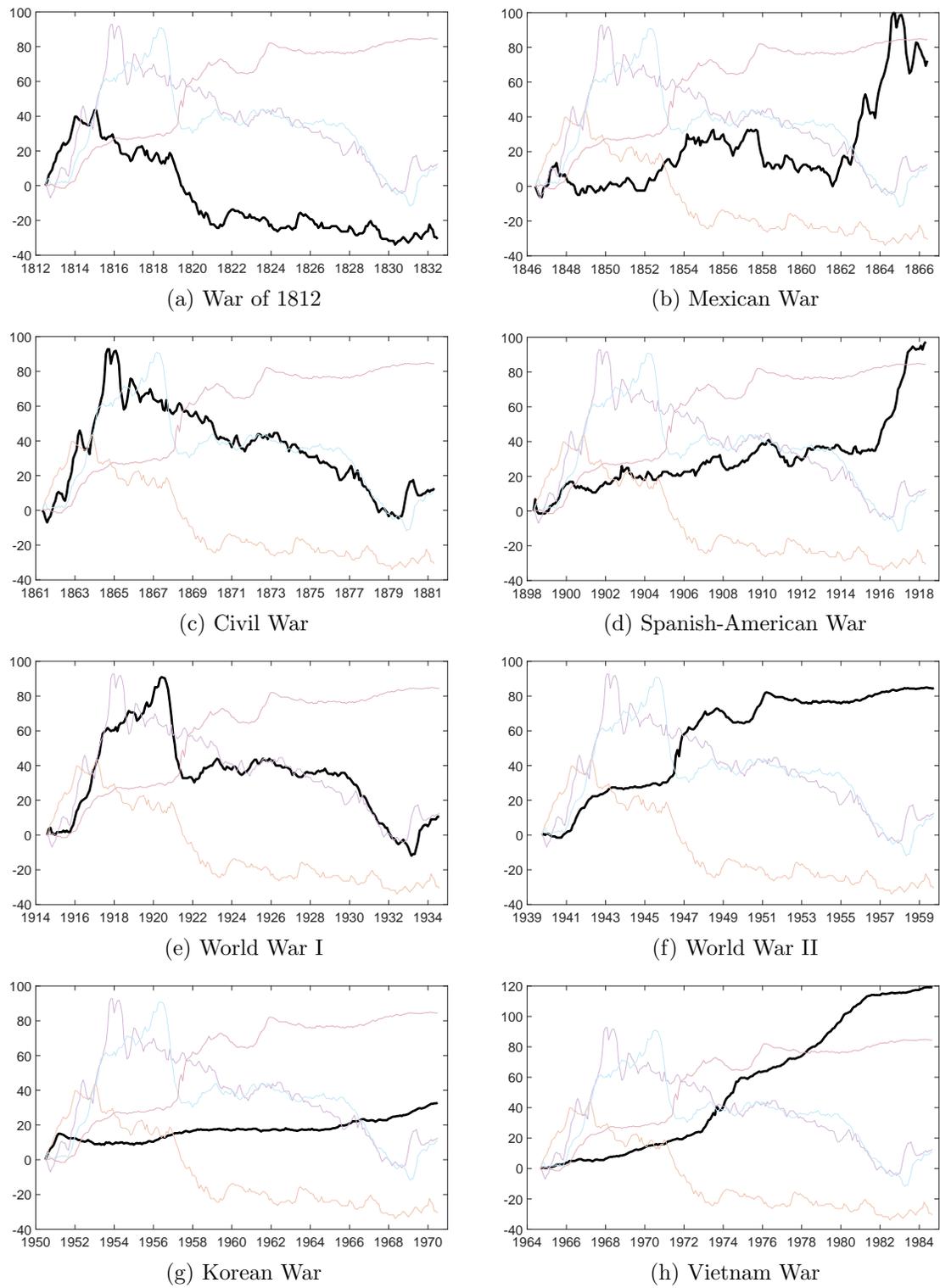


Figure 10: The Natural Log of the Price Level

Each panel displays $100 \times (\log P_t - \log P_{\text{start of war}})$.

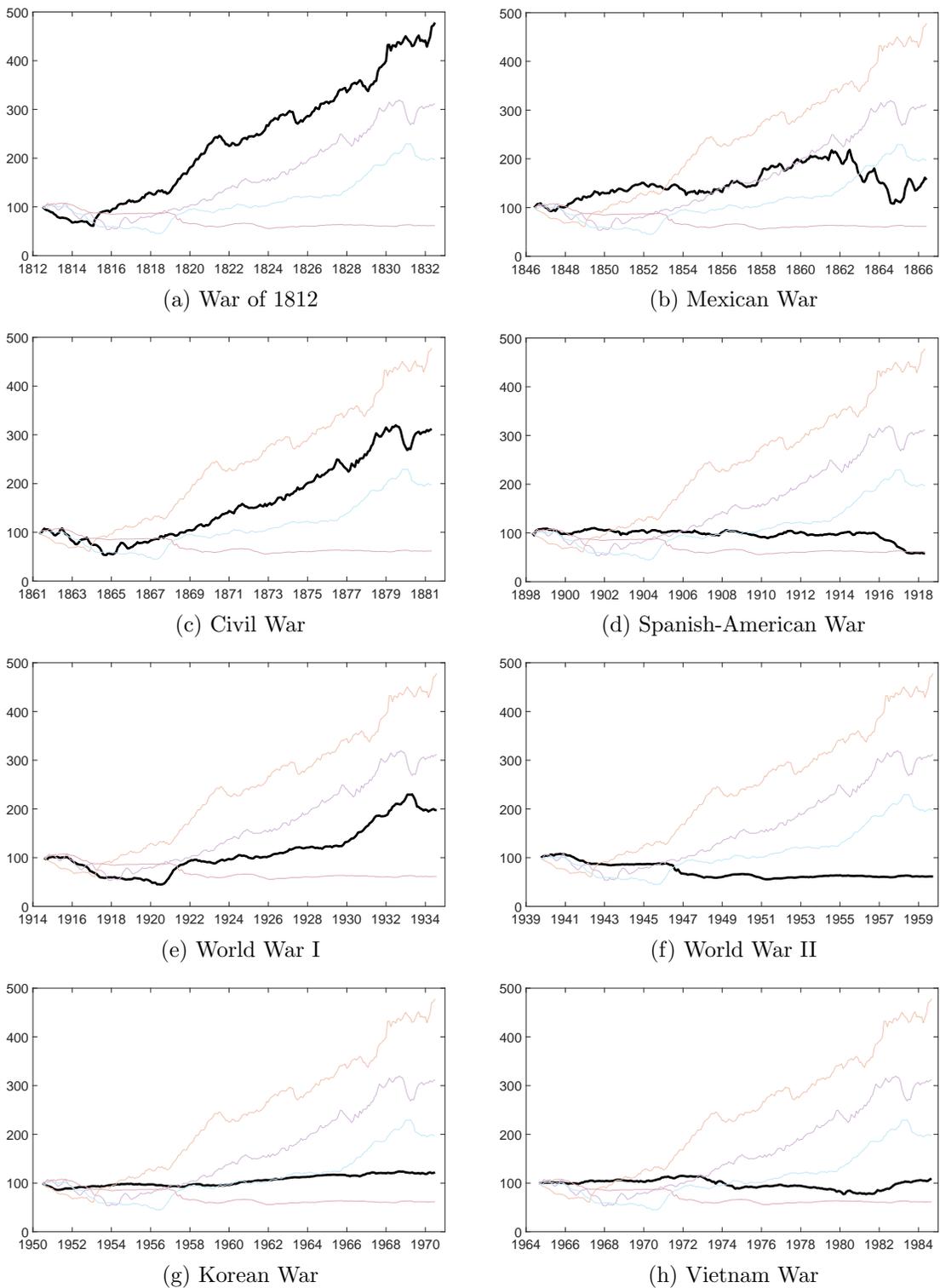


Figure 11: Real Value of a \$100 Portfolio of Treasury Securities Invested at the Start of Each War

The black line in each panel reports the cumulative real values coming from continually reinvesting in a value-weighted re-balanced portfolio of all outstanding U.S. Treasury securities of an initial investment of \$100 at the start of each war. The faded lines are the cumulative values of the portfolios for the War of 1812 (orange), the Civil War (purple), World War I (blue), and World War II (red).

reinvesting in a value-weighted re-balanced portfolio of all outstanding U.S. Treasury securities, starting with an initial investment of \$100.²⁰ These cumulative returns are data analogs of simulated portfolio values from the Lucas-Stokey model plotted in the right panel of figure 1. In each panel, the faded lines are cumulative values of the portfolios for the War of 1812 (orange), the Civil War (purple), World War I (blue), and World War II (red).

Notice three patterns. For the War of 1812, the Mexican War, the Civil War, and World War I, the price level rises during the war and falls after the war. (You have to squint to detect this for the Mexican War.) See panels 10a, 10b, 10c and 10e. This pattern is consistent with the Bordo and Kydland (1995) view of the gold standard as helping to deliver Lucas and Stokey state-contingent returns on debt. These price level paths transmitted into wartime real capital losses for bondholders and postwar real capital gains for bondholders. Note that the cumulative real return series displayed panels 11a, 11b, 11c and 11e bear the “ladle” shape observed in right-hand side panel of figure 1. (Again, you have to squint at the Mexican War panel 11b.)

Table 4 summarizes numbers behind the graphs. The price level rose 14.70, 14.65 and 11.05 percent at annual rates during the War of 1812, the Civil War and World War I respectively, bringing wartime real returns on Treasury debt of -10.58, -5.69 and -8.60 percent at annual rates. During the 15 years after the war, deflations brought postwar real returns of 12.01, 8.47 and 5.52 percent at annual rates. For the Korean War, there was no postwar deflation, but we see wartime negative and postwar positive real returns.²¹ We find this pattern of returns broadly consistent with the prescription of the Lucas-Stokey model.

A second pattern revealed by figure 11 is that postwar returns to government bondholders have declined steadily from the War of 1812 to the Vietnam War. After the three wars fought since the U.S. left the gold standard in 1933, postwar real returns were essentially flat. As reported in table 4, the postwar real holding period returns fall from 12.01 percent after the War of 1812 to 8.47 percent after the Civil War to 5.52 percent after the World War I to -1.42 percent after World War II.

Finally, we verify two important findings by earlier authors. Panels 10c, 10e, and 10f and numbers in table 5 confirm the finding of Friedman (1952) that prices rose more slowly during World War II than in World War I or the Civil War. Our calculation of the nominal holding period returns during World War II, reported in table 4, are consistent with Samuelson’s (1945) characterization of World War II as a “2-per-cent war.”

²⁰The 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.

²¹See section 6.7 for further discussion of returns during the Korean War.

War Start - End (U.S. entry -)	war time			postwar		
	nominal holding period return	inflation rate	real holding period return	nominal holding period return	inflation rate	real holding period return
War of 1812 1812:6 - 1815:2	4.20	14.70	-10.58	7.05	-4.73	12.01
Mexican War 1846:5 - 1848:2	3.55	1.36	3.95	5.57	2.59	3.21
Civil War (Union) 1861:4 - 1865:4	7.64	14.65	-5.69	5.66	-2.68	8.47
Spanish-American War 1898:4 - 1898:8	8.09	0.00	8.14	1.86	2.10	-0.21
World War I 1914:7 - 1918:11 (1917:4 -)	2.00 3.55	11.13 11.05	-8.79 -8.60	4.12	-1.31	5.52
World War II 1939:9 - 1945:8 (1941:12 -)	2.16 1.78	2.62 4.23	-0.63 -2.50	1.82	3.28	-1.42
Korean War 1950:6 - 1953:6	0.73	3.96	-3.24	2.85	1.72	1.13
Vietnam War 1964:8 - 1973:6	4.40	4.02	0.46	8.57	6.55	2.02
Mean	4.10	6.56	-2.05	4.69	0.94	3.84
Mean (U.S. involvement)	4.24	6.75	-2.26			

Table 4: Average Annual Returns and Inflation Rates During Each War and for the Subsequent 15 Years

	World War II	World War I	Civil War
start of war	Sept 1939	July 1914	April 1861
price peak (Friedman)	Aug 1948	May 1920	Jan 1865
price peak (this paper)	Aug 1948	May 1920	Aug 1864
RATE OF RISE, PER CENT PER YEAR			
wholesale prices (Friedman)	8.7	15.3	24.5
wholesale prices (this paper)	8.2	15.6	27.8

Table 5: Price Level Increases in Three Wars

6 Debt Design, Marketing, and Management

Since Albert Gallatin's 1807 Report, successive Secretaries of the Treasury have sought to finance wars at minimum cost to taxpayers, a motive captured by the loss function (1) for the section 2 benchmark models. However, during the four most expensive wars as measured by their government spending/GDP ratios, namely, the War of 1812, Civil War, and both World Wars, the Treasury faced an additional challenge ignored by our benchmark models. At the start of those big wars, possible government creditors anticipated the rapid expansion of Treasury debt required to finance prospective sharp increases in military and civilian expenditures. That made them reluctant to purchase long-term Treasury securities early in a war because they anticipated increased rises in the price level and nominal interest rates, so postponing bond purchases offered higher real returns.²² To respond to such behavior by prospective government creditors, members of Congress, Treasury officials, and (after 1914) Federal Reserve officials experimented with new debt designs, methods for selling new issues to the public, and debt management policies that could attract early investors.

Article 1, Section 8 of the U.S. Constitution grants Congress exclusive authority to manage Federal debt. Between 1776 and 1920 Congress authorized and designed each individual Treasury security. For each security, Congress set the coupon rate, the principal or par value, the redemption and maturity dates, a unit of account, tax exemptions, and call and conversion features. Congress gradually abandoned these ways of doing things during the two decades after World War I. Acceding to requests from successive Secretaries of the Treasury, Congress delegated more and more authority to design securities and manage the composition of the debt to the Treasury.²³ By 1939, Congress had delegated nearly all decisions about security design and debt management to the Treasury.

Security design and debt management policies alter the allocation of interest rate risk between the Treasury and its creditors. Over time, innovations along both lines helped the Treasury to expand the market for Treasury securities from just the nation's elite to a broad spectrum of investors.

²²In the Barro model, the interest rate is fixed. In the Lucas-Stokey model, at the outbreak of the war, the Ramsey equilibrium outcome awards a capital loss to existing government bondholders. Bondholders understood this possibility when they purchased the bonds and chose to bear this risk. In return, bondholders anticipate high returns when war ends. However, such a state-contingent policy would have been difficult to implement in practice. With the exception of the Korean War, at the start of each U.S. war the outstanding stock of Treasury debt was low, so imposing a one-time capital loss would not have generated much revenue. If a long spell of peace had preceded the war, a Ramsey plan for the Lucas model would have had the government acquiring claims on the public that it would redeem at the outset of the war.

²³See Garbade (2012, ch.21) and Hall and Sargent (2015).

6.1 The War of 1812

Between 1801 and 1809, President Thomas Jefferson’s administration dismantled the Federalist’s administrative machinery for collecting internal revenue. Ignoring Albert Gallatin’s warnings, the Jefferson administration’s embargo of trade with Britain caused customs revenues to plunge from \$16.4 million in 1808 to \$7.3 and \$8.5 million in 1809 and 1810, respectively. Partly as a consequence of these and other monetary, fiscal, and military preparedness policies of the two Jefferson and first Madison administrations, when Congress declared war on Britain on June of 1812, the U.S. was poorly prepared.

Between March 1812 and February 1815 the Congress authorized the Treasury to issue five long-term loans with a total face value of \$66 million. Those bonds received a cautious reception from the relatively small group of wealthy men who comprised the main pool of prospective buyers. Opposition to the war from merchants and financiers in the Northeast and Congress’s inability to put together a sustainable prospective revenue stream sufficient to service them limited what prospective buyers were willing to pay for these bonds. To respond to this situation, beginning in 1813 Albert Gallatin included in invitations for bond subscriptions a promise that if later subscribers were offered better terms, earlier subscribers would be “placed on the same footing.”²⁴ Events in 1814 forced Gallatin to honor this promise.

Although loans issued in the previous year had sold for only \$88.25 per \$100 of face value, on March 24, 1814 Congress authorized the largest increase in new Treasury debt in the nation’s short history, a \$25 million loan promising a 6% coupon. In an attempt to obtain the most favorable terms for the government, the Treasury divided the sale of this loan into three installments. In the first installment of \$10 million, a portion of the bonds were sold at \$88 per \$100 of face value; but the Treasury was soon forced to sell the remainder of the installment at \$80 per \$100 of face value, prompting the Treasury to issue additional shares to compensate earlier buyers. The Treasury canceled the second and third installments. The “Ten Million Loan of 1814” raised only \$7,935,581 at the cost of increasing the face value of Federal debt by \$9,919,476.25.²⁵ Further, this official \$7.9 million figure overstates the true revenue raised because the Treasury accepted at face as payment private bank notes whose market values were much less than par.

Despite having issuing debt at sharp discounts during the war, after the war Congress and the Treasury honored their financial commitments. This full repayment in conjunction with a falling price level resulted in high postwar real returns. As we report in table 4, in the 15 years after the war, bondholders earned on average 12% annual real returns. Also see figures 10a and 11a.

²⁴See document B2 on page 562 and the letters from David Parish, Stephen Girard, and John Jacob Astor marked C and D on page 565 of Elliot (1845).

²⁵See page 127 of Bayley (1882).

6.2 The Mexican War

When the Mexican War broke out in 1846, the U.S. government stood on much stronger financial footing than it had three and a half decades earlier. Three decades of strong economic growth and the credibility the U.S. Treasury earned from repaying its debts refinanced and assumed in 1790 and incurred during the War of 1812 meant that the federal government could borrow from domestic investors on better terms than it ever had.²⁶ To finance the war, along with two sales of short-term notes, the Treasury issued three long-term bonds. In contrast to the War of 1812, when the Treasury accepted depreciated private bank notes at face value, subscribers of these Treasury bonds and notes were required to pay in specie. Even so, there was ample demand for these bonds.

Interest rates *fell* during the late 1840s. As Dewey (1912, p.256) notes

An error in judgement was made in compelling so high a rate of interest as 6 per cent with long terms of ten and twenty year before maturity, for on account of business prosperity the bonds quickly went to a premium, and their redemption when the government wished to pay its debt from the surpluses enjoyed in 1850-1856 was a costly operation.

Memories of this “error in judgement” motivated the Treasury to sell callable bonds during the Civil War.

6.3 The Civil War: 7-30s and 5-20s

During the U.S. Civil War, Treasury Secretary Salmon Chase made two significant innovations in wartime finance. First, in response to the Treasury’s inability after the Mexican War to repurchase at par the non-callable debt it had issued to finance the war, Chase introduced long-term bonds with embedded calls. Second, he extended Treasury subscriptions beyond the financial institutions in Baltimore, Philadelphia, New York, and Boston, so that for the first time, the federal government actively marketed government securities to middle class households throughout the country.²⁷ When war came in Spring 1861, the federal government was under considerable financial stress. Tax revenues had not recovered from the drop in 1857 that coincided with a

²⁶The federal government did not possess the same credibility with international investors. Eight states and one U.S. territory defaulted on their debts in the early 1840s. Many European investors felt that the precedent set by the federal assumption of state debts in 1790 implied federal backing of state debts. Thus, despite the fact that the federal government had a 50 year record of full repayment on its own debts, Joshua Bates of Barings Bank wrote in October 1841, “At a distance people do not see the local differences and argue that as Mississippi may repudiate her debt, so may Massachusetts, and so the credit of all the States and that of the United States is involved in one common ruin.”

²⁷McPherson (1988, pp. 428-453) and Thomson (2019) provide more complete descriptions of Union financing during the Civil War era. See Brands (2006, ch. 3) for a fascinating account of Jay Cooke and “The Bonds of Union”.

banking panic. Further reducing revenue, fears of secession had led to a failed loan offering in 1860 and by early 1861 southern ports diverted federal customs receipts to the CSA Treasury.

To meet war expenses, Congress authorized the Treasury to sell \$250 million short-term, long-term, and non-interest bearing securities under the “Loan of July and August, 1861.” Much of the short-term debt was in the form of three-year “7-30s” – Treasury notes paying an interest rate of 7.3% with a minimum denomination of \$500.²⁸ To sell 20-year bonds, Chase continued the long-standing practice of soliciting subscriptions from banks in northeastern financial centers that would then resell these notes and bonds to a small circle of wealthy investors in a limited secondary market.

Union military defeats at Ball’s Bluff and the failure of General George B. McClellan’s peninsular campaign in the fall of 1861 followed by Treasury Secretary Chase’s December request for an additional \$200 million in borrowing led to a collapse in confidence in the Union military and Treasury. Northern banks were reluctant to purchase more Treasury securities at par, while the Treasury was unwilling to repeat its War of 1812 policy of selling bonds below their par values. By December 30, banks in New York, Boston and Philadelphia suspended specie payments and the federal government quickly followed.

There followed a strange episode involving what Simon Newcomb (1865) and other observers regarded as a serious case of “money illusion” on the part of Federal decision makers. To enable the Treasury to sell long term bonds at par, the Union issued a paper dollar not linked to the gold dollar but in terms of which Treasury bonds *would* sell at par.²⁹ In February 1862, Congress passed the Legal Tender Act. The Act authorized the Treasury to \$150 million in United States notes (“greenbacks”) that were to be legal tender for all public and private debts, except customs receipts and coupon payments on federal bonds.³⁰ Official concerns about selling Union bonds below par were quickly assuaged when the market soon discounted a greenback relative to a gold dollar enough that federal bonds could be sold at par for greenback dollars, as the Act had authorized.³¹ The Act also authorized the Treasury to sell \$500 million of “5-20s,” a bond bearing a 6 percent coupon, maturing in twenty years, and callable at par at the U.S. Treasury’s discretion after five years. Over the next six years, the Congress authorized 7 tranches of these loans. The 5-20’s were the first U.S. Treasury bonds to include a call option. Over the following two decades, the Treasury issued a sequence of partial calls. Calls were for bonds bearing particular serial

²⁸The 7.3 percent interest rate was chosen since it made it easy to compute the nominal return: 2 cents per day for every \$100 in face value.

²⁹Newcomb (1865) roundly criticized the reasoning that led to this and other aspects of how the Union financed the war.

³⁰In 1870, the Chief Justice Chase wrote the 5-3 majority Supreme Court decision in *Hepburn v. Griswold* declaring the legal tender clause unconstitutional for violating the due process clause of the 5th amendment. Subsequent Courts soon reversed that decision in *Knox v. Lee* and *Parker v. Davis*. The great hard money Jacksonian Democratic historian George Bancroft (1886) passionately argued that it was *Hepburn v. Griswold* that had been decided correctly.

³¹Treasury notes issued during the War of 1812 could also be used to buy Federal bonds at par.

numbers.

To sell bonds, Chase innovated by contracting with his friend Jay Cooke to purchase bonds as a monopolist wholesaler to distribute bonds retail.³² Cooke owned a Philadelphia investment banking firm and was well-connected with Ohio Republican leaders. Cooke administered the first large-scale war-bond drive by hiring a network of sales agents and placing informative and patriotic advertisements in newspapers to sell bonds denominations as small as ten dollars to ordinary middle- and working-class northerners. Payments in greenbacks could be made in monthly installments. He dispatched sales agents throughout the states. Cooke's advertisements highlighted the high returns promised by the 5-20 bonds. For example, the poster in panel 12a proclaims "At the present PREMIUM ON GOLD these bonds yield about EIGHT per cent per annum."

Congress bedeviled the 5-20s with an ambiguity that it passed on to subsequent Congresses. The authorizing legislation provided that coupons would be paid in coin (i.e., gold), but it was silent about whether principal would be paid in coin or "lawful money" (i.e., greenbacks). Ambiguity about 5-20 principal payments would be resolved only with the election of U.S. Grant as President in 1868 and the March 1869 passage of 'An Act to Strengthen the Public Credit' that promised repayment in gold or its equivalent.³³ From 1866 to 1881, real returns to federal government creditors averaged 8.5% per year. See table 4 and figure 11c.

The U.S. Treasury designed and sold other new securities, so that by the war's end, it had issued 19 unique interest-bearing securities and five different forms of currency. Panel 16c plots the Treasury's debt service profile at the end of 1865. The figure shows repayment of \$676 million in principal for the 7-30s owed in 1868 and of \$515 million in principal for the 5-20s of 1862 owed in 1882. Total federal tax revenues averaged a little over \$350 million per year during the two decades after the war, so repaying all debt as it came due was out of the question. Instead, it was rescheduled, other securities being issued to raise funds to repay wartime loans.

6.4 The Spanish-American War: 10-20s of 1908-1918

The Spanish-American War lasted for only three months in 1898. One bond was sold to finance the war: a 3 percent, 20 year bond, redeemable after 10 years. Congress designed the "10-20s of 1908-1918" to be sold widely to small investors rather than banks. It was sold by subscription at par in denominations between \$20 to \$300 with individual investors being given first priority. Two considerations motivated this design and marketing policy. First, there remained popular resentment over the government's relying on a J.P. Morgan and August Belmont syndicate to

³²Chase's actions were first steps on a process extending over succeeding wars in which Treasury Secretaries and Congresses struggled to strike a balance between "client private placement" vs "retail" vs "wholesale" vs "auction" vs "forced loan" financing. See the proposal of Friedman (1959, pp. 64-65) to reform the way the Treasury sold its bonds.

³³Bondholders were also voters, and, evidently, Grant's electoral success benefitted from Jay Cooke's campaign to create widespread ownership of the 5-20s.

underwrite 4% bonds issued three years earlier as part of the Cleveland administration's efforts to defend the gold standard. Second, Congress intended that subscriptions should express popular support for the war. The bond issue was oversubscribed. Garbade (2012, pp. 41-44) tells how contemporary commentators argued that, had the 10-20s been auctioned, they would have sold above par. Hence, the government sacrificed revenue from those bond sales to gain what it interpreted as a popular expression of support for the war.

6.5 World War I: Options and Federal Reserve “Borrow and Buy”

To finance World War I, Secretary of the Treasury William Gibbs McAdoo studied how the Union had during the Civil War. McAdoo (1931, p. 373) said that he “did not get much in the way of inspiration or suggestion from a study of the Civil War, except a pretty clear idea of what not to do.” Rather than issuing 19 separate securities that had been improvised as the Civil War had unfolded, McAdoo convinced Congress to authorize the Treasury to issue and market five securities sequentially.

McAdoo personally took an active role in marketing the new debt. He named the bonds “Liberty Loans” rather than giving them hyphenated natural number nicknames indicating coupon rates, maturities, and call dates. He sought to bypass middlemen, like Jay Cooke. Instead he established national fund drives that held mass rallies to sell Liberty bonds directly and widely. He enlisted celebrities such as Charlie Chaplin to act in short films and employed commercially successful artists, such as Howard Chandler Christy, to illustrate posters advertising Liberty Loans. Some of these posters now strike us as pretty heavy-handed, for example the posters in panels 12b and 12c. McAdoo (1931, pp. 378-9) described how

We went direct to the people; and that means to everybody – to business men, workmen, farmers, bankers, millionaires, school-teachers, laborers. We capitalized on the profound impulse called patriotism.

The Federal Reserve actively helped market Liberty Loans. In particular, the Fed's “borrow and buy” program encouraged individual investors to finance purchases of Liberty Loans by borrowing from their local banks. The banks could discount those loans at the Fed's discount window.³⁴ Thus, the Fed lent to member banks at a preferred discount rate so long as proceeds were used to purchase Liberty and Victory bonds that the Fed then accepted as collateral. To finance this program, the Fed dramatically increased the monetary base, contributing what amounted to seignorage revenue.³⁵ See panels 13a and 13b.

Partially to protect its creditors from later rises in interest rates, the First and Second Liberty Loans granted the investor the right to convert their bonds into new ones bearing higher coupon

³⁴See the various advertisements and articles in the *New York Times* on October 24, 1917.

³⁵For further discussion of the expansion of the Fed's balance sheet during World War I, see Friedman and Schwartz (1963), Meltzer (2010), and Hall and Sargent (2019).

rates if subsequent issues paid higher coupon rates; these new bonds had the same maturity dates and call provisions as the original loans but bore the coupon rates and tax provisions of subsequent issues. Interest rates and coupon rates on the Liberty Loans indeed increased as the war went on, inducing many owners of First and Second Liberty Loan bonds to exercise their conversion options. Of the nearly \$2 billion First Liberty Bonds sold, about \$560 million were converted into higher coupon-paying bonds. Of the nearly \$4 billion Second Liberty Bonds sold, nearly all were ultimately converted.³⁶

Despite these conversion provisions, interest rates and consumer prices rose enough that by June 30, 1920 prices of the Liberty Loans had fallen to between \$84.64 to \$90.80 per \$100 of face value. Furthermore, to take advantage of the Fed' "borrow and buy" program, many small investors bought Liberty Loans on credit, using the bonds themselves as collateral. Thus, the Federal Reserve had encouraged individual investors to borrow short from their bank and lend long to the government. This leveraged position meant that when bond prices fell after the War, many investors realized capital losses. For these losses, some blamed "... the wicked devices of bond sharps and swindlers who took advantage of the inexperience of many small investors in Liberty bonds whom the Treasury was ... powerless to protect."³⁷ But Secretary McAdoo was less sympathetic to these new investors; before the Committee on Ways and Means of the House of Representatives in connection with the third Liberty bond bill, on March 27, 1918, he argued:³⁸

There is a curious feeling in the breast of the average man that if he buys a Government bond, even though he contracts to lend his money to the Government, nevertheless if he gets tired of his investment and wants to get his money back, that he ought to be able to sell the bond at par regardless of the fact that the Government is not under any obligation to redeem that bond before maturity. It is extraordinary the extent to which that feeling exists. ... It is a perfectly unreasonable feeling, but one of the things we have got to reckon with.

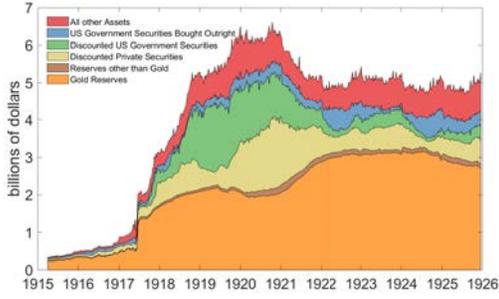
Ultimately, real returns to owners of Liberty Loans during the fifteen years after the war were far below those paid out during fifteen periods after the War of 1812 or the Civil War.³⁹ See panel 11e. This pattern opens up comparisons and interpretations taken up in detail in Hall and Sargent (2019).

³⁶The conversion rate was lower for the First Liberty Bonds because conversion to a higher coupon bond also meant a less favorable tax treatment.

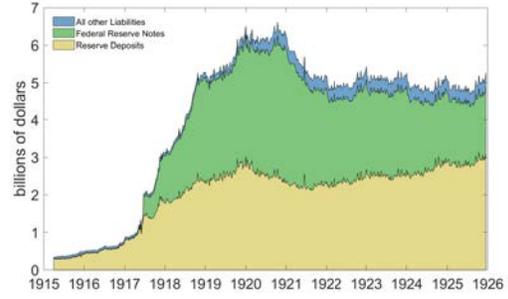
³⁷Treasury Secretary Carter Glass letter to Senator William Calder, March 31, 1919, *Annual Report of the Secretary of the Treasury*, 1919, page 48.

³⁸*Annual Report of the Secretary of the Treasury*, 1920, page 110.

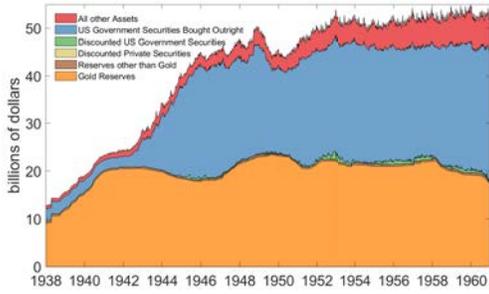
³⁹Again, bondholders were also voters, and these low returns came back to haunt the Democrats in the 1920 and 1924 elections. Hilt and Rahn (2018) document that relative to voting patterns prior to World War I, counties in which citizens purchased Liberty Loans at higher rates turned away from the Democratic Party after war.



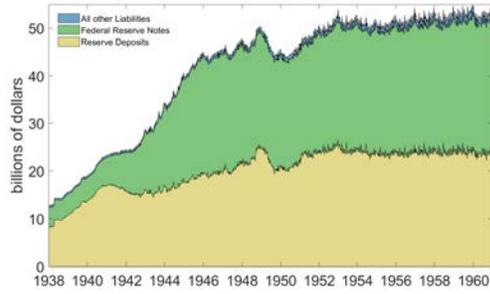
(a) Assets: 1915-1925



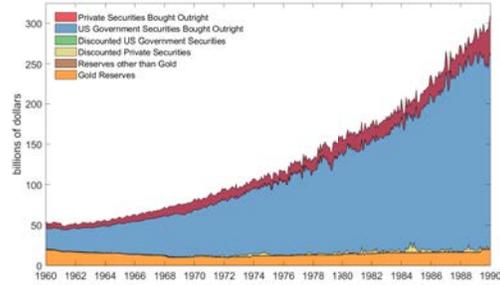
(b) Liabilities: 1915-1925



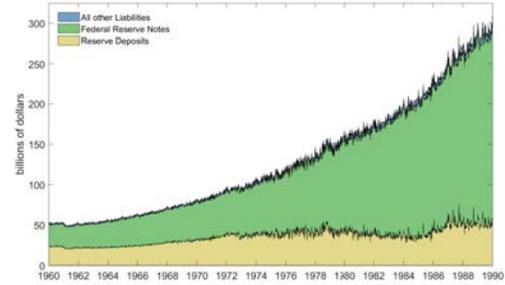
(c) Assets: 1938-1960



(d) Liabilities: 1938-1960



(e) Assets: 1960-1990



(f) Liabilities: 1960-1990

Figure 13: Federal Reserve Balance Sheet

6.6 World War II: Nonmarketable Debt, Fixed Yield Curve, Fed Support

Secretary of Treasury Henry Morgenthau Jr. sought to avoid a recurrence of the deep post-World War I losses incurred by savers who had participated in Secretary McAdoo's "borrow and buy" program. This inspired three key innovations in markets for Treasury securities:

1. Establishment of a non-marketable savings bond program,
2. A Federal Reserve and Treasury joint operation to peg and flatten the term structure of nominal yields on federal bonds, and
3. The Federal Reserve's policy of purchasing marketable securities rather than lending money to banks to finance loans to individuals who had purchased Treasury securities.

By the late 1930s, Congress had delegated the design and management of the debt almost completely to the Treasury. In contrast to earlier wars, federal securities that financed World War II were designed by the Treasury and not by a Congressional committee. Secretary Morgenthau wanted "the securities offered should be those best suited to the needs of the investors to whom they are sold." To do that, the Treasury issued a wide range of marketable and nonmarketable securities.

Relative to previous wars, the Treasury issued many more types of securities. Spacings of maturity dates were designed partly to smooth out prospective refinancings and rollovers. While there were only four different classes of marketable securities, the Treasury's designed securities with to meet "needs of the investors" by varying maturities, call features, and tax exemptions. That might have promoted initial sales, but it did so by limiting liquidity in secondary markets.

Like earlier Treasury secretaries, Morgenthau viewed successful bond sales as meaningful expressions of public support for the war. In his radio address of May 6, 1943 he said⁴⁰

When the people really become aflame with the war spirit, all other problems seem to solve themselves. Labor and management get together; production rises to an all time high; and bond sales go up automatically The sales of war bonds . . . is actually a barometer of the spirit and enthusiasm of the Home Front.

Consequently, Secretary Morgenthau wanted to sell federal securities to small investors. To make that happen, he thought that he had to protect these investors against prospective declines in prices of their bonds. In his history of Treasury financing of World War II, Morse (1971, p. 22) recalled that

Thousands of people with modest income still remember that they had purchased Liberty Bonds during World War I, only to find, when forced by circumstances to

⁴⁰Morse (1971, p. 106).

sell their bonds before maturity, that the market price had sharply declined. Bonds purchased for \$100 often sold for as little as \$82. Thousands of frugal and patriotic people felt that they had somehow been “swindled,” and were likely to be “gun-shy” when again asked to buy Government bonds.

In response to those attitudes, the Treasury created a non-negotiable pure discount security, the U.S. Savings Bond. While the investor could not transfer ownership of the bond to someone else, he or she could redeem it on demand according to a fixed price schedule, assuring liquidity and eliminating prospects of negative nominal returns. The Treasury promoted savings bonds through payroll savings plans and sold them at Post Offices in denominations starting at \$25. Between May 1941 and January 1946, the Treasury sold \$54.7 billion of such savings bonds to over 85 million individuals.⁴¹ In December 1945, savings bonds accounted for over 17% of the par value of total Treasury debt.⁴²

Investors of marketable securities also wanted protection from rising interest rates and declining bond prices. To satisfy that preference, in 1942 the Treasury and the Federal Reserve agreed to cap interest rates on long term Treasury debt at $2\frac{1}{2}$ percent and 3-month Treasury bills at $3/8$ percent.⁴³ Other rate caps were interpolated to give a smooth upward sloping yield curve; for example, the rate on 1 year bills was set at $7/8$ percent and the rate on 7 to 9 year bonds was set at 2 percent. In an attempt to limit inflation, from early 1942 until late 1946 the federal government instituted price controls on most consumer goods. These controls worked imperfectly, but they did slow the rate of price increases, at least according to official price indices.⁴⁴

An unintended consequence of sharply reducing interest rate risk through the interest rate and price controls in combination with the Treasury’s decision to issue a wide range of securities was that private buyers favored long-term bonds and shunned Treasury bills. This left the Federal Reserve to become the primary buyer of short-term Treasury securities. As in World War I, the Fed expanded its balance sheet to support the Treasury market, but unlike the World War I “borrow and buy” program, in World War II the Federal Reserve directly purchased these securities rather than holding them books as collateral. See panels 13c and 13d. As figure 15a illustrates, from 1944 to 1948, the Federal Reserve held between 40 and 89 percent of outstanding Treasury bills. Other government agencies held roughly 30 percent of the Treasury bills issued from 1944 to 1947.

⁴¹See Morse (1971, p. 285). Note that the U.S. population in 1945 was 140 million.

⁴²Marketable securities are negotiable and transferable and thus may be sold on the secondary market. Today, marketable securities consist of bills, notes, bonds, and TIPS. During World War II, the Treasury did not issue TIPS but did issue marketable certificates of indebtedness, a short-term coupon-bearing security. Non-marketable securities such as U.S. savings bonds, special issues, debt series issued to government trust funds (e.g., OASDI, unemployment insurance, and civil service retirement funds), are not sold on a secondary market. Total gross debt is the sum of all marketable and nonmarketable securities, matured debt and non-interest bearing securities, regardless of ownership. By the end of 1945, nonmarketable debt comprised 28 percent of the total gross debt outstanding. See figure 14.

⁴³See Garbade (2020) and Meltzer (2010, pp. 580-585).

⁴⁴See Friedman and Schwartz (1963, p. 557).

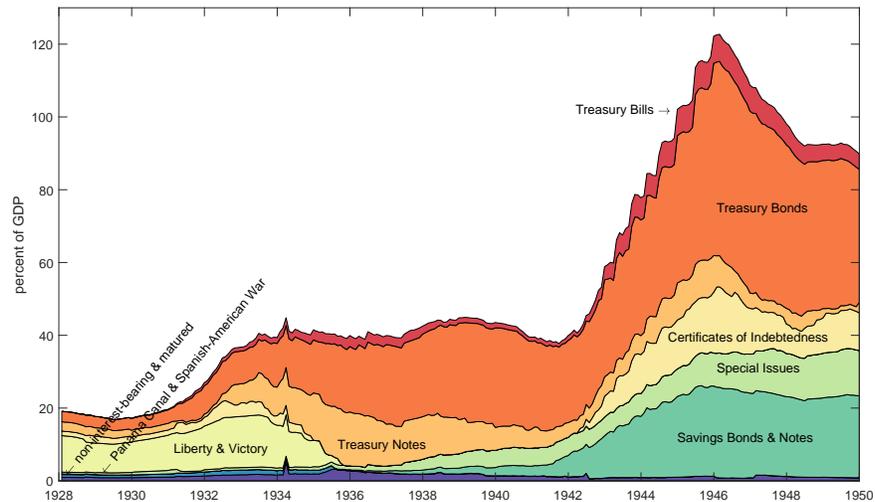


Figure 14: Face Value of Treasury Gross Debt Outstanding Decomposed by Class

Because the Treasury fixed the rate of return below a market clearing level, the Treasury again resorted to bond drives. The Treasury again induced celebrities to sell bonds. Posters and films were created. See the poster in figure 12d. Unlike Jay Cooke’s Civil War advertisements, these posters did not promise high rates of return. The sales campaign was more positive and subtle than the ones that marketed World War I Liberty Loans.

Inflation surged when the government removed price controls after the war. Because private investors holdings were concentrated in long-term bonds, they were hit particularly hard by the real capital losses brought by inflation. Five years later, President Harry Truman would argue⁴⁵

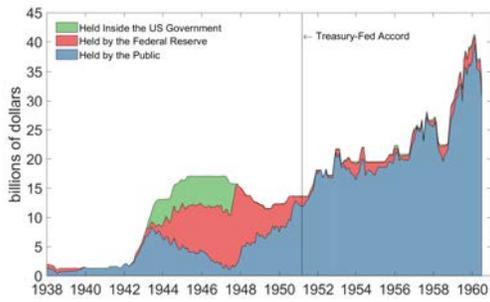
During World War II, taxes were not high enough, and the Government was forced to borrow too much. As a result, when controls were taken off after the war, prices skyrocketed and we paid in inflation for our failure to tax enough. The value of people’s savings was cut down by the higher prices they had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

6.7 Korean War and Treasury-Federal Reserve Accord

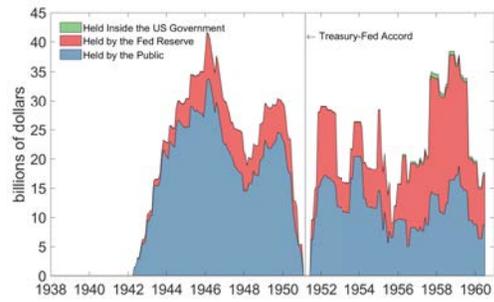
At the start of the Korean War, federal debt held by the private investors stood at 66.5% of GDP. President Harry Truman opposed delivering a state-contingent capital loss to government creditors as prescribed by a Lucas-Stokey model. Historian Robert Donovan (1996, p. 329) noted that

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

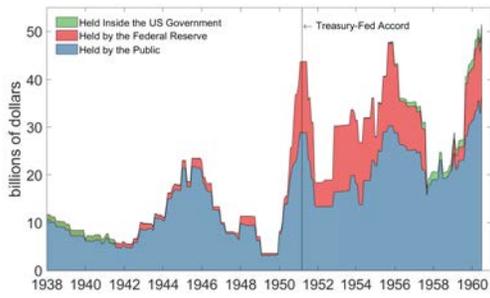
⁴⁵Special Message to the Congress Recommending a “Pay as We Go” Tax Program, February 2, 1951.



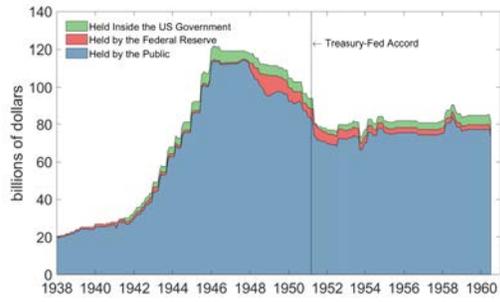
(a) Treasury Bills



(b) Certificates of Indebtedness



(c) Treasury Notes



(d) Treasury Bonds

Figure 15: Marketable U.S. Treasury Debt By Ownership

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.

Evidently, Truman was one of the inexperienced small investors who had felt “swindled” by the post-Armistice drop in Liberty bond prices. Nevertheless, as can be seen in panels 10g and 11g, when the war broke out, with fresh memories of World War II rationing, consumers rushed to purchase consumer goods, driving up the price level and delivering a small real capital loss to bondholders. Thus, under President Truman, real returns to bondholders fell at the *news of war* for the first time in American history.

In a continuation of its World War II policy, the Fed supported the Treasury market in the early months of the Korean by purchasing Treasury debt in order to fix the nominal yield curve and place a floor on bond prices. But the Treasury’s goal of low interest rates conflicted with Fed’s goal of using monetary policy to control inflation. That created pressure to revise coordination arrangements between Treasury and the Federal Reserve, a tension resolved when on March 4, 1951, the Treasury and Federal Reserve issued a joint statement ending the Fed’s commitment to purchasing Treasury securities in order to maintain a floor on bond prices.⁴⁶

While little new federal debt was issued during the Korean War, postwar real returns were low relative to earlier postwar experiences. As witnessed in table 4 and panel 11g, in the 15 years after the war, the average annual real return on the Treasury’s portfolio was a mere 1.13% – a sharp contrast to the more generous returns to bondholders after the War of 1812, the Civil War, and World War I.

6.8 Vietnam

After 1950, the Treasury standardized securities, shortened maturities on average, and space bonds in more orderly ways. As an example of increased standardization, the share of long term bonds with embedded call options declined sharply.⁴⁷ By the end of the Vietnam War in December 1974, there were 120 unique securities outstanding across three classes of marketable securities: bills, notes and bonds. As can be seen in panel 16h, sales of securities were managed to avoid a lumpy debt service schedule.

⁴⁶For a history of the Treasury-Fed Accord, see Meltzer (2010, pp. 684-724).

⁴⁷See figure 14 of Faraglia, Marcet, Oikonomou, and Scott (2014).

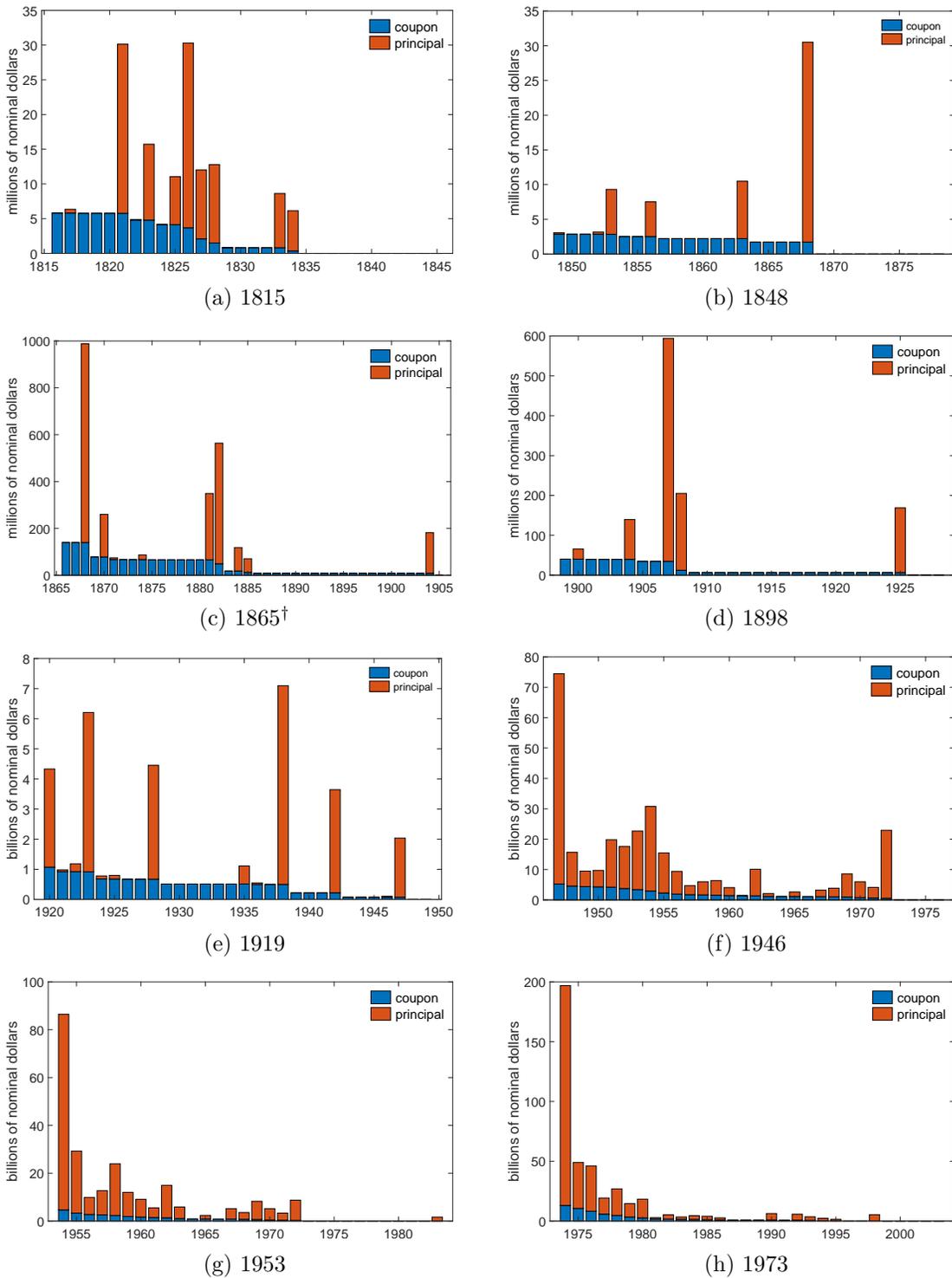


Figure 16: U.S. Treasury Debt Service Profiles on December 31

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

[†] For 1865, the time horizon is 40 years.

7 Revolutions

In addition to the eight wars studied above, residents of the present-day United States participated in two revolutions: from 1775 to 1783, the War for Independence from England, which succeeded, and from 1861 to 1865 the attempt to secede from the United States and establish a Confederate States of America (CSA), which failed. We study the funding of these two conflicts in a manner that is not fully integrated with our treatment of the other eight conflicts for three reasons. First, at the start of a revolution, no tax and debt policies exist. A new government must create laws and administration to gather the funds to fight. Second, unlike the other eight conflicts, these two revolutions were existential fights; failure to prevail meant that a government would cease to exist. Third, data shortcomings make it infeasible to construct our full accounting prior to 1790 or for the CSA.⁴⁸

The Continental (1774-1781) and Confederation (1781-1789) governments and the Confederate States of America were organized under a strong state, weak federal government model. Power to tax stayed exclusively with state governments. In both insurrections, states' reluctance to remit revenue to the central government compelled the Continental and Confederation governments and the CSA government, respectively, to run large wartime deficits. In figure 17a and 17b, we plot expenditures (net of interest payments) and receipts for the Continental government during the American Revolution and the CSA during the U.S. Civil War. Both governments acquired substantial flows of resources during the first three years of their conflicts despite collecting little tax revenue.

The Continental and Confederate governments implemented different strategies for financing these large deficits. Ultimately, both governments issued large quantities of interest-bearing and non-interest bearing certificates, but with different intertemporal patterns. From 1775 to 1780, the Continental government relied almost entirely on seignorage from non-interest bearing notes; only after the value of these notes collapsed did the government begin issuing interest-bearing securities in substantial quantities. In contrast, the Confederate States of America issued a variety of interest and non-interest bearing securities from the start of the war. As the war progressed, the CSA gradually increased the relative issuance of non-interest bearing securities even as the value of Confederate money fell. Both funding strategies generated hyperinflations, with wartime price level increasing five times more than in the U.S. during the Civil War and World War I. In the end, both governments defaulted on their non-interest bearing notes. Holders of Continental interest-bearing securities collected partial payment eventually; holders of Confederate securities received nothing.

In June 1775, the Continental Congress issued the first *bills of credit* that came to be known as Continental dollars, small denomination, non interest bearing promises to pay Spanish dollars.

⁴⁸In particular, we have no consistent price data on Continental securities prior to mid-1786, and between 1787 and 1790 price quotes are spotty. We have no GDP data prior to 1790 and no GDP data for the CSA.

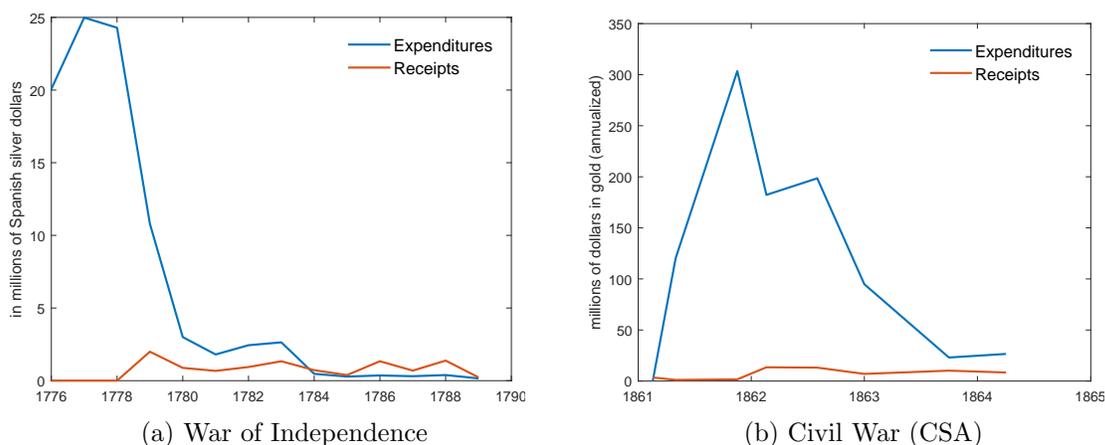


Figure 17: Government Expenditures (net of interest payments) and Revenues.

For the Continental government, in Spanish silver dollars. For the CSA, in gold dollars.

As figure 18 illustrates, between 1775 and 1780 the Continental Congress issued many of these bills. At their peak in 1780 nearly \$200 million in face value were outstanding. Over the following decade, roughly \$120 million were accepted by the states for tax payments and currency swaps, remitted to the national government and burned.⁴⁹ Spanish dollars and British pounds, not Continental dollars served as units of account for both government and private transactions during and after the war.

By late 1776, markets valued Continental dollars far less than they did the Spanish dollars for which the Continental Congress had promised to redeem them. On June 28, 1780, the Continental Congress rescinded its earlier promise to repay one Continental dollar with one Spanish dollar and made a new promise to repay 40 Continental dollars with one Spanish dollar, never mind what was still written on faces of outstanding Continental dollars. That revised promise continued between 1780 and 1790, when the U.S. Congress reset the ratio to the 100 Continental dollars for 1 Spanish dollar that Alexander Hamilton (1790) had recommended in his *First Report on Public Credit*.

Only after the 1780 “revaluation of” (i.e., reputation of most of) the Continental dollar did the Continental government issue large quantities of interest-bearing securities.⁵⁰ The two primary interest-bearing securities issued to finance the war were loan office certificates and certificates of indebtedness. Loan office certificates were bonds (most promised a 6 percent coupon) sold chiefly

⁴⁹See Grubb (2012).

⁵⁰Baack (2001) argues that, given the small outstanding quantity of interest-bearing debt issued by the Continental government in the fall of 1777, had the war ended after the Battle of Saratoga with a negotiated settlement, the U.S. would have avoided the debt crisis of the 1780s that led to the new constitution in 1787. In that case, the U.S. would have emerged as a loose confederation of 13 independent states.

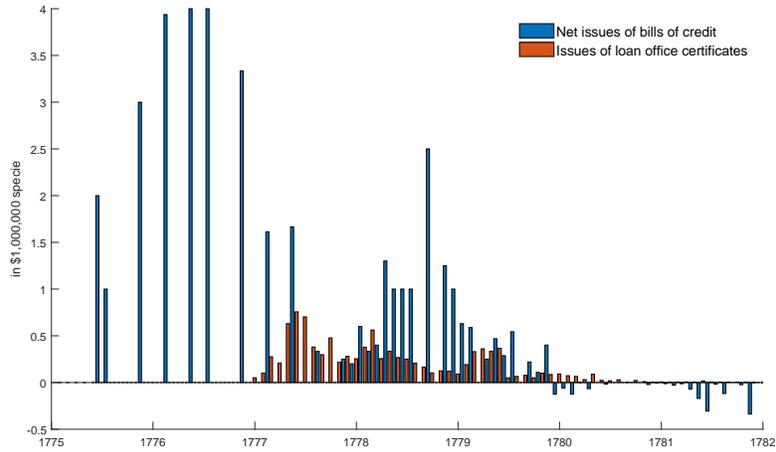


Figure 18: Monthly Net Issuance of Continental Bills of Credit and Loan Office Certificates by the Continental Government from June 1775 to December 1781

In 1,000,000 of specie dollars.

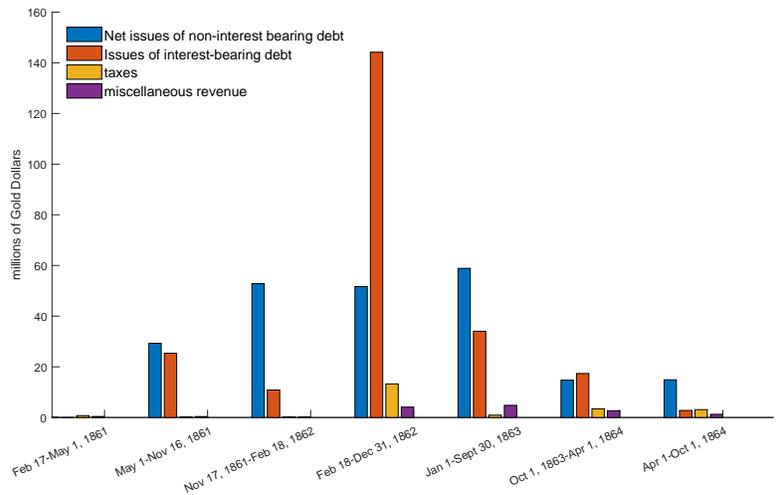


Figure 19: Issuance of Interest-Bearing and Non-Interest Bearing Debt, and Tax and Miscellaneous Revenue for the Confederate States of America from February 1861 to October 1864

In 1,000,000 of gold dollars.

to domestic investors, but sometimes issued to pay suppliers. We plot the issuance of the loan office certificates in figure 18. As can be seen in this figure, the Continental government issued 4 times the number of bills of credit than it issued of loan office certificates. Issuance of the loan office certificates increased as the emission of bills of credit began to diminish.⁵¹

Certificates of indebtedness were interest-bearing, most promising a 6 percent coupon. They were issued by quartermasters, commissaries, and other officers to civilians in exchange for supplies impressed for the army. Ferguson (1961, ch. 4) asserts that after the collapse in value of the Continental dollar in 1778 and 1779, certificates issued by the Quartermaster and Commissary departments were the primary means of payments for supplies. Poor recording keeping and the destruction of many records prevent us from knowing how many of these certificates were actually issued.

In contrast, from the start of the war, the CSA financed its deficits with a more balanced mix of non-interest bearing and interest bearing debt than did the Continental government. In figure 19, we plot issues of non-interest bearing Confederate dollars and interest bearing Confederate bonds along with tax and miscellaneous revenue, from 1861 to 1864.⁵² Note that in the second year of the war, from February 1862 to December 1862, the Confederate government issued over twice as much interest-bearing debt as non-interest bearing debt. Near the end of the war, issuance of Confederate dollars exceeded issuance of Confederate bonds.

Unlike the Continental period, during which a foreign coin was the domestic unit of account, the CSA Treasury succeeded in promoting the Confederate dollar as the unit of account throughout the Confederacy early in the Civil War.⁵³ When Confederate banks suspended specie payments in 1861, CSA Treasury Secretary Christopher Memminger convinced bankers at their July 24, 1861 Bankers' Convention to accept CSA dollars as the "standard value." In his March 14, 1862 *Report*, Memminger stated that

Throughout the Confederacy the banks and people promptly responded to these measures of the Government, and everywhere the Treasury Notes were accepted as currency. These notes thus became part of the regular circulating medium and furnished the Government with a large and available loan, free of interest.

Despite governments' attempts to control prices, both wartime economies experienced big

⁵¹Scholars including Wright (2008, p. 53) have praised those who purchased these loan office certificates, naming some for special recognition as especially generous patriots. In on-going work with the original state loan office ledgers, we have reconfirmed and refined findings of Ferguson (1961, ch. 4) that many of these patriots recorded in these ledgers (including two of the three major purchasers mentioned by Wright) were actually members of the quartermaster, commissary and hospital corps who used these loan office certificates to purchase supplies. Others on these lists were government contractors who accepted loan office certificates as payment of goods and services.

⁵²Data in this figure are computed from eight CSA Treasury Reports. Note that the time periods are not equal, and the records end prior to the end of the war.

⁵³See Ball (1991, p. 164) and Morgan (1985, ch. 9) for further discussion of the acceptance of the Confederate dollar.

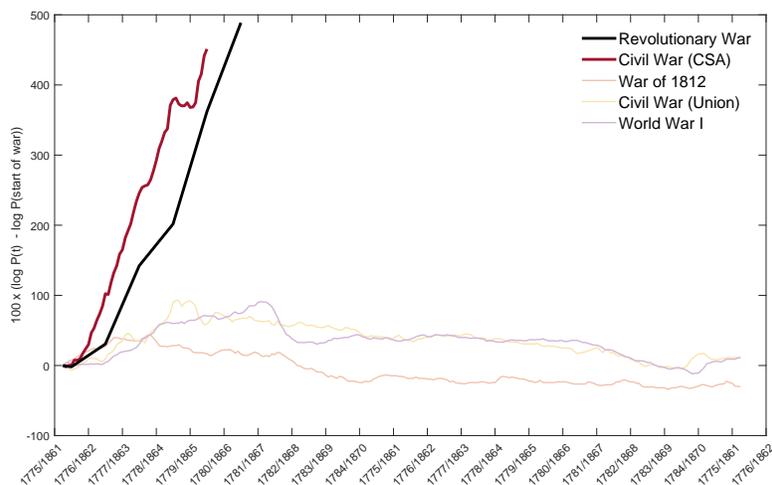


Figure 20: Natural Log of the Price Level

The figure displays $100 \times (\log P_t - \log P_{\text{start of war}})$.

inflations with price levels increasing nearly 500 percent. In figure 20, we plot natural logs of price levels during the two wars, a counterpart to figure 10. In both conflicts, inflation was markedly higher than in the eight wars studied earlier in this paper.

Differences in returns to bondholders across the two wars were direct consequences of the wars' military outcomes. Creditors of the victorious Continental government were repaid something. Creditors of the lost cause CSA government received nothing. Data limitations render us unable to compute a time series of returns for the portfolio of debt for the Continental and CSA governments; so in figure 21, we plot the price in Spanish silver dollars of the Continental Loan Office Certificates, the main domestic bonds issued during the Revolution, and the price in gold of the CSA 100 Million Dollar Loan.

During the American War for Independence, the price of Continental Loan Office certificates fell steadily. During the Confederation period that followed peace but preceded the U.S. Constitution, prices of these certificates stabilized in a range between 20 and 40 percent of their face values. Via a sequence of refunding transactions that discriminated across different classes of Continental and state creditors, in 1790, the U.S. Treasury, led by Secretary Alexander Hamilton, issued new securities to holders of Revolutionary-era certificates. Continental creditors exchanged their claims for new securities that had market values of about 75% of the original promises.⁵⁴ The new federal government did not pay as much as the Continental-era creditors had been promised, but it still paid substantial amounts to creditors other than holders of Continental dollars.

Confederate bondholders were less fortunate. As was the case with Continental-era certificates,

⁵⁴Hall and Sargent (2014) document this refunding in detail.

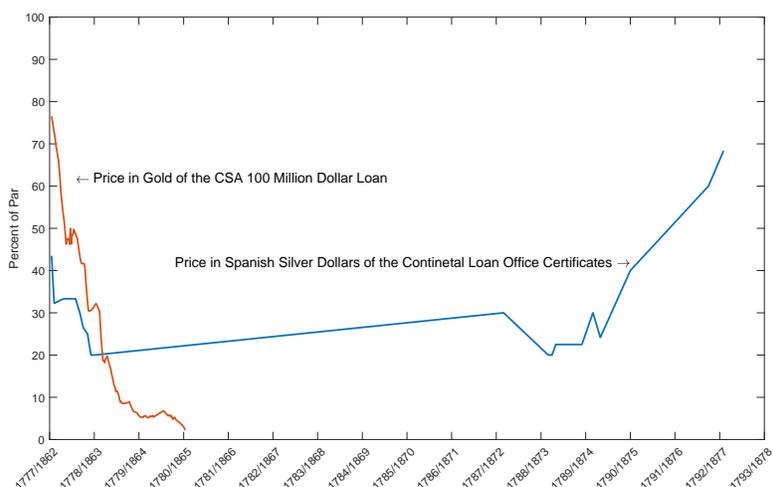


Figure 21: Bond Prices

the price of CSA securities fell steadily during the war. See figure 21. The U.S. Congress made sure that the Confederate government had no say in the postwar resolution of debts. In 1868, the 14th Amendment to the U.S. Constitution was adopted. Section 4 states that “neither the United States nor any state shall assume or pay any debt or obligation incurred in aid of insurrection or rebellion against the United States, ...; but all such debts, obligations and claims shall be held illegal and void.”

8 Qualifications

In the government budget constraint, equation (22), we consider three explicit sources of revenue: taxes, debt and money creation. However governments can also raise resources implicitly though the nationalization of private assets, the confiscation of goods from its enemy as well as its own people, and the drafting of its citizens into the military. The U.S. government has used all of these measures at various times, but perhaps the most important of these indirect revenue measures is the draft.⁵⁵

In order to raise large fighting forces without paying market wages, during the Civil War, World War I, World War II, the Korean War and the Vietnam War, the federal government drafted men into the military.⁵⁶ By requiring young men to join the military at below market wages, a reluctant soldier or sailor paid in kind a tax equal to the difference between what he could

⁵⁵See Ferguson (1961, ch. 4) for a description of the impressment of goods by Continental quartermasters and commissaries during the American Revolution and McAdoo (1931, ch. 29-30) for a first-hand account of the federal assumption of the railroads during World War I.

⁵⁶As noted by Marmion (1969), during the American Revolution, Massachusetts and Virginia conscripted men into their militias. In February 1778, George Washington recommended to the Continental Congress that all colonies begin conscription, but no universal conscription was implemented.

have earned elsewhere and his actual military pay. Previous authors have estimated revenues from this tax for various wars, but due to an absence of consistent data across wars on market wages and numbers of men drafted, we ignore this implicit tax in the revenue decomposition reported in table 1.⁵⁷

In both the Barro (1979) and Lucas and Stokey (1983) models, wars are well-understood, purely exogenous shocks to government spending, and taxpayers and bondholders are the same people. In both models, the government wishes to minimize dead-weight losses from distorting taxes. These models provide sharp statements about optimal time paths of taxes, borrowing, and returns on debt for financing a large temporary government expenditure. In their elegance and simplicity, these models necessarily ignore three concerns that frequently arise in political discussions of war finance.

1. While some wars are thrust upon a government, in many cases, the government's decision to go to war is a choice.
2. Soldiers and sailors risk their lives, while those who stay home risk less, bringing issues of fairness to the fore.
3. Taxpayers and bondholders are distinct groups whose interests often conflict.

In sections 4 and 6 we described how these three concerns influenced Congress' choices of debts and taxes and Congress' and Treasury's decisions on how to design and market the debt. We'll say a little more about this now.

While the U.S. arguably had no choice but to enter World War II after the bombing of Pearl Harbor, arguably the U.S. government chose to enter the other wars we are studying in this paper.⁵⁸ In the U.S. and elsewhere, contemporary observers have argued that by minimizing the deadweight losses of raising enough funds, tax smoothing policies make it politically feasible for democratic governments to join discretionary wars and prolong the duration of these wars. Adam Smith (1776, ch. 11) wrote:

The ordinary expense of the greater part of modern governments in time of peace being equal or nearly equal to their ordinary revenue, when war comes they are both unwilling and unable to increase their revenue in proportion to the increase of their expense. They are unwilling for fear of offending the people, who, by so great and so sudden an increase of taxes, would soon be disgusted with the war; and they are

⁵⁷For World War I, Clark (1931, p. 110) estimates that average annual pay for soldiers and sailors for the three years 1917-19 was \$1,015. Average rate of civilian pay for those three years was \$1,055 per year – thus a \$40 gap between civilian and military pay. He put the “national dividend” from underpaying the soldiers and sailors at \$230 million. For an analysis of the Vietnam War era draft, see Oi (1967) and Gates (1970).

⁵⁸For a discussion of the choices that led to the U.S. entering World War I, see the introduction of Hall and Sargent (2019). For a statement of doubts about whether the U.S. should have entered World War II so controversial that his family and other defenders blocked its publication for decades, see Hoover (2011).

unable from not well knowing what taxes would be sufficient to produce the revenue wanted. The facility of borrowing delivers them from the embarrassment which this fear and inability would otherwise occasion. By means of borrowing they are enabled, with a very moderate increase of taxes, to raise, from year to year, money sufficient for carrying on the war, and by the practice of perpetually funding they are enabled, with the smallest possible increase of taxes, to raise annually the largest possible sum of money.

More recently, Zielinski (2016) and Kreps (2018) argued that the use of debt-financing is inversely related to the public's support for the war. Kreps (2018, p. 8) stated

leaders, seeking to minimize constraints in war, pursue strategies that both anticipate and deflect opposition that would arise from the public's sensitivity [to war costs]. That means they turn to less visible or onerous approaches such as borrowing rather than imposing war taxes when individuals express little appetite for fiscal sacrifice in wartime.

If taxes are a more visible means of finance relative to borrowing, then it is noteworthy that over the last 200 years the U.S. government has chosen to finance an increasing share of war costs with taxes.⁵⁹ Maybe it is that the public wants to demonstrate their support for a war by agreeing to incur the deadweight loss of taxation.⁶⁰ Newspaper op-ed writers often make this argument.⁶¹ Rumbaugh (2013) recommended state-contingent wartime taxes so that all calls for military action must explicitly include a call for increased taxes, forcing the question of whether the stakes in the military situation are worth the cost. He stated "If the American people agree [that higher taxes] are worth it, the president will get both the political support and financing he needs. By tying military action to additional revenue, the president would actually have a freer hand in deciding when to use force." That policy involves tax-bunching – not tax smoothing.

Wars inspire calls for "shared sacrifices".⁶² Some argued that tax-financing wartime expenditures would be fairer than debt-financing, particularly to those being drafted or volunteering to serve in the military. Before World War I Sprague (1917) argued that taxation placed the burden of paying for the war on those who could best afford it. With loans, a draftee or volunteer pays twice: first while serving in the army, and then again with higher taxes to service the bonds when he returned. During the Korean War, this argument was echoed by House Speaker Sam Rayburn who stated, "I think the boys in Korea would appreciate it more if we in this country were to

⁵⁹See table 1. The fact the Treasury advertised the bonds sold to finance various wars (e.g., the posters in figure 12) challenges the view that debt financing is necessarily less visible than tax financing.

⁶⁰This argument contrasts with the view discussed in section 6 that popular support for a war can be expressed through robust bond sales.

⁶¹See Washington Post (1898) and Dionne (2007) for examples.

⁶²See Fisher (1918), Truman (1951), Bank et al. (2008), and Rockoff (2012).

pay our own way instead of leaving it for them to pay when they get back.” President Truman’s Treasury Secretary James Synder agreed when he testified before the Senate Finance Committee, “You passed a bill up here to draft boys of 18, to send them to war. I think it is just as important we draft some of the profits to help pay for the expenditures.”

Not all have agreed that tax financing a war is fairer than debt financing. As Treasury Secretary Andrew Mellon (1924, pp. 26-27) wrote regarding the financing of World War I:

The view sometimes advanced that the present generation can avoid in part the burden of the cost of the war by passing the war debt on to future generations is fallacious when the debt is entirely domestic, as in the case of the present debt of the United States. A domestic debt is simply a liability of the people to pay themselves, or rather to pay the group holding Government securities; and while this liability may be handed down to the next generation, equivalent assets in the form of Government securities would also be handed down, and that generation, viewed as a whole, would be neither richer nor poorer. From the viewpoint of the country as a whole, the war was paid for when it was fought. ... If the war had been financed entirely through taxation, as some suggested at the time, or if the supplies needed by the Government had simply been commandeered and not paid for, it can readily be seen that the whole burden of the war would have been borne at that time. The financing of the conflict in part by loans was simply an arrangement under Government supervision whereby those who were in position could pay more than their proper proportion of the cost and be reimbursed later with interest by those who were not in position at the time to meet their proper proportion under the tax system without too great sacrifices and hardships.

Barro (1974) described conditions under which debt financing and tax financing are equivalent.

Finally, in both benchmark models, taxpayers, bondholders and the government commit to a stream of payments and returns conditional on a realization of a fully-understood shock process; promises are kept. Implementation of these policies depends on future governments’ choosing to confirm promises made today. In democratic republics, commitments are sustainable only when future majorities want to honor promises made by previous governments and only to make new promises that even later majorities want. To purchase bonds when immediate returns are low during a war selfish creditors must believe that future governments will deliver high rates of return. Experiences of USA and CSA creditors after the Civil War provides contrasting instances of how anticipations were actually realized. After the Civil War, the Union government confirmed creditors wartime anticipations of high postwar real returns. Section 4 of the 14th Amendment forbade payments to Confederate creditors.⁶³

⁶³Nevertheless, states in the former Confederacy paid pensions to CSA veterans.

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A Accounting

To understand how the par value of the government debt is related to the market value of debt, we bring in information about bonds’ coupons and prices of (presumably risk-free) promises to future dollars. Let the market price q_{t+j}^t be the number of dollars at time t that it takes to buy a risk-free claim to a dollar at time $t + j$. Thus, the superscript t denotes the date at which the price is quoted, while the subscript $t + j$ refers to which the date at which a promise is to be fulfilled. At any date t , let there be a list of prices $\{q_{t+j}^t\}_{j=1}^{n_t}$, where n_t is the maximum horizon over which the government has promised payments.⁶⁴ The price q_{t+j}^t is linked to the yield to maturity ρ_{jt} for j -period risk-free zero-coupon bonds by

$$q_{t+j}^t = \frac{1}{(1 + \rho_{jt})^j}.$$

At time t the government promises to pay s_{t+j}^t dollars at times $t + j, j = 1, 2, \dots, n_t$. Promised payments consist of coupons c_{t+j}^t and principal repayments (also known as par values) b_{t+j}^t :

$$s_{t+j}^t \equiv c_{t+j}^t + b_{t+j}^t. \tag{29}$$

These are sums of the corresponding components associated with each bond.

The market value of government debt at time t is

$$\sum_{j=1}^{n_t} q_{t+j}^t s_{t+j}^t, \tag{30}$$

⁶⁴When the government has issued perpetual *consols*, $n_t = \infty$.

which states that the total value of government debt is the sum of a collection of prices times quantities. The time t outstanding total par value is

$$\sum_{j=1}^{n_t} b_{t+j}^t, \tag{31}$$

which differs from the market value of government debt

$$\sum_{j=1}^{n_t} q_{t+j}^t s_{t+j}^t = \sum_{j=1}^{n_t} q_{t+j}^t (c_{t+j}^t + b_{t+j}^t)$$

for two reasons:

- It neglects the government’s outstanding promises to pay coupons that are economically indistinguishable from promises to pay principal

$$\sum_{j=1}^{n_t} c_{t+j}^t; \tag{32}$$

and

- The par value given by equation (31) fails to discount future payments of principal b_{t+j}^t by multiplying them by the market prices, or “discount factors,” q_{t+j}^t .

The first omission causes the par value to understate the market value of debt, while the second omission tends to make it overstate it. This means that it is possible for the par value, $\sum_{j=1}^{n_t} b_{t+j}^t$, either to exceed or to fall short of the market value of government debt $\sum_{j=1}^{n_t} q_{t+j}^t s_{t+j}^t$. In figure 4, we plot the par value of the debt in red and market value of the debt in blue from 1776 to 2018.

In the analysis in this paper we report the value-weighted holding period return on the portfolio of U.S. Treasury debt as defined in expression (23). This measure differs from the U.S. Treasury’s series of *Interest Expense on the Debt Outstanding*. The Treasury’s series is an accounting measure of the interest on the government debt, namely:

1. Before 1929:

$$c_t^{t-1}$$

2. After 1929:

$$c_t^{t-1} + r_{t-1,t}^1 b_{1,t}^{t-1}$$

where $b_{1,t}^{t-1}$ is the par value of pure discount one-period treasury bills issued at $t - 1$, and $r_{t-1,t}^1$ is the net nominal rate of return on one-period debt. This official measure reports the sum of

coupon payments on longer maturity bonds and the net yield on one-period zero-coupon Treasury bills (these have existed only since 1929).

B Data Sources

We use the prices and quantities of individual U.S. Treasury securities from Hall, Payne, and Sargent (2018) and the CRSP Treasury bond files and the zero-coupon yield curves from Gurkaynak et al. (2007) to compute the par and market values, holding period returns, and decompositions of the U.S. Treasury's debt portfolio.

Nominal GDP and the GDP deflator come from www.measuringworth.com. We linearly extrapolate pre-1790 GDP in figures 3, 4, and 5. In tables 1 and 2 we use the annual GDP deflator as our measure of the price index. For all other calculations we use the monthly price level index from Craighead (2010).

Federal expenditures and revenues from 1790 to 1940 are from the *Annual Report of the Secretary of the Treasury on the State of the Finances*.⁶⁵ The numbers we use are summarized on pages 642 - 650 of the 1940 Annual Report.⁶⁶ Federal expenditures and revenues from 1934 to 2018 are from the Office of Management and Budget (OMB).⁶⁷ The U.S. Treasury and OMB reports federal receipts and expenditure data annually by fiscal year. The first fiscal year after the establishment of the U.S. Treasury started January 1, 1789. In 1842, Congress changed the beginning of the fiscal year from January 1 to July 1. In 1977, it was changed again from July 1 to October 1 where it remains today. We interpolated the calendar-year GDP data to conform it with the fiscal data,

The money supply is the sum of the non-interest bearing Treasury debt and Federal Reserve credit outstanding. Federal Reserve credit outstanding represents the loans and investments of the twelve Federal Reserve Banks. It 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.

B.1 Pre-1790

Continental expenditures from 1776 to 1781 were recorded by Joseph Nourse (1791) in Section E of his *Statements of Receipts and Expenditures of Public Monies*. This section is a report submitted by Henry Knox, the first Secretary of War. Most of the expenditures listed are clearly military in nature, but there are entries for expenditures on Indian Affairs, the Post Office, the Secret Committee and Advances to the States.

⁶⁵See <http://fraser.stlouisfed.org/publication/?pid=194>.

⁶⁶See http://fraser.stlouisfed.org/docs/publications/treasar/AR.TREASURY_1940.pdf.

⁶⁷See <http://www.whitehouse.gov/omb/budget/Historicals>.

The expenditures from 1781 to 1789 are reported by Robert Morris (1790) *Statement of the Financial Affairs of the United States*.⁶⁸ Total expenditures from 1775 through November 1, 1784 are also reported in *General Hamilton's estimate of revolutionary war expenditures, cut down to specie*. See Elliot (1845, p. 10).

The pre-1790 receipts data are from Robert Morris (1790).

In figure 18, we compute the emission of the loan office certificates using records from Record Group 53 of the National Archives and Records Administration. The sources for the net emissions of the bills of credit are Grubb (2008) and Grubb (2012). We deflate these emissions using the depreciation schedule of Bullock (1895, p. 135).

B.2 Confederate States of America

Revenue and expenditures for the Confederate States of America (CSA) are from eight *Reports of the Secretary of the Treasury* issued by Christopher Memminger. The unit of account is Confederate dollars. To convert these numbers into gold dollars we use the gold-grayback exchange rates reported on page 375 of Schwab (1901). Since the eight Treasury reports cover periods of varying length, we annualize the revenue and expenditure flows.

These data are not complete. While the war ended in April 1865, the final Report was issued in October 1864. These Reports combine coupon and principal payments into “payments on the debt.” Burdekin and Langdana (1993) provide an excellent discussion and analysis of the CSA Reports.

The source for CSA revenue and debt issuance debt in figure 19 is the CSA Treasury Reports. We convert nominal CSA dollars into gold dollars using the schedule from Todd (1954, Appendix C, p. 198).

In figure 21, the gold price of the 100 million dollar loan is from Burdekin and Weidenmier (2003).

B.3 Federal Reserve Balance Sheets

The source of the weekly data displayed in figure 13 are the tables of assets and liabilities of the twelve Federal Reserve Banks reported in each issue of the Board of Governors of the Federal Reserve System (1915-2018).

The sharp increase in gold reserves on the assets side and Federal Reserve Notes in circulation on the liabilities side of the balance sheet that occurred on June 22, 1917 is due to an amendment of the Federal Reserve Act which permitted Federal Reserve Banks to count gold held by its Federal Reserve Agent as part of its required note reserve. Prior to this amendment, the liability

⁶⁸There is one year of overlap between the two reports: 1781. The title of the table in Nourse's report states that the expenditures listed are exclusive of the money paid by the Superintendent of Finance and listed in Morris (1790) report.

of Federal Reserve Banks on outstanding Federal Reserve notes was reduced by the amount of gold held by the Federal Reserve Agent instead of the gold being considered as a collateral reserve.

For the Federal Reserve's assets, before the passage of the June 1917 amendment, *Gold reserves* are the sum of Gold coin and certificates in vault, Gold Settlement fund, and Gold redemption fund. After this amendment, Gold with Federal Agents and Gold with foreign agencies are included in the Gold Reserves. Gold reserves include Gold held against Federal Reserve Notes starting in November 1919, and Gold and Certificates held by banks starting in December 1923. *Reserves Other than Gold* are Legal tender notes, silver, etc. *Discounted U.S. Government Securities* are Bills discounted: Secured by U.S. Government obligations, and *Discounted Private Securities* are Bills discounted: All other. *U.S. Government Securities Bought Outright* include Bills bought in open market, U.S. government bonds, U.S. victory notes, Treasury notes, and U.S. certificates of indebtedness. *All Other Assets* are the sum of Non-Reserve Cash, All other earning assets/other securities, Bank Premises, Gold in transit or in custody in foreign countries, Due from other Fed Banks (in transit), Due from Foreign banks, Uncollected items, Federal Reserve Notes, net assets, Five per cent redemption fund against Federal Reserve Bank notes, All other assets, and Federal Deposit Insurance Corporation stock.

For the Federal Reserve's liabilities, *Reserve Deposits* are the sum of Government Deposits/U.S. Treasurer general account, Due to Members - reserve account/Member bank reserve account, Due to non-member banks clearing account, Deferred availability items, Reserved for Government franchise tax, Foreign bank, and Other deposits. Prior to the June 1917 amendment, *Federal Reserve Notes* are all notes and banknotes in circulation, net gold held by Federal Reserve Agents. After June 1917, *Federal Reserve Notes* records all Federal Reserve notes and banknotes in circulation. *All Other Liabilities* are the sum of Capital paid in/Capital accounts, Surplus Funds, Special deposits, Reserve for contingencies, and All other liabilities.

We entered the balance sheet data by hand. We later learned that these data are available from Bao, Chen, Fries, Gibson, Paine, and Schuler (2018).