Did the U.S. really grow its way out of its WWII debt? *

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Abstract

The fall in the U.S. public debt-to-GDP ratio from 106% in 1946 to 23% in 1974 is often attributed to high rates of economic growth. In this paper, we re-examine the roles played by primary surpluses and real interest rate distortions–through both pegged nominal interest rates before the Fed-Treasury Accord of 1951 and surprise inflation in the 1960s and 70s–in driving down the debt ratio. Under our baseline calibration, we estimate that the public debt-to-GDP ratio would only have declined from 106% to 73% over the same period if primary balances had always been equal to zero and there were no real interest rate distortions. Under the same assumptions, we find that the debt-to-GDP ratio would have persistently remained above its pre-war level and reached 91% in 2021. Put differently, the U.S. would not have grown its way out of its WWII debt without interest rate distortions and primary surpluses.

Keywords: Public Debt, Inflation Surprises, Primary Balance

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1 Introduction

Does a high level of national debt impose a burden on future generations who must pay it off? In the last few years, economists such as Blanchard (2019), and Furman and Summers (2020) have suggested that the answer may be no, because $r < g$: the real interest rate on the debt is usually below the growth rate of the economy. In that case, the government can roll over the debt and accumulating interest without raising taxes to retire the debt and the debt-GDP ratio will fall over time. Because of this possibility, there is a growing view that, as Blanchard (2019) puts it, "public debt may have no fiscal cost [...] and its welfare costs may be smaller than typically assumed". This has decreased concern about the current debt of around 100% of GDP.

Thinking on this issue has been influenced by a salient historical experience: the decline in the debt/GDP ratio after World War II. Paying for the war increased the debt/GDP ratio[1] from 42% in 1941 to 106% in 1946—a level that is roughly tied with today for the highest level in history—but then it fell steadily until it reached 23% in 1974 (Figure 1). As Elmendorf and Mankiw (1999) report, "an important factor behind the dramatic drop [...] is that the growth rate of GNP exceeded the interest rate on government debt for most of that period". Krugman (2012) says that the "debt from World War II was never repaid and just became increasingly irrelevant as the U.S. economy grew"[2]. This interpretation of history lends credence to the idea that the current high level of debt should not cause great concern. Others, however, have pointed out two reasons to question this interpretation. First, as emphasized by authors such as Hall and Sargent (2011), the U.S. actually did pay off part of the debt by running substantial primary surpluses—that is, by levying taxes in excess of current government spending—over much of the period when the debt-income

[1] Throughout this paper we will focus on the debt held by the public, i.e. excluding intergovernmental holdings.

[2] Quote from Krugman: Nobody Understands Debt, New York Times, Jan. 1, 2012.

ratio was falling. Second, as emphasized by authors such as Reinhart and Sbrancia (2015), interest rates were held down relative to economic growth through policies that not likely to be feasible and/or desirable in the future. Interest rates were held down through policies of financial repression, most clearly the Fed's interest rate peg from 1942-1951, which was aimed at decreasing the fiscal cost of the war (Hetzel and Leach (2001)). In addition, ex post real interest rates were reduced by unexpected increases in inflation following the elimination of price controls[3] in 1946, and later in the 1960s and 1970s. For these reasons, the post-World-War-II experience does not necessarily suggest that the U.S. economy can naturally grow its way out of debt.

This paper seeks to help explain the path of the debt/GDP ratio after World War II. We seek to quantify the effects on the evolution of the debt-GDP ratio since World War II of primary surpluses, the interest rate peg before 1951 and surprise inflation. We summarize these effects by doing counterfactual estimates of the path that the debt-GDP ratio would have followed if primary surpluses had been zero, there was no interest rate peg, and there was no erosion of real interest rates through surprise inflation. In this scenario, we find that the debt-GDP ratio would have fallen only from 106% in 1946 to 73% in 1974, rather than to 23% as in reality. Moreover, if we extend the scenario, we find that the debt-GDP ratio would have persistently remained well above its pre-war level of 47% and would have reached 91% in 2021, almost back to the post World War II level (although not as high as the actual 2022 level of 110%, which is explained mainly by persistent primary deficits since 1974). Thus, the elimination of the World War II debt is most accurately interpreted as resulting mostly from primary surpluses and interest-rate distortions, not an excess of economic growth rates above equilibrium real interest rates. Put differently, the U.S. would

[3] Those price controls reduced the price level 30 percent below what it would have been otherwise, according to Paul Evans (1982). When the caps were lifted in 1946, prices climbed significantly. For example, food prices alone rose 13.8 percent in July after food price controls expired on June 30th. The inflationary episode after World War II ended after two years as domestic and foreign supply chains normalized and consumer demand began to level off.

not have grown its way out of its WWII debt without interest rate distortions and primary surpluses. Our methodology for estimating counterfactual debt paths builds on the work of others but uses a richer set of information to make our quantitative results as accurate as possible. A key step is to construct a 'reverse maturity structure' of the debt in each year that gives the amount of current debt that was issued in each past year, which we do using the granular data on Treasury securities produced by Hall et al. (2018) before 1960 and by CRSP thereafter. We also construct a term structure of inflation expectations from surveys of short-term and long-term inflation expectations, which allows us to estimate the effects of surprise inflation on the real interest rates paid by debt issued in different years. Finally, we estimate the effects of the pre-1952 interest rate peg by comparing the pegged interest rates on debt of various maturities to market interest rates for the post-peg period of 1952-1960. Our various calculations require a few assumptions about variables that we do not observe, but we show that our results are not greatly changed by varying these assumptions in reasonable ways.

The rest of the paper is organized as follows. In section 2, we provide some historical background regarding the post-WWII period. In section 3, we describe our methodology to construct counterfactual paths of the debt-to-GDP ratio. We provide details regarding the sources and construction of our data in section 4, and present our results in section 5. Section 6 concludes.

2 Debt, Primary Balance, Interest Rate Peg, and Inflation Surprises Since WWII

In this section we give an overview of the evolution of the public debt after WWII, and the factors that influenced it—in particular primary surpluses, the average interest rate paid on the debt, and inflation surprises.

2.1 Main Fiscal Variables

The debt held by the public reached its peak as a share of GDP at 106% GDP in 1946, and a through at 23% GDP in 1974. In 2021, the debt-to-GDP ratio was equal to 110% (Figure 1). The marketable debt held by the public represented about 65% of the total debt held by the public in 1951. This share has been increasing since then, and reached 95% in 2020 (Figure 21). The average effective interest rate paid on the debt increased from 2% after WWII to more than 12% in 1981, and then decreased back to 2% in 2020 (Figure 2). Note that this is the average interest rate on all the outstanding debt, and that different securities have different interest rates because they where issued at different time and/or because they have a different maturity. The primary balance showed massive deficits during WWII, which were rapidly followed by primary surpluses during the following two decades (Figure 3). The primary balance has always been in deficit since 1974, except for a few years around 2000, and showed again important deficits as a result of policymakers' response to the global financial and COVID-19 crises.

2.2 Interest Rate Peg

In April 1942, at the request of the Department of the Treasury, the Federal Reserve formally committed to maintaining a low interest-rate peg of 3/8 percent on short-term Treasury bills.

The Fed also implicitly capped the rate on long-term Treasury bonds at 2.5 percent. The goal of the peg was to stabilize the securities market and allow the federal government to engage in cheaper debt financing of World War II, which the United States had entered in December 1941. Note that the peg meant that the Federal reserve was not independent and was unable to adjust rates to stabilize and control the economy. The Fed maintained the low interest rate by buying large amounts of government securities, which also increased the money supply. Because the Fed was committed to a specific rate, it had to keep buying securities even if the members of the Federal Open Market Committee (FOMC) might have preferred a different monetary policy (Hetzel and Leach (2001)). As a consequence, the government relied on price controls during wartime in order to control inflation. However, strict price controls or policies giving up the Fed its ability to control inflation are not likely to be attractive to policymakers in coming years. By February 1951, CPI inflation had reached an annualized rate of 21 percent. As the Korean War intensified, the Fed faced the possibility of having to monetize a substantial issuance of new government debt, which would have placed even greater upward pressure on prices. But the administration continued to urge the Fed to maintain the peg, a position the FOMC found increasingly untenable. On March 4, 1951, the Treasury and the Fed issued a statement saying they had 'reached full accord with respect to debt management and monetary policies to be pursued in furthering their common purpose and to assure the successful financing of the government's requirements and, at the same time, to minimize monetization of the public debt' (William McChesney Martin, Jr., Collection 1951). Reinhart and Sbrancia (2015) also discuss other financial repression policies, such as interest caps on bank deposits, which they argue increased the demand for Treasuries and thus artificially reduced their rates. The recent quantitative easing above and beyond what is needed to bring the economy to its potential level could seen as a form of financial repression.

2.3 Inflation and Inflation Surprises

Figure 4 shows the path of inflation as measured by the GDP deflator since WWII. There was a massive inflation in 1946 following the elimination of price controls, and also high inflation rates in 1951 during the Korean War, and in 1974 and 1981 following the oil shocks. Inflation is less volatile since the mid-1980s, and has been below 2% for many years in the recent period. Figure 5 shows short-term (1-year ahead) and long-term (average over the next 10 years) inflation expectations. The data come from different surveys, and we extend the data to obtain short-term and long-term GDP deflator series back to 1951. The methodology is presented in the Data section. Long-term inflation expectations are flat after 1997. As shown in Figure 6, short-term inflation surprises were consistently positive up to 1980, and negative since 1980. Long-term inflation surprises, which are smoother, follow the same pattern. Note that the short-term inflation surprise became positive again in 2021 following the recent surge in inflation.

3 Constructing Counterfactual Paths of Debt-to-GDP Ratios

This section provides an overview of the procedure used to compute our counterfactual debt dynamics. More details are provided in the Appendix. Throughout this paper, the notation $X_T^{s,J,t}$ will refer to the value of a variable X at time T regarding a public debt security s of type t which was first issued during year $T-J$. Our objective is to compare actual debt dynamics to a counterfactual with non-distorted real interest rates (i.e. no inflation surprises and no nominal interest rate peg), and different primary surpluses. The fundamental equation describing the evolution of the par value[4] of the debt is:

$$D_t = (1 + i_t)D_{t-1} - P_t + \epsilon_t \tag{1}$$

where D_t is the debt held by the public at the end of fiscal year[5] t, i_t is the average effective interest rate on the debt held by the public, P_t is the primary balance in t, and ϵ_t represents a residual which makes the equation hold exactly[6]. Our counterfactual debt dynamics is given by:

$$\hat{D}_t = (1 + \hat{i}_t)\hat{D}_{t-1} - \hat{P}_t + \hat{\epsilon}_t \tag{2}$$

where we use the notation $\hat{}$ to denote the value of a variable in the counterfactual scenario. We assume that $\hat{\epsilon}_t = \epsilon_t \; \forall t$. In the counterfactual analysis section, we will assume different paths for the primary balance: either $\hat{P}_t = P_t$ or $\hat{P}_t = 0 \; \forall t$. Throughout the paper, we calculate the evolution of nominal debt using this formula, and divide it by nominal GDP to obtain the debt-to-GDP ratio.

While the counterfactual with zero primary balance is relatively straightforward and obtained by setting $\hat{P}_t = 0 \; \forall t$, the counterfactual with no real interest rate distortions is more complicated. The basic idea is that we will make some adjustment to the interest rate on all debt securities every year. Yet, the nature of the adjustment will depend on when the security was issued: either before the peg period, during the peg period (1942-1951), or after the peg period. Moreover, the adjustment will also depend on the nature of the security.

[4]Compared to Hall and Sargent (2011), we focus on the par value, not the market value of the public debt. The par value relative to GDP is the focus of most policy discussions. In any case, looking at the market value instead of the par value would complicate our analysis but not make much difference to our results (see Figure 26).

[5]The unit of time is throughout this paper is the fiscal year. A complication is that the definition of the fiscal year changed over time. From January 1842 until 1977, the fiscal year began in July. From July 1977 onward, the fiscal year has started in October. For example, FY 2021 started on October 1st 2020 and ended on September 30th 2021. The period from July 1st to August 31st of 1976 is referred to as the 'transitional quarter'. We will ignore this in the main text, but refer to the Appendix for more details regarding the adjustments made to our calculations around the switch in fiscal year.

[6]This residual includes other means of financing the deficits such as Treasury cash management operations.

For example, the interest rate on Treasury bills and TIPS are not adjusted. For exposition simplicity we will focus on the first type of adjustment in the main text, and provide details regarding our full procedure in the Appendix. We proceed as follows.

First, for the debt issued after the Fed-Treasury Accord, the counterfactual is such that there is no effect of unexpected inflation, i.e. that ex post real interest rates are equal to ex ante real interest rates. The key step is to estimate expected inflation over various horizons. Second, for the debt issued during the peg period, distortions come from both below market nominal interest rates and inflation surprises. Because market interest rates are not observable for this period, we compute the total effect due to both distortions by estimating what the ex ante real rate would have been absent the peg. Third, we do not adjust the debt issued before 1942. In principle, the value of this debt could have been eroded by surprise inflation, but we do not know a credible way to measure expectations made before 1942 of inflation after 1946. We view this assumption as conservative because it is unlikely that interest rates before 1942 were set with anticipation of the high inflation rates in the late 40s and early 50s.

At a broad level, the average effective interest rate adjustment x_t^{j+1}, which is adjustment on the average interest rate paid at time t on debt securities which were first issued in fiscal year $t-1-j$ is given by:

$$x_t^{j+1} = \begin{cases} 0 & \text{for } t-1-j \leq 1942 \\ \tilde{r}_t^{j+1} - \left(i_t^{j+1} - \pi_t\right) & \text{for } 1943 \leq t-1-j \leq 1951 \\ \pi_t - \mathbb{E}_{t-1-j}[\pi_t] & \text{for } 1952 \leq t-1-j \end{cases} \tag{3}$$

where $\tilde{r}_t^{j+1}$ is the average ex ante real interest rate on debt securities outstanding at $t-1$ and which were first issued in year $t-1-j$. In our baseline calibration, it is computed by assuming that ex-ante real interest rate on debt securities issued during the peg period

(1942-1951) before the Fed-Treasury Accord of March 1951 was equal to the average ex-ante real rate for debt securities with similar maturity issued between 1951 and 1960, and i_t^{j+1} is computed as the weighted average interest rate on debt securities outstanding in $t-1$ and issued under the peg regime in year $t-1-j$. The Data section provides more details regarding the construction of those variables.

For a given year, computing the counterfactual average interest rate on the debt consists in taking a weighted average of interest rates over debt issued at different times. For our purposes, it will be useful to introduce the concept of reverse maturity structure. The reverse maturity structure of the debt indicates the share of outstanding debt at time t which was first issued at time $t-j$ for different values of j. Define the share of outstanding debt at the end of year $t-1$ which was first issued at $t-1-j$ as:

$$w_{t-1}^{j} \equiv D_{t-1}^{j}/D_{t-1} \tag{4}$$

The reserve maturity structure of total outstanding debt held by the public at any time t is given by the vector of $w_t^j \; \forall j \in [0, M]$, where M is the maximum reverse maturity of the outstanding debt securities and D_{t-1}^{j} is the amount of debt securities outstanding at the end of year $t-1$ which were first issued in year $t-1-j$. We compute the non-distorted average effective interest rate as:

$$\hat{i}_t = \sum_{j=0}^{M} \left(i_t^{j+1} + x_t^{j+1} \right) \hat{w}_{t-1}^{j} \tag{5}$$

where i_t^{j+1} is the average effective interest rate paid at time t on debt securities which were first issued in year $t-1-j$.

If we assume that the reverse maturity structure is the same in the counterfactual scenario as in the actual realization of history, i.e. if $\hat{w}^j_{t-1} = w^j_{t-1}\ \forall t$, then:

$$\hat{i}_t = i_t + \underbrace{\sum_{j=0}^{M} x_t^{j+1} w^j_{t-1}}_{\equiv x_t} \tag{6}$$

where x_t is the average effective interest rate adjustment, and is computed as the weighted average of the interest rate adjustment by year of issuance, where the weights are given by the reverse maturity structure of the debt.

There are a few details that were omitted in this overview of our procedure but which are taken into account in our calculations. First, we implicitly assume that all debt is issued and matures as the end of a given fiscal year. We do not think this is likely to be quantitatively important and the errors do not appear to necessarily go in the direction of overstating the effects we seek to measure. Second, most Treasury bills are rollover at short intervals within a year and their interest rate will adjust to inflation news. Thus, to be conservative, we assume that none of the value of T-bills is eroded by surprise inflation. Moreover, starting in 1997 some debt was indexed to inflation. Surprise inflation does not erode their value, so we take this into consideration in computing our interest rate adjustment. The share of Treasury bills in total debt held by the public increased dramatically between the early 1950s to the mid 1970s, from about 5% to more than 30%. This share was about 24% in 2020, while the share of TIPS was around 8%. Third, we decompose the debt between marketable and non-marketable debt. Non-marketable debt has on average a longer reverse maturity structure than marketable debt, consistent with the fact that new issuance of non-marketable debt is limited and its share has been decreasing over time. The share of non-marketable debt in total interest-bearing debt held by the public decreased from 23% in 1960 to 9% in 1996, with a short-lived peak at 27% in 1973-1974. Since the 1980s, on average more than 50% of the public debt outstanding at any end of fiscal year had been issued during either the current or previous fiscal year. Fourth, we treat carefully the transitional quarter and the switch in fiscal year.

Our methodology requires to construct the reverse maturity structure of the debt, as well as a term structure of inflation expectations. We use survey data for one-year and ten-year inflation expectations, and develop procedures to extend those data back to 1951 and get proxies for the term structure of inflation expectations. The next section provides more details regarding the sources and construction of our variables.

4 Data and Sources

This section describes the procedure followed to construct the fiscal and inflation variables used to produce the counterfactual debt dynamics.

4.1 Main Fiscal Variables

The main sources for our aggregate fiscal variables are the OMB, the Hall database, and the Treasury Bulletin.

Debt. The nominal GDP data come from the OMB. The outstanding aggregate debt held by the public D_t comes from the OMB historical database. Debt held by the public means debt held by the private sector and the Federal Reserve system. This measure, which is the most commonly used measure of debt in the literature, excludes intergovernmental holdings[7] of the public debt. The aggregate outstanding marketable and non-marketable[8] debt held

[7] Intragovernmental Holdings are mostly made up of the Government Account Series (GAS) held by government trust funds, revolving funds, and special funds. Debt Held by the Public includes all federal debt held by individuals, corporations, state and local governments, foreign governments, and GAS deposit funds.

[8] Debt for which there is no secondary market. The holders of such debt may have to wait until it falls due for redemption, or may be able to get it redeemed by the borrower at any time, but possibly on terms involving some penalty. This is the position, for example, with National Savings certificates in the US.

by the public D_t^m and D_t^{nm} come from the Hall database. The share of marketable debt is computed using the Hall database as:

$$m_t = \frac{D_t^m}{D_t^m + D_t^{nm}} \tag{7}$$

See Figures 20 and 21.

We combine the information from two main sources to build our security-level database. For the period from 1942 to 1960, we use the Hall, Payne, and Sargent (2018) database[9] which provides quantities and description of all securities issued by the U.S. Treasury between 1776 and 1960. For the period from 1960 to 2021, we use the CRSP Monthly US Treasury Database which provides quantities and descriptions of marketable securities held by the public, excluding Treasury bills, issued by the U.S. Treasury since 1925.

Reverse Maturity Structures. Let us denote by s a uniquely identified security[10] which belongs to our database S of securities issued by the U.S Treasury. For each fiscal year t, we compute the sum of the total outstanding public debt at the end of year t to obtain $\tilde{D}_t$:

$$\tilde{D}_t = \sum_{s \in S} D_t^s \tag{8}$$

where D_t^s is the outstanding amount of security s held by the public at the end of fiscal year t. We compute the sum of total outstanding public debt by year and date of issuance[11] to

Holders cannot sell their rights to anybody else, though they may be used as collateral for loans from other financial institutions.

[9]Data are available at https://github.com/jepayne/US-Federal-Debt-Public.

[10]Securities are identified by either the L1ID variable in Hall et al. (2018) or the CRSPID variable in CRSP. Securities are uniquely identified by multiple characteristics, among which their maturity date, coupon rate, type of issue (Treasury bill, non-callable bond, callable bond, inflation-adjusted bonds, etc.), and uniqueness number. A uniqueness number is assigned to distinguish between otherwise similar securities issued at different dates.

[11]Using the variables FirstIssueYear in Hall et al. (2018) and TMFSTDAT in CRSP.

obtain $\tilde{D}_t^j$:

$$\tilde{D}_t^j = \sum_{s \in S} D_t^{s,j} \tag{9}$$

where $D_t^{s,j}$ is the outstanding amount of security s issued at $t - j$ and held by the public at time t. Using those variables, we compute w_t^j, the share of outstanding debt at the end of year t which was first issued at $t - j$, as:

$$w_{t-1}^j \equiv \tilde{D}_{t-1}^j / \tilde{D}_{t-1} \tag{10}$$

Ideally, the sum of securities contained in our database would match to the penny the aggregate official numbers reported by the OMB. This is not the case. Yet, the coverage of securities is overall excellent before 1960, using the Hall et al. (2018) database, and after 1960 for marketable debt using the CRSP database. The reserve maturity structure of total outstanding debt held by the public is shown in Figure 11. Note that we compute the different reverse maturity structures, for marketable, non-marketable, and TIPS securities by using all the securities issued by the U.S. Treasury and contained in our database. Because we do not have detailed information regarding non-marketable debt after 1960, we assume that the reversed maturity structure of non-marketable debt in any year t after 1960 is the same as the reversed maturity structure that prevailed in 1960. As discussed above, the share of non-marketable debt steadily decreased over time and only represented a small fraction of total debt held by the public, so reasonable changes to this assumption would not change our results.

Bills and TIPS. The share of TIPS z_t is computed by dividing aggregate TIPS securities at the end of fiscal year, obtained from the Treasury Bulletin, by the outstanding debt held by the public from the OMB. The variables s_{t-1} and z_{t-1}^j are computed using data from the Treasury Bulletin for the amount of Treasury bills, and the reversed maturity structures defined above. See Figure 22.

Effective Average Interest Rates. The average interest rate at time t, i_t, is computed by dividing total interest payments at time t by the outstanding amount of debt at $t-1$. For consistency with our measure of debt which excludes intergovernmental holdings, we define total interest payments as the gross interest paid on Treasury debt securities GI_t minus the interest received by trust funds[12] TF_t. The data for the interest expenditures are only available starting from 1962. Before 1962, we approximate total interest payment by net interest payments NI[13]. This series differs from our measure used after 1962 because it excludes the category 'Other Interest' payments OI_t. Using historical data, we find that on average the measure $GI_t - TF_t$ is about 10% higher than the net interest payments NI_t between 1962 and 2020. We use this approximation to compute the effective interest rate before 1962. The Appendix documents that this procedure is accurate in years when it can be checked against an exact measure of the interest paid by the Treasury and that it gives similar results to other reasonable approaches. We have:

$$i_t = \begin{cases} 1.1\frac{NI_t}{D_{t-1}} \text{ if } t < 1962 \\ \frac{GI_t - TF_t}{D_{t-1}} \text{ if } t \geq 1962 \end{cases} \tag{11}$$

where public debt D_{t-1} corresponds to the outstanding amount held by the public[14] at $t-1$, which is the sum of public debt held by private agents and the Federal Reserve system.

[12]Source: OMB, historical data. Table 3.2. series 901 Interest on Treasury Debt securities (gross), 902 Interest received by on-budget trust funds, and 903 Interest received by off-budget trust funds.

[13]Source: OMB, historical data. Table 3.2. series 900 Interest on Treasury Debt securities (net), computed as Interest on Treasury Debt securities (gross) minus Interest received by on-budget and off-budget trust funds minus Other Interest and Other Investment income.

[14]Source: OMB, historical data. Table 7.1. series Held by the Public (Total)

For the outstanding debt first issued during the peg period (1942-1951), we compute the average interest rate paid at time t on debt securities which were first issued in year $t-j-1$ as[15]:

$$i_t^{j+1} = \sum_{s \in S} i_t^{s,j+1} \frac{D_{t-1}^{s,j}}{\tilde{D}_{t-1}^{j}} \tag{12}$$

where $i_t^{s,j+1}$ is the interest rate of security s issued at $t-j-1$ and which pays interest at time t.

Primary Balance. We compute the primary balance P_t as the sum of the total fiscal balance[16] B_t and total interest payments using our measure of the interest rate i_t given by equation (11):

$$P_t = B_t + i_t D_{t-1} \tag{13}$$

Residual. To recover our exact debt dynamics, we compute the residual ϵ_t as:

$$\epsilon_t = D_t - (1 + i_t) D_{t-1} + P_t \tag{14}$$

where ϵ_t represents a residual from the above equality and the actual history for debt, interest rates and primary balances. In our counterfactual analysis, we will assume that $\hat{\epsilon}_t = \epsilon_t \; \forall t$, i.e. that the residual remains the same as in actual history. This will allow us to make different assumptions regarding the primary balance in our counterfactual in an internally consistent manner.

[15]We use the variables CouponRate in Hall et al. (2018) as the measure of $i_t^{s,j+1}$. We complement the information contained in the CouponRate variable, whenever it is missing, with data from Friedman and Schwartz and the maturity of the security. Indeed, during the peg years, the interest rates were pegged by maturity. Thus, for each security issued during the peg years, we use the InitialMaturity variable, computed as the PayableDate minus the FirstIssueDate, to determine its coupon rate.

[16]The source for the total fiscal balance B_t is OMB.

4.2 Fiscal Data: Additional Remarks

The data from Hall et al. (2018) on outstanding debt held by the public covers the entire universe of government securities up to 1960[17]. After 1960, we use the CRSP database which only contains information on marketable non-bills securities[18][19]. As we assume that Treasury bills are perpetually rolled over and not affected by unexpected inflation, we only need aggregate, not security-level, data regarding the outstanding amount of bills at the end of each fiscal year[20]. Hall provides an online database, available on his website, which reports the par value and market value of the debt from January 1790 to September 2021, and has a decomposition between marketable and non-marketable debt held by the public. The aggregate data contained in that database (the sum of marketable and non-marketable debt) are very close to the data reported by the OMB (see Figure 18 in Appendix).

We assume that the reverse maturity structure of non-marketable debt remains constant after 1960[21]. Note that the share of non-marketable debt in total interest-bearing debt held by the public decreased from 23% in 1960 to 9% in 1996, with a short-lived peak at 27% in 1973-1974.

We emphasize that we focus on the par value of the debt, and that our counterfactual indicates what would have happened if the interest payments in the government accounting were not distorted and indexed for inflation. This gives us a counterfactual for the evolution of the par value of debt. Like the government, we ignore capital gains and losses from

[17] Total debt held by the public obtained by adding up all the securities in the Hall et al. (2018) data do not match to the penny total debt in aggregate OMB data, but the discrepancies are small. See Figure 19.

[18] The securities covered in CRSP add up to an amount which is lower than the aggregate reported by the OMB because CRSP reports the debt held by private agents only, i.e. CRSP excludes amounts held by Federal reserve banks, while in official data debt held by the public includes amounts held by the Federal reserve banks.

[19] Figure 25 confirms that the reverse maturity structure of the debt does not substantially change across the two data-sets for the fiscal year 1960, the only year during which they overlap.

[20] Source: https://fraser.stlouisfed.org/title/treasury-bulletin-407/september-1979-6993/federal-debt-410822.

[21] The reserve maturity structures of marketable and non-marketable are different before 1960.

changes in the market value of the debt. Hall and Sargent (2011) use instead the market value of the debt. Yet, as shown in Figure (26) in Appendix, given the relatively small difference between the par value and the market value of the debt, using one definition or the other would not change our main results. Note that we assume that nominal GDP and inflation remain unchanged in our counterfactual, independently of our adjusted interest rate or primary balance.

4.3 Inflation and Inflation Expectations

The main sources for our inflation and inflation expectations variables are the Livingston survey, the SPF, and the Fed.

Inflation Rate. Our measure of the actual inflation rate uses the quarterly GDP price index from the the National Income and Product Accounts (NIPA) tables by the Bureau of Economic Analysis available from 1947Q1[22]. We complement those data with the GNP inflation rate from the NBER "American Business Cycle" dataset from fiscal year 1942 to 1947. As Figure 4 shows, the two measures are very close for the years during which both are available. The GDP deflator inflation rate in a given fiscal year t is from the last quarter of fiscal year $t-1$ to the last quarter of fiscal year t. We provide more details in the Appendix[23]. We have:

$$\pi_t^{GDP} = (P_t^{GDP}/P_{t-1}^{GDP}) - 1 \tag{15}$$

where π_t^{GDP} is the GDP deflator inflation rate in fiscal year t and P_t^{GDP} is the GDP price

[22] Downloaded from: FRED database.

[23] In particular, we put into special consideration the period from July 1st, 1976 to September 30th, 1976, known as the Transitional Quarter, henceforth abbreviated as TQ. In this paper, we treat TQ as a separate Fiscal period, between fiscal years 1976 and 1977.

level index in the last quarter of fiscal year t.

We will also use the quarterly Consumer Price Index from the U.S. Bureau of Labor Statistics[24], and available from 1942Q1. Using the same notation as before, we compute the CPI inflation rate in fiscal year t as:

$$\pi_t^{CPI} = P_t^{CPI} / P_{t-1}^{CPI} - 1 \tag{16}$$

Short-term Inflation Expectations. We define short-term inflation expectations π_t^{eS} as the expectations made in the last quarter of fiscal year t for the inflation rate in the following year. We denote this 1-year ahead expected inflation rate as:

$$\pi_t^{GDP,eS} \equiv \mathbb{E}_t[\pi_{t+1}^{GDP}] \tag{17}$$

Our data for this 1 year-ahead or 'short-term' inflation expectations come from two different surveys. For fiscal years $1970 \leq t \leq 2021$, we use the median growth rate forecast of the GDP price index from the Survey of Professional Forecasters[25]. Specifically, we use the 4-quarter ahead expectations formed in the last quarter of each fiscal year between 1970 and 2021.

Since data on GNP/GDP deflator inflation expectations begin only from fiscal year 1970, we exploit the information from the CPI inflation forecasts for fiscal years 1951 to 1969. We use CPI inflation forecasts from the June edition of the semiannual Livingston Survey, compiled by the Federal Reserve Bank of Philadelphia. The June survey is conducted 2 months in advance, i.e. in April, for the 14-month expected CPI inflation rate, from which

[24] Downloaded from FRED database.

[25] Data are available at the Survey of Professional Forecasters website at the Federal Reserve Bank of Philadelphia. Note that the SPF provides the GNP deflator 1-year inflation forecast up until 1991, and the GDP deflator 1-year inflation forecast starting from 1992. Yet, as Figure 4 shows, the GNP and GDP deflator measures are very close for the years during which both are available, so we consider them as equivalent.

the 1-year (annualized) expected CPI inflation rate is calculated as[26]:

$$\pi_t^{CPI,eS} = \left(\frac{\mathbb{E}_{t,April}\left[P_{t+1,June}^{CPI}\right]}{P_{t,April}^{CPI}} \right)^{12/14} \quad \text{for } 1951 \le t \le 1969 \tag{18}$$

In order to compute the short-term GDP deflator inflation expectations before 1970, we make the assumption that short-term expectations errors of the CPI inflation rate are equivalent to short-term expectations errors of the GDP deflator inflation rate from FY1951 to FY1969[27]. We have:

$$\mathbb{E}_{t-1}\left[\pi_t^{GDP}\right] = \pi_t^{GDP} + \left(\mathbb{E}_{t-1}\left[\pi_t^{CPI}\right] - \pi_t^{CPI}\right) \text{ for } 1951 \le t \le 1969 \tag{19}$$

where $E_{t-1}[\pi_t^{GDP}]$ is the one year-ahead expected GDP deflator inflation rate in year $t-1$, $E_{t-1}[\pi_t^{CPI}]$ is the one year-ahead expected CPI inflation rate in year $t-1$, and π_t^{GDP} and π_t^{CPI} are, respectively, the GDP deflator inflation and the CPI inflation rate in fiscal year t.

Long-term Inflation Expectations. We define long-term inflation expectations in the last quarter of fiscal year t, $\pi_t^{GDP,eL}$, as the average of the expected annual inflation rates for the next 10 years:

$$\pi_t^{GDP,eL} \equiv \frac{1}{10}\sum_{j=1}^{10} \mathbb{E}_t[\pi_{t+j}^{GDP}] \tag{20}$$

Equivalently, we denote this as the 10-year expected annual average inflation rate. We use the quarterly FRB/US 10-year annual average PCE inflation forecasts, available from 1968, and again assume that long-term or 10 year-ahead expected annual average PCE inflation

[26] See the Livingston documentation for the Median CPI computation on page 15 using the variable $G\_BP\_To\_12M$.

[27] we provide evidence in chart 29 in Appendix that this is a reasonable assumption to make.

rate forecasts are equivalent to GDP deflator inflation rate forecasts.[28]

In order to extend the long-term inflation expectations series back to 1951, we regress the difference between the long-term and the HP filtered short-term GDP deflator expectations on the change in the HP filtered short-term GDP deflator expectation for the period between 1968 and 1997, and obtain the fitted values for long-term GDP deflator expectation for the period from 1951 to 1967. More details are provided in Appendix[29].

Term Structure of Inflation Expectations. This subsection describes our procedure to obtain GDP deflator inflation expectations for different horizons, using both the short-term (1-year ahead) and long-term (average over the next 10 years) inflation forecasts defined above. To obtain our estimates, we assume that inflation expectations adjust linearly for the first 5 years, then remain constant after 5 years.

More specifically, we have:

$$\mathbb{E}_t[\pi_{t+j}^{GDP}] = \pi_t^{GDP,eS} + (j-1)k_t \text{ for } 2 \le j \le 5 \tag{21}$$

$$\mathbb{E}_t[\pi_{t+j}^{GDP}] = \mathbb{E}_t[\pi_{t+5}^{GDP}] \text{ for } j > 5 \tag{22}$$

where $k_t = (\pi_t^{GDP,eL} - \pi_t^{GDP,eS})/3$, and $\mathbb{E}_t[\pi_{t+j}^{GDP}]$ is the expected inflation for year $t+j$ made in year t. See Figure 7. More details in Appendix[30].

[28] As shown in Figure 4, the actual GDP deflator inflation rate and the actual PCE price index inflation rate are similar to each other, thereby allowing us to assume that PCE inflation rate forecasts are equivalent to GDP deflator forecasts.

[29] We apply the HP filter on short-term expectations for the entire sample from 1950 to 2021. The smoothing parameter λ is set to 100. The regression results are presented in Appendix.

[30] We are careful about expectations made up to 5 years before the TQ regarding inflation expectations after the TQ. Therefore, to be consistent with the fiscal years and the TQ, we have to compute the expected inflation rate for fiscal years from 1972 to 1976 using quarterly increments instead of annual increments. We describe this ‘quarterly’ procedure in Appendix.

4.4 Ex-Ante Real Interest Rate

We define $\tilde{r}_t^{j+1}$ as the average ex ante real interest rate on debt securities outstanding at $t-1$ and which were first issued in year $t-1-j$. In our baseline calibration, it is computed by assuming that ex-ante real interest rate on debt securities issued during the peg period (1942-1951) before the Fed-Treasury Accord of March 1951 was equal to the average ex-ante real rate for debt securities with similar maturity issued between 1951 and 1960. Our procedure is as follows.

For every fiscal year, we collect data from the Global Financial Database on i_t^m, the average nominal yield by maturity on U.S. public debt securities at issuance. More specifically, for every fiscal year from 1951 to 1960, we compute the average yield on 1-year, 2-year, 3-year, 5-year, 7-year, 10-year and 30-year securities. Then, we compute the ex-ante real yield by fiscal year as the difference, for each of those 7 maturities, between the nominal yields i_t^m and the average expected inflation rate over the same maturity $\mathbb{E}_t[\pi_m^{GDP}]$. We have:

$$\tilde{r}_{t,m} = i_t^m - \mathbb{E}_t[\pi_m^{GDP}] \tag{23}$$

where $\mathbb{E}_t[\pi_m^{GDP}] = \frac{1}{m}\sum_{k=1}^{m}\mathbb{E}_t[\pi_{t+k}^{GDP}]$, and $\mathbb{E}_t[\pi_{t+k}^{GDP}]$ is the expected inflation for year $t+k$ made in year t, as described in the previous subsection. Lastly, we take the average of the obtained ex-ante real yield by maturity over 1951-1960 and denote it $\tilde{r}_m$. we have:

$$\tilde{r}_m = \frac{1}{10}\sum_{t=1951}^{1960}\tilde{r}_{t,m} \tag{24}$$

See Figure in Appendix for the ex ante real yield curve. The numbers range from 1.4% at 1-year to 2.1% at 5-year, and 2.5% and 2.65% at, respectively, 10-year and 30-year horizons. Using averages over the entire sample gives similar results.

Because we only have data for a few maturities, we obtain the entire yield curve, i.e.

$\tilde{r}_m \; \forall m \in [1, 30]$, by linear interpolation. For example, $\tilde{r}_4 = \frac{\tilde{r}_3 + \tilde{r}_5}{2}$. Moreover, we assume that $\tilde{r}_m = \tilde{r}_{30} \; \forall m > 30$. Then, we compute the weights $v_t^{m,j+1}$ which represent the share of debt securities with maturity m in debt securities outstanding at time $t-1$ and which were first issued in year $t-1-j$.

Finally, we obtain:

$$\tilde{r}_t^{j+1} = \sum_{m \in M} \tilde{r}_m v_t^{m,j+1} \tag{25}$$

This measure of ex-ante real interest rate will be used to adjust the interest rate on debt issued during the peg period.

5 Results

In this section we provide our counterfactual debt dynamics using different hypotheses. In our baseline analysis, we provide counterfactual debt dynamics assuming either both non-distorted real interest rate and primary balances equal to zero, or assuming one without the other. In an alternative analysis, we perform a similar exercise but do not adjust real interest rates for debt securities issued during the peg period. This allows us to quantify the role played by distortions associated with the peg. We start our analysis in 1946, the year during which the debt-to-GDP ratio reached its post WWII peak at 106%. We then perform our analysis from 1947 through 2021 by applying the procedure described in the previous sections.

Our main results are shown in Figure 13, which shows the actual debt dynamics, and two counterfactual scenarios with no real interest rate distortions and both no real interest rate distortions and a balanced primary budget. As shown by the blue line in this figure, there are two distinct periods to be considered. The first one goes from 1946 to 1974, which corresponds to the year when the debt-to-GDP ratio reached its trough at 23%. The second corresponds to the debt buildup which followed 1974. We consider those two periods in turn.

5.1 Post WWII Erosion of Debt, 1947-1974

Figure 14 shows the effects of primary surpluses and real interest rate distortions. We find that both primary surpluses and real interest rate distortions were important factors in driving down the debt-to-GDP ratio after WWII. Yet, the latter was more important than the former in driving down the debt-to-GDP ratio. Under our baseline calibration, we estimate that the public debt-to-GDP ratio would only have declined from 106% in 1946 to 73%, instead of 23%, in 1974 if primary balances had always been equal to zero and there were no real interest rate distortions. This 33 percentage points decrease in then debt-to-GDP ratio corresponds to the part explained by growth rates exceeding equilibrium ex ante real rates, i.e. negative $r - g$. The other 50 percentage points of the decrease in the debt-to-GDP ratio is explained by both primary surpluses and real interest rates distortions. More specifically, primary surpluses accounted for 17 percentage points (pp), real interest rate distortions for 27 pp, and their combined effect for 6 pp.

Figures 15 and 16 show a counterfactual analysis for which we do not adjust real interest rates for debt securities issued during the peg period. The stark difference between those results and the ones obtained in our baseline scenario emphasize the importance of financial repression—the combination of both below market nominal rates and high unexpected inflation after the removal of price controls—in driving down the debt-to-GDP ratio post WWII. The actual debt-to-GDP ratio declined from 66% in 1951 to 23% in 1974. Absent real interest rate distortions on debt issued after the peg, the debt-to-GDP ratio would have declined to 31% in 1974.

Tables 1 and 2 provide a decomposition of the average effective interest rate adjustment x_t by reverse maturity. This table shows the importance of real interest rate distortions in the two years which immediately followed the end of the war in driving down the debt-to-GDP ratio. The average effective interest rate adjustment x_t was equal to 9.5% and 13%, respectively, in 1946 and 1947. Given that the debt-to-GDP ratio was equal to 106% in 1946, the distortions in those two years alone contributed to reduce the debt-to-GDP ratio by more than 20 percentage points. There was also some important liquidation of the debt in 1951, which marks the signature of the Fed-treasury accord. In the late 60s to mid-70s (and up to the early 1980s) there were also important distortions, which mainly affected debt with long reverse maturity (issued more than 5 years ago), while the adjustment mainly affected debt with short reverse maturity during the peg period.

5.2 The Debt Buildup, 1974-2021

We extend our counterfactual analysis of the debt after 1974, assuming primary balances had always been equal to zero and there were no real interest rate distortions. Debt has risen most of the time since 1974, and in particular after 2008, and stood at 110% in 2021. This largely reflects a reversal in factors that reduced the debt-to-GDP ratio before that date. In particular, inflation rates turned from being systematically above their expectations before 1980 to being systematically below their expectations after 1980 as Volcker initiated a long decline in inflation through high short-term rates (see Figures 8 and 10). Moreover, primary deficits since 2008 fueled the dramatic increase in the debt-to-GDP ratio over the past 20 years.

Over whole sample, the net effect of interest rate distortions has been to reduce the debt below its counterfactual with no distortions. Strikingly, if we remove the distortions to the debt issued during the peg, then the net effect of rate distortions over the whole sample shrinks to zero (the red and blue lines on Figure 15 are very close towards the end of the sample). While interest rates distortions contributed to reduce the debt before 1980, they started to increase the debt burden after 1980 as inflation remained below its expected value. As seen in Table 2, the average effective interest rate adjustment was negative for most years in the 1980s. The adjustment in 2021 was about 2%, in stark difference with recent values, but far below its pre-1980s average. Surpluses in the primary balance have on net contributed to reduce the debt up to 2010. However, because of large primary deficits since 2008, the net effect of deviations from primary balance over the whole sample is to raise the debt.

5.3 Takeaways

We draw three main lessons from our exercise. First, financial repression—the combination of both below market nominal rates and high unexpected inflation after the removal of price controls—played a major role in quickly driving down the debt-to-GDP ratio up to 1951. The debt-to-GDP ratio went down from 106% in 1946 to 66% in 1951. We estimate that absent real rate distortions, the debt-to-GDP ratio would only have declined to 87% in 1951. Moreover, the primary surpluses also played a major role in decreasing the debt-to-GDP ratio. We estimate that absent real rate distortions and primary surpluses, the debt-to-GDP ratio would only have declined to 102% in 1951. Thus the rapid drop of 40 percentage points in the debt-to-GDP ratio between 1946 and 1951 is almost entirely explained by interest rate distortions and high primary surpluses, not by negative $r - g$.

Second, we find that the debt-to-GDP ratio would have persistently remained well above its pre-war level of 47% and reached 91% in 2021 under our baseline calibration. Put differently, the U.S. would not have grown its way out of its WWII debt without interest rate distortions and primary surpluses. This fact is important to bear in mind in thinking about lessons for the future. We argue that the common view that the U.S. may be able to costlessly 'grow its way out of debt' as it did after WWII should be interpreted very carefully.

As our results show, it is not so easy to grow out of debt without distorting real interest rates, even after 75 years and with no primary deficits.

Third, in our counterfactual scenarios with primary balance equal to zero, the debt-to-GDP ratio rose after 1980, and either stabilized after 2009 if we assume no interest rate adjustment, or even decrease after 2009 if we assume no interest rate distortions (because of negative surprise inflation). This result is relevant for the debate over the generality of $r < g$. It is true that the inequality holds over the entire sample, but this is due entirely to the period before 1980. Since 1980, we have $r > g$ on average, i.e. a rising debt-to-GDP ratio even if primary balances are equal to zero (though much less than in reality with important primary deficits).

This may seem inconsistent with Blanchard (2019). However, we should emphasize two main differences relative to his study. First, Blanchard uses market rates and treatment of taxes, while we measure the average effective interest rate on debt (which accounts for the reverse maturity structure). Second, we adjust for real interest rate distortions. Thus while Blanchard looks at ex-post interest rates, our focus is on ex-ante non-distorted real interest rates. Lastly, we reproduce the exercise performed by Blanchard and find a very different result. See Figure 17.

6 Conclusions

In this paper, we re-examine the roles played by primary surpluses and real interest rate distortions–through both pegged nominal interest rates before the Fed-Treasury Accord of 1951 and surprise inflation in the 1960s and 70s–in driving down the debt ratio.

We find that both primary surpluses and real interest rate distortions were important factors in driving down the debt-to-GDP ratio after WWII. Under our baseline calibration, we estimate that the public debt-to-GDP ratio would only have declined from 106% in 1946 to 102% (instead of 66%) in 1951, and to 73% (instead of 23%) in 1974 if primary balances had always been equal to zero and there were no real interest rate distortions. Moreover, we estimate that the public debt-to-GDP ratio would only have declined from 106% in 1946 to 87% in 1951, and to 51% in 1974 if there were no real interest rate distortions. We conclude that financial repression—the combination of both below market nominal rates and high unexpected inflation after the removal of price controls—played a major role in quickly driving down the debt-to-GDP ratio up to 1951.

Strikingly, under our baseline calibration, we find that the debt-to-GDP ratio would have persistently remained well above its pre-war level of 47% and reached 91% in 2021. Put differently, the U.S. would not have grown its way out of its WWII debt without interest rate distortions and primary surpluses. This is in sharp contrast with the message from Blanchard's influential presidential address to the AEA. This fact is important to bear in mind in thinking about lessons for the future. We argue that the common view that the U.S. may be able to costlessly 'grow its way out of debt' as it did after WWII should be interpreted very carefully. As our results show, it is not so easy to grow out of debt without distorting real interest rates, even after 75 years and with no primary deficits.

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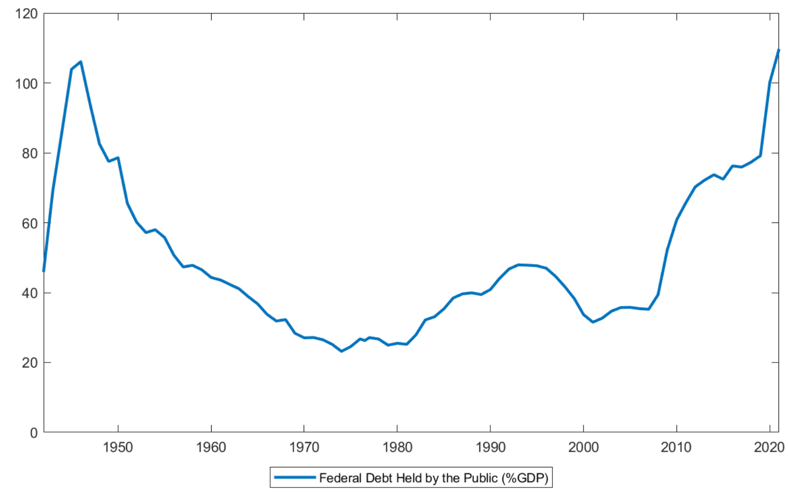
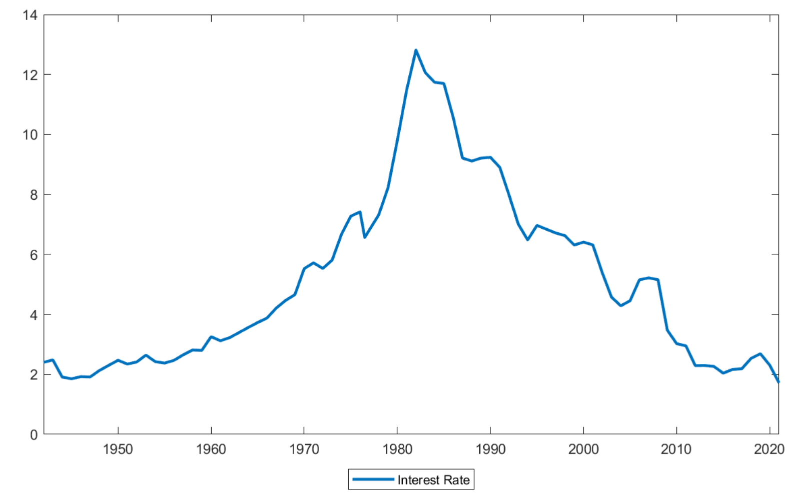
A Appendix - Charts

Figure 1 Federal Debt Held by the Public as a Percent of GDP: D_t



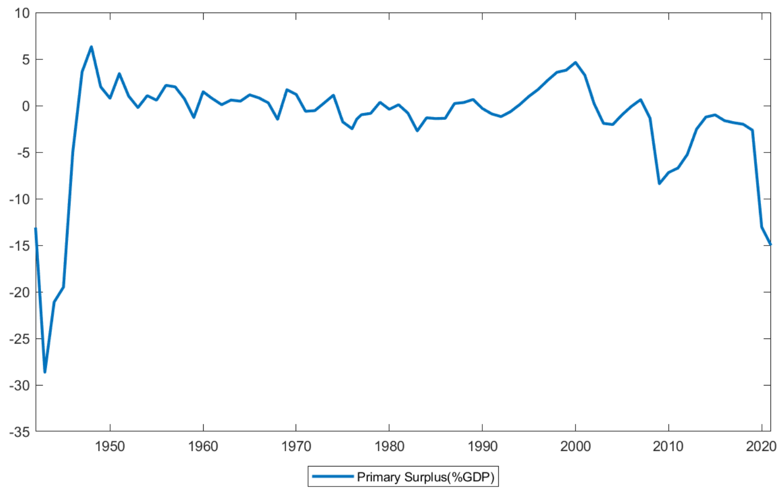
Note. The line represents the ratio of the par value of outstanding Treasury securities held by the public to GDP. Source: OMB.

Figure 2 Effective Annual Interest Rate on Debt Held by Public: i_t



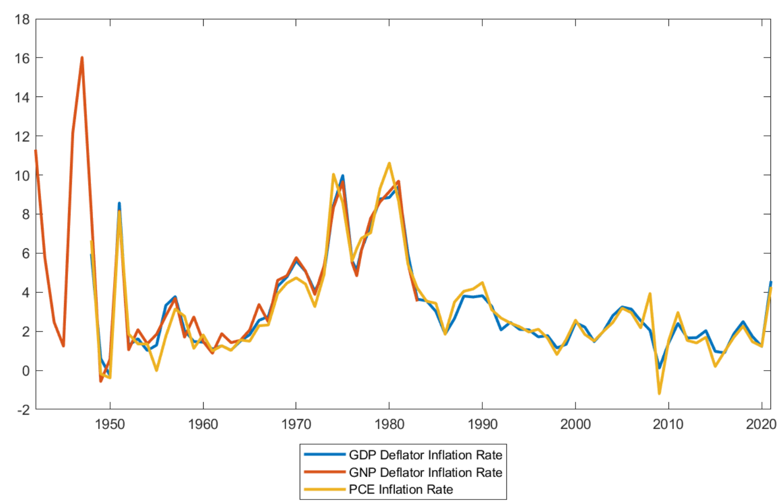
Note. The line represents the effective annual interest rate on debt held by the public. This measure is computed as interest payment in a year divided by the outstanding debt in the previous year. As discussed in the main text, this series is extended before 1962. Source: OMB, MSPD.

Figure 3 PRIMARY BALANCE AS A PERCENT OF GDP: P_t



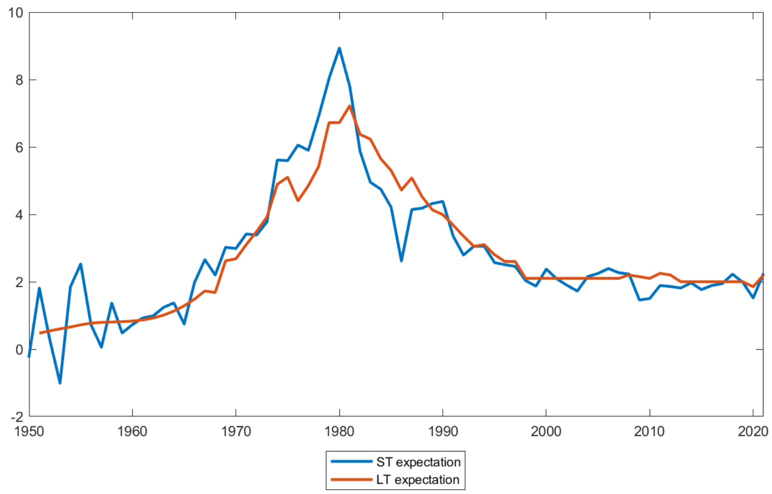
NOTE. The line represents the ratio of the primary balance to GDP. It is computed as the ratio of the sum of the total fiscal balance plus interest payment to GDP. Source: OMB, authors' calculations.

Figure 4 GDP DEFLATOR (1948-2021) AND GNP INFLATION (1942-1983): π_t^{GDP}



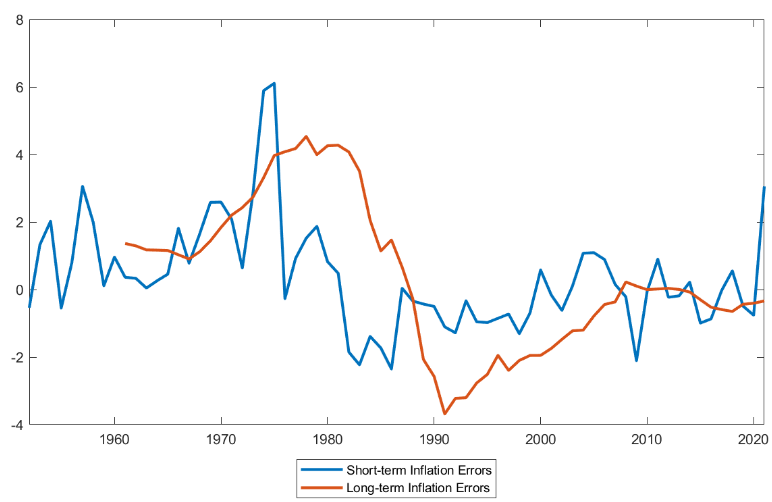
NOTE. The blue, orange, and yellow lines represent, respectively, the GDP deflator inflation rate, the GNP deflator inflation rate, and the PCE inflation rate. Sources: Bureau of Economic Analysis, NBER "The American Business Cycle" Database.

Figure 5 SHORT-TERM AND LONG-TERM INFLATION EXPECTATIONS TIME SERIES: $\pi_t^{GDP,eS}$ AND $\pi_t^{GDP,eL}$



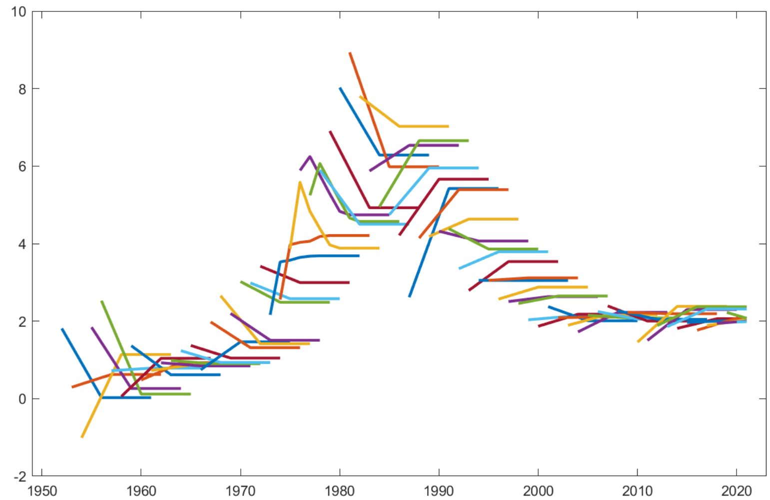
NOTE. Sources: Livingston Survey, Survey of Professional Forecasters, Federal Reserve Bank of New York FRB/US Model, authors' calculations.

Figure 6 SHORT-TERM AND LONG-TERM INFLATION EXPECTATIONS ERRORS



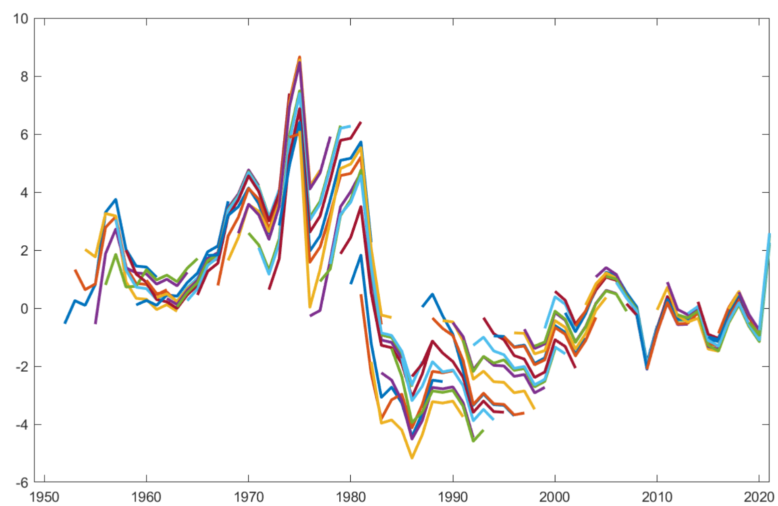
NOTE. Sources: Livingston Survey, Survey of Professional Forecasters, Federal Reserve Bank of New York FRB/US Model, authors' calculations. The short-term expectations errors are computed as: $\pi_t^{GDP} - \pi_{t-1}^{GDP,eS}$. The long-term expectations errors are computed as: $\frac{1}{10}\sum_{j=0}^{9}\pi_{t-j}^{GDP} - \pi_{t-10}^{GDP,eL}$. Variables are defined in the Data section.

Figure 7 Term Structure of Inflation Expectations: $\mathbb{E}_{t-1-j}[\pi_t]$



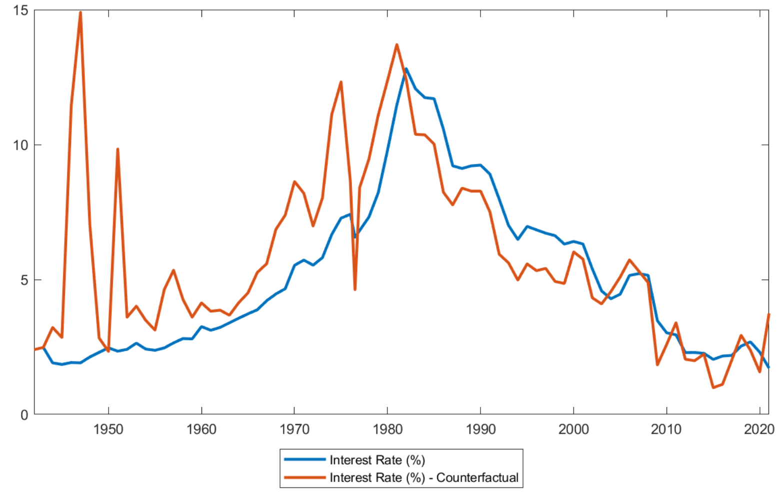
Note. Each line indicates inflation expectations made at the year previous to the beginning of the line. For example, the line beginning at 1952 indicates inflation expectations formed at 1951. Sources: Livingston Survey, Survey of Professional Forecasters, Federal Reserve Bank of New York FRB/US Model, authors' calculations.

Figure 8 Inflation Surprises: $\pi_t - \mathbb{E}_{t-1-j}[\pi_t]$



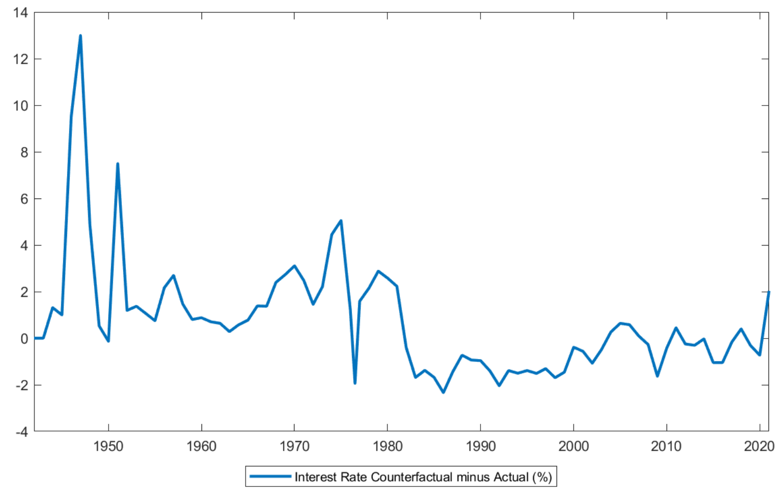
Note. Each line indicates the inflation expectation errors from expectations made at the year previous to the beginning of the line. Sources: Livingston Survey, Survey of Professional Forecasters, Federal Reserve Bank of New York FRB/US Model, authors' calculations.

Figure 9 Effective Average Interest Rate: Actual i_t versus Counterfactual $\hat{i}_t$



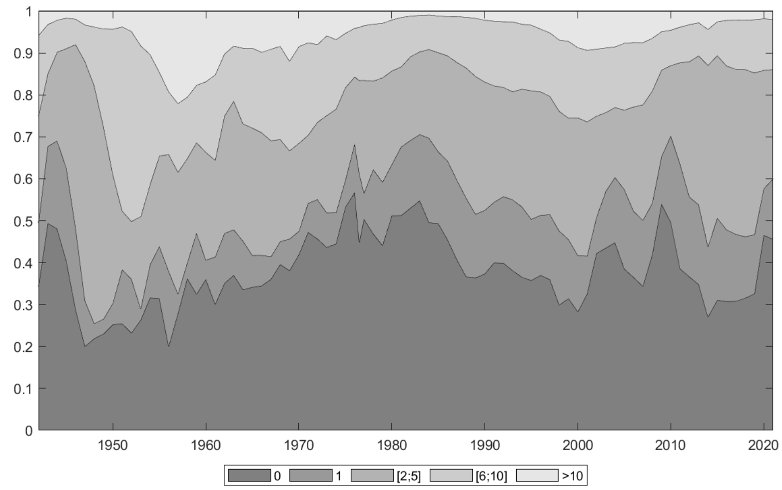
Note. The lines represent the average effective interest rate on debt held by the public and its counterfactual. Source: Authors' calculations.

Figure 10 Effective Interest Rate Differential: x_t



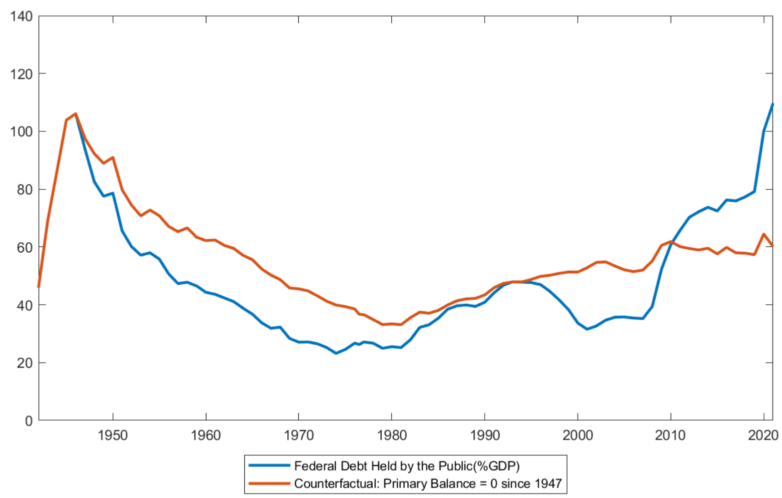
Note. The line represents the difference between the counterfactual and actual average effective interest rate on debt held by the public. Source: Authors' calculations.

Figure 11 Reverse Maturity Structure of All Public Debt: w_{t-1}^j



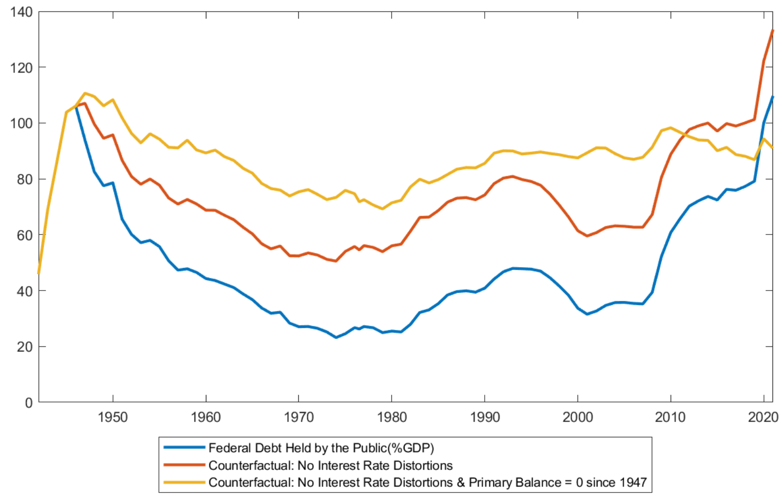
Note. This chart represents the reverse maturity structure of total outstanding debt held by the public. The different shades represent the share of the outstanding debt held by the public at the end of fiscal year t which was issued in the same year, last year, 2 to 5 years ago, 6 to 10 years ago, and more than 10 years ago. Lighter shades are associated with longer reverse maturity. Source: Authors' calculations.

Figure 12 Actual D_t and Counterfactual $\hat{D}_t$ Debt Dynamics: Primary Balance Adjustment



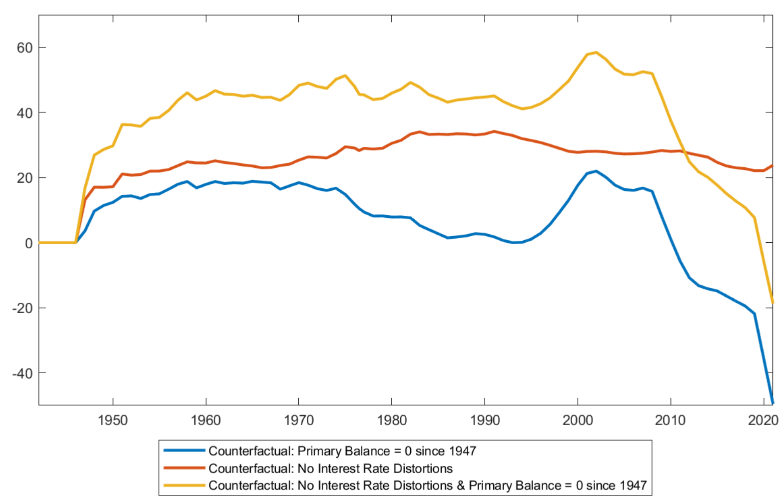
Note. The lines represent the the ratio of the par value of outstanding Treasury securities held by the public to GDP and its counterfactual assuming a primary balance equal to zero for every fiscal year starting from 1947. Source: Authors' calculations.

Figure 13 Actual D_t and Counterfactual $\hat{D}_t$ Debt Dynamics: Real Rates and Primary Balance Adjustments



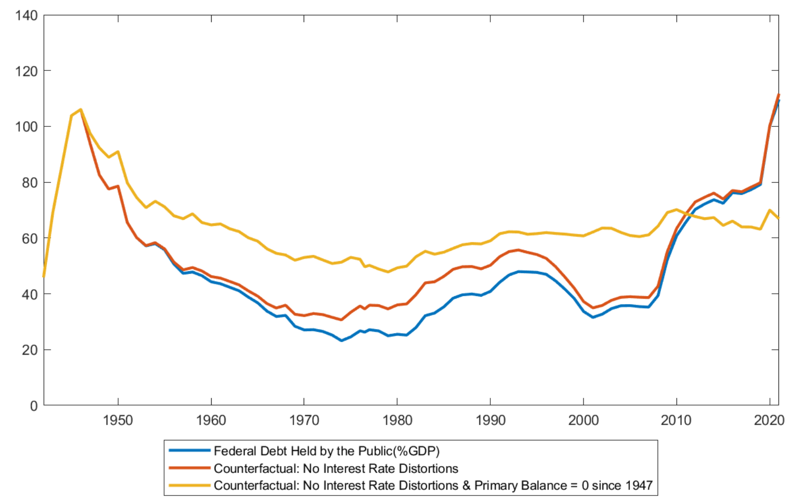
Note. The lines represent the the ratio of the par value of outstanding Treasury securities held by the public to GDP and its counterfactual assuming no interest rate distortions alone, and both no interest rate distortions and a primary balance equal to zero for every fiscal year starting from 1947. Source: Authors' calculations.

Figure 14 Difference in Debt Dynamics



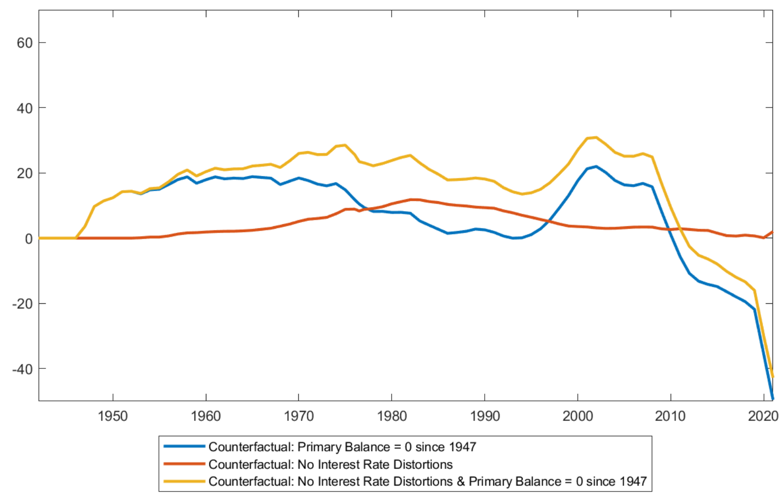
Note. The lines represent the differences in percentage points between our counterfactual estimates and the actual debt to GDP ratio. Source: Authors' calculations.

Figure 15 ACTUAL D_t AND COUNTERFACTUAL $\hat{D}_t$ DEBT DYNAMICS: PRIMARY BALANCE AND POST ACCORD REAL RATES ADJUSTMENTS



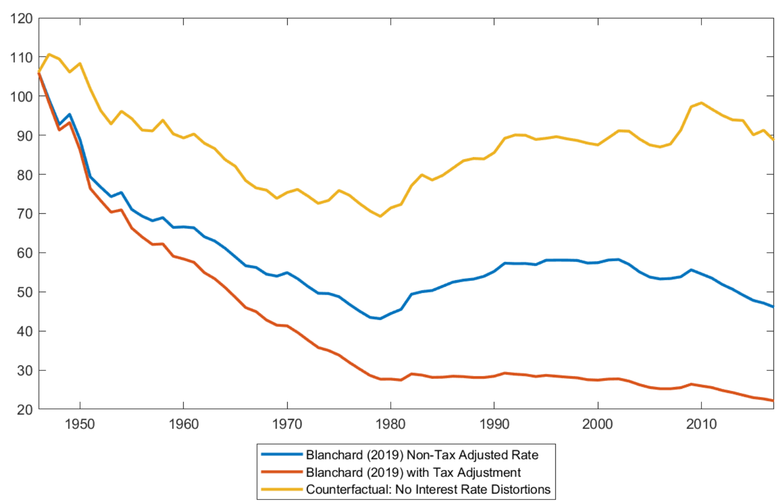
NOTE. The lines represent the the ratio of the par value of outstanding Treasury securities held by the public to GDP and its counterfactual assuming no interest rate distortions for debt issued after the Fed-Treasury Accord, and both no interest rate distortions for debt issued after the Fed-Treasury Accord and a primary balance equal to zero for every fiscal year starting from 1947. Source: Authors' calculations.

Figure 16 Difference in Debt Dynamics:
Primary Balance and Post Accord Real Rates Adjustments



Note. The lines represent the differences in percentage points between our counterfactual estimates and the actual debt to GDP ratio, assuming no interest rate distortions for debt issued after the Fed-Treasury Accord. Source: Authors' calculations.

Figure 17 Debt Dynamics, with Zero Primary Balance, starting in 1947



Note. The lines represent our counterfactual debt dynamics versus a replication of the debt dynamics in Figures 5 and 6 from Blanchard (2019) Source: Authors' calculations.

Table 1 Decomposition of the Average Effective Interest Rate Adjustment x_t
Selected Years post WWII

Variable	**j**	**1946**	**1947**	**1948**	**1951**	**1957**	**1969**	**1970**	**1974**	**1975**
$\mathbf{x_t}$		9.51	12.99	4.90	7.50	2.69	2.73	3.11	4.45	5.05
$x_t^{j+1} w_{t-1}^j$	0	4.99	4.63	1.20	2.27	0.33	0.45	0.35	0.84	0.85
	1	2.76	3.15	0.66	0.44	0.33	0.13	0.27	0.41	0.45
	[2:5]	1.76	5.22	3.05	2.64	0.89	0.88	0.86	1.37	1.71
	> 5	0.00	0.00	0.00	2.14	1.15	1.27	1.62	1.83	2.04
w_{t-1}^j	0	0.29	0.20	0.22	0.25	0.28	0.38	0.42	0.45	0.53
	1	0.19	0.11	0.04	0.13	0.05	0.08	0.06	0.07	0.06
	[2:5]	0.44	0.57	0.57	0.14	0.29	0.21	0.21	0.25	0.22
	> 5	0.08	0.12	0.18	0.48	0.38	0.33	0.32	0.23	0.18
x_t^{j+1}	0	17.34	23.09	5.47	8.92	1.16	1.17	0.83	1.89	1.60
	1	14.25	28.96	18.40	3.43	7.25	1.75	4.88	5.47	6.96
	[2:5]	4.01	9.15	5.37	18.91	3.05	4.16	4.10	5.53	7.73
	> 5	0.00	0.00	0.00	4.49	2.99	3.82	5.15	7.84	11.18

Note. The table provides a decomposition of the average effective interest rate adjustment x_t for selected years. The years shows corresponds to the ones for which the adjustment x_t was above the average adjustment x_t over the period 1946-1975. Source: Authors' calculations.

Table 2 Decomposition of the Average Effective Interest Rate Adjustment x_t
Selected Years post 1975

Variable	**j**	**1979**	**1980**	**1981**	**1983**	**1984**	**1985**	**1986**	**1987**	**2021**
$\mathbf{x_t}$		2.88	2.58	2.23	-1.69	-1.38	-1.68	-2.34	-1.45	2.03
$x_t^{j+1} w_{t-1}^j$	0	0.38	0.16	0.11	-0.51	-0.34	-0.38	-0.56	0.01	0.69
	1	0.50	0.37	0.22	-0.64	-0.39	-0.48	-0.55	-0.36	0.29
	[2:5]	1.00	1.13	1.07	-0.56	-0.62	-0.73	-1.02	-0.85	0.71
	> 5	1.00	0.93	0.83	0.02	-0.02	-0.09	-0.21	-0.24	0.34
w_{t-1}^j	0	0.44	0.51	0.51	0.55	0.50	0.49	0.45	0.41	0.46
	1	0.15	0.12	0.16	0.16	0.20	0.17	0.19	0.19	0.14
	[2:5]	0.25	0.22	0.19	0.20	0.21	0.24	0.25	0.28	0.26
	> 5	0.16	0.14	0.13	0.10	0.09	0.10	0.11	0.12	0.14
x_t^{j+1}	0	0.87	0.30	0.22	-0.93	-0.70	-0.78	-1.23	0.02	1.52
	1	3.28	3.02	1.36	-4.06	-1.94	-2.78	-2.90	-1.91	1.99
	[2:5]	4.03	5.06	5.60	-2.82	-2.93	-3.08	-4.08	-3.04	2.74
	> 5	6.27	6.49	6.21	0.22	-0.27	-0.96	-1.94	-1.96	2.43

Note. The table provides a decomposition of the average effective interest rate adjustment x_t for selected years. Source: Authors' calculations.

B Appendix - Methodology

B.1 Counterfactual Debt Dynamics

This section describes the procedure used to compute our counterfactual debt dynamics. In this paper, $X_T^{s,J,t}$ will refer to the value of a variable X at time T regarding a public debt security s of type t which was first issued during year $T-J$.

Our objective is to compare actual debt dynamics to a counterfactual with non-distorted real interest rates (i.e. no inflation surprises and no nominal interest rate peg), and different primary surpluses. The actual debt dynamics is given by:

$$D_t = (1 + i_t)D_{t-1} - P_t + \epsilon_t \tag{1}$$

where D_t is the debt held by the public at the end of t, i_t is the average effective interest rate on the debt held by the public, P_t is the primary balance in t, and ϵ_t represents a residual which makes the equation hold exactly[31]. Our counterfactual debt dynamics is given by:

$$\hat{D}_t = (1 + \hat{i}_t)\hat{D}_{t-1} - \hat{P}_t + \hat{\epsilon}_t \tag{2}$$

where we use the notation $\hat{}$ to denote the value of a variable in the counterfactual scenario. We assume that $\hat{\epsilon}_t = \epsilon_t \ \forall t$. In the counterfactual analysis section, we will assume different paths for the primary balance. We define the average effective interest rate adjustment as:

$$x_t \equiv \hat{i}_t - i_t \tag{3}$$

The outstanding debt at the end of year t can be written as the sum of the outstanding debt at the end of year t which was first issued during the year $t-j$:

$$D_t = \sum_{j=0}^{M} D_t^j \tag{4}$$

where M is the maximum reverse maturity of the outstanding debt securities and D_t^j is the amount of debt securities outstanding at the end of year t which were first issued in year $t-j$.

Outstanding debt can further be decomposed between marketable and non-marketable debt:

$$D_t = D_t^m + D_t^{nm} = \sum_{j=0}^{M} D_t^{j,m} + \sum_{j=0}^{M} D_t^{j,nm} \tag{5}$$

where D_t^m is the total marketable debt outstanding at time t, D_t^{nm} is the total non-

[31] This residual includes other means of financing the deficits such as Treasury cash management operations.

marketable debt outstanding at time t, $D_t^{j,m}$ is the amount of marketable debt securities outstanding at the end of year t which were first issued in year $t-j$, and $D_t^{j,nm}$ is the amount of non-marketable debt securities outstanding at the end of year t which were first issued in year $t-j$.

Following the same logic, the total interest payment at time t, which is the product of the average interest rate at time t and the outstanding stock of debt at time $t-1$, can be written as:

$$i_t D_{t-1} = \sum_{j=0}^{M} i_t^{j+1} D_{t-1}^{j} = i_t \left(D_{t-1}^{m} + D_{t-1}^{nm} \right) = \sum_{j=0}^{M} i_t^{j+1} \left(D_{t-1}^{j,m} + D_{t-1}^{j,nm} \right) \tag{6}$$

where M is the maximum reverse maturity of the outstanding debt securities, D_{t-1}^{j} is the amount of debt securities outstanding at the end of year $t-1$ which were first issued in year $t-1-j$, and i_t^{j+1} is the average effective interest rate paid at time t on debt securities which were first issued in year $t-1-j$. We can define the average effective interest rate adjustment by year of first issuance:

$$x_t^{j+1} \equiv \hat{i}_t^{j+1} - i_t^{j+1} \tag{7}$$

For our purposes, it will be useful to introduce the concept of reverse maturity structure. The reverse maturity structure of the debt indicates the share of outstanding debt at time t which was first issued at time $t-j$ for different values of j. Define the share of outstanding debt at the end of year $t-1$ which was first issued at $t-1-j$ as:

$$w_{t-1}^{j} \equiv D_{t-1}^{j} / D_{t-1} \tag{8}$$

The reserve maturity structure of total outstanding debt held by the public at any time t is given by the vector of $w_t^j \; \forall j \in [0, M]$. Similarly, define the share of outstanding marketable and non-marketable debt at the end of year $t-1$ which was first issued at $t-1-j$:

$$w_{t-1}^{j,m} \equiv D_{t-1}^{j,m} / D_{t-1}^{m} \tag{9}$$
$$w_{t-1}^{j,nm} \equiv D_{t-1}^{j,nm} / D_{t-1}^{nm} \tag{10}$$

The reverse maturity structures of marketable and non-marketable outstanding debt held by the public at any time t are given, respectively, by the vector of $w_t^{j,m}$ and $w_t^{j,nm} \; \forall j \in [0, M]$. Define the share of marketable debt within total outstanding debt at the end of year $t-1$ as:

$$m_{t-1} \equiv D_{t-1}^{m} / D_{t-1} \tag{11}$$

Using equations (4)-(11), the reverse maturity structure of the debt can be rewritten as[32]:

$$w_{t-1}^{j} = w_{t-1}^{j,m} m_{t-1} + w_{t-1}^{j,nm}(1 - m_{t-1}) \tag{12}$$

Using equations (6), (9), (10) and (11), we obtain:

$$i_t = \frac{\sum_{j=0}^{M} i_t^{j+1}\left(D_{t-1}^{j,m} + D_{t-1}^{j,nm}\right)}{D_{t-1}} = \sum_{j=0}^{M} \frac{i_t^{j+1}\left(w_{t-1}^{j,m} D_{t-1}^{m} + w_{t-1}^{j,nm} D_{t-1}^{nm}\right)}{D_{t-1}} = \sum_{j=0}^{M} i_t^{j+1}\left(w_{t-1}^{j,m} m_{t-1} + w_{t-1}^{j,nm}(1 - m_{t-1})\right) \tag{13}$$

Using the same logic, we obtain the non-distorted average effective interest rate:

$$\hat{i}_t = \sum_{j=0}^{M} \hat{i}_t^{j+1}\left(\hat{w}_{t-1}^{j,m} \hat{m}_{t-1} + \hat{w}_{t-1}^{j,nm}(1 - \hat{m}_{t-1})\right) = \sum_{j=0}^{M}\left(i_t^{j+1} + x_t^{j+1}\right)\left(\hat{w}_{t-1}^{j,m} \hat{m}_{t-1} + \hat{w}_{t-1}^{j,nm}(1 - \hat{m}_{t-1})\right) \tag{14}$$

B.2 Assumptions and Interest Rate Adjustment

Assumption 1: We assume that the reverse maturity structure of marketable and non-marketable debt are the same in the counterfactual as in actual history[33], i.e. that $\hat{w}_{t-1}^{j,m} = w_{t-1}^{j,m}$ and $\hat{w}_{t-1}^{j,nm} = w_{t-1}^{j,nm}$ $\forall t$ and $\forall j \geq 0$. We also assume that the share of marketable debt within total outstanding debt is the same in the counterfactual as in actual history, i.e. $\hat{m}_t = m_t$ $\forall t$. This gives us:

$$\hat{i}_t = i_t + \sum_{j=0}^{M} x_t^{j+1}\left(w_{t-1}^{j,m} m_{t-1} + w_{t-1}^{j,nm}(1 - m_{t-1})\right) = i_t + \underbrace{\sum_{j=0}^{M} x_t^{j+1} w_{t-1}^{j}}_{=x_t} \tag{15}$$

Assumption 2: As we only have detailed data at the security level for non-marketable debt up to 1960, in our computations we will assume:

$$w_{t-1}^{j,nm} = w_{1960}^{j,nm} \ \forall t > 1961 \text{ and } \forall j \geq 0.$$

Assumption 3: Given the lack of information regarding expected inflation, and the fact that nominal rates were not determined by the market during that period, we assume that the ex-ante interest rate on debt securities issued during the peg period (1942-1951)

[32]Proof:

$$w_{t-1}^{j} \equiv \frac{D_{t-1}^{j}}{D_{t-1}} = \frac{D_{t-1}^{j,m} + D_{t-1}^{j,nm}}{D_{t-1}} = \frac{D_{t-1}^{j,m}}{D_{t-1}^{m}}\frac{D_{t-1}^{m}}{D_{t-1}} + \frac{D_{t-1}^{j,nm}}{D_{t-1}^{nm}}\frac{D_{t-1}^{nm}}{D_{t-1}} = w_{t-1}^{j,m}\frac{D_{t-1}^{m}}{D_{t-1}} + w_{t-1}^{j,nm}\frac{D_{t-1}^{nm}}{D_{t-1}} = w_{t-1}^{j,m} m_{t-1} + w_{t-1}^{j,nm}(1 - m_{t-1})$$

[33]We could instead assume the maturity structure of newly issued debt at time t is the same in our counterfactual as in actual history.

before the Fed-Treasury Accord of March 1951[34] was equal to the average ex-ante real rate for debt securities with similar maturity issued between 1951 and 1960. We provide different calibrations as robustness checks by assuming that the ex ante real rate on all securities was either 1% or 2% (Reinhart and Sbrancia (2015)). This does not affect our main results.

Assumption 4: We assume that debt securities issued during year $t-j$ are all issued[35] at the end of year $t-j$. We also assume that debt securities maturing during year t all mature at the end of year t, except for Treasury bills which are constantly rolled over during the year.

Assumption 5: We assume that the counterfactual history of debt first diverges from the actual history after $t = 1946$, which corresponds to the year during which the debt-to-GDP ratio reached its peak:

$$\hat{D}_{1946} = D_{1946} \tag{16}$$

Assumption 6: We assume that the nominal GDP and the inflation rate remain unchanged in our different counterfactual scenarios, independently of our adjusted interest rate or primary balance.

[34]In April 1942 the United States Treasury and the Federal Reserve agreed to control nominal interest rates on short-term and long-term government securities. The interest-rate peg became effective in July 1942. With respect to short-term securities, the Fed announced that it would buy at a rate of 3/8 percent all 3-month Treasury bills presented by the public. With respect to longer-term securities, the Fed agreed to support 25-year government bond prices at a level consistent with a 2.5 percent interest rate ceiling. Whereas the Treasury and Fed ended the bill rate peg by mutual consent in July 1947, the ceiling on 25-year government bond rates lasted until the Accord of March 1951.

[35]Because we consider that all debt issued in a year is issued at the end of this fiscal year, we assume that debt issued in FY 1951 is issued under the peg regime while debt issued in FY 1942 is not.

Interest Rate Adjustment. For our purposes, it will be useful to define the amount of outstanding Treasury bill[36] securities as the share of outstanding debt at the end of year $t-1$ which was issued in year $t-1$:

$$s_{t-1} \equiv \frac{D_{t-1}^{0,bills}}{D_{t-1}^{0}} = \frac{D_{t-1}^{0,bills}}{w_{t-1}^{0} D_{t-1}} \tag{17}$$

Define the share of TIPS[37] securities within outstanding debt at the end of year $t-1$ as:

$$z_{t-1} \equiv D_{t-1}^{tips}/D_{t-1} \tag{18}$$

Define the share of outstanding TIPS at the end of year $t-1$ which was first issued at $t-1-j$:

$$w_{t-1}^{j,tips} \equiv D_{t-1}^{j,tips}/D_{t-1}^{tips} \tag{19}$$

The reserve maturity structure of TIPS securities held by the public at any time t is given by the vector of $w_t^{j,tips}$ $\forall j \in [0, M]$. Finally, define the share of TIPS securities among total outstanding debt at the end of year $t-1$ which was first issued at $t-1-j$:

$$z_{t-1}^{j} \equiv \frac{D_{t-1}^{j,tips}}{D_{t-1}^{j}} = \frac{D_{t-1}^{j,tips}}{D_{t-1}^{tips}} \frac{D_{t-1}^{tips}}{D_{t-1}} \frac{D_{t-1}}{D_{t-1}^{j}} = \frac{w_{t-1}^{j,tips} z_{t-1}}{w_{t-1}^{j}} \tag{20}$$

The average effective interest rate adjustment x_t^{j+1}, which is adjustment on the average interest rate paid at time t on debt securities which were first issued in fiscal year[38] $t-1-j$ is given by:

$$x_t^{j+1} = \begin{cases} 0 & \text{for } t-1-j \leq 1942 \text{ and } j \geq 0 \\ \pi_t + \tilde{r}_t^{j+1} - i_t^{j+1} & \text{for } 1943 \leq t-1-j < 1951 \text{ and } j \geq 0 \\ \pi_t + \tilde{r}_t^{j+1} - i_t^{j+1} & \text{for } t-1-j = 1951 \text{ and } j > 0 \\ (1-s_{t-1})(\pi_t + \tilde{r}_t^{j+1} - i_t^{*,j+1}) & \text{for } t-1-j = 1951 \text{ and } j = 0 \\ \pi_t - \mathbb{E}_{t-1-j}[\pi_t] & \text{for } 1952 \leq t-1-j < 1997 \text{ and } j > 0 \\ (1-s_{t-1})\left(\pi_t - \mathbb{E}_{t-1-j}[\pi_t]\right) & \text{for } 1952 \leq t-1-j < 1997 \text{ and } j = 0 \\ \left(1-z_{t-1}^{j}\right)\left(\pi_t - \mathbb{E}_{t-1-j}[\pi_t]\right) & \text{for } 1997 \leq t-1-j \text{ and } j > 0 \\ \left(1-s_{t-1}-z_{t-1}^{j}\right)\left(\pi_t - \mathbb{E}_{t-1-j}[\pi_t]\right) & \text{for } 1997 \leq t-1-j \text{ and } j = 0 \end{cases} \tag{21}$$

where $\tilde{r}_t^{j+1}$ is the average ex ante real interest rate on debt securities outstanding at $t-1$ and which were first issued in year $t-1-j$, π_t is the GDP deflator at time t, $\mathbb{E}_{t-1-j}[\pi_t]$ is

[36] Source for outstanding Treasury Bills: https://fraser.stlouisfed.org/title/treasury-bulletin.

[37] Source for outstanding TIPS: https://fraser.stlouisfed.org/title/treasury-bulletin.

[38] From January 1842 until 1977, the fiscal year began in July. From July 1977 onwards, the fiscal year has started in October. For example, FY 2021 started on October 1st 2020 and ended on September 30th 2021.

the expectation of the GDP deflator at time t made at time $t-1-j$, and $i_t^{*,j+1}$ is the average interest rate paid at time t on non-bills debt securities which were first issued in year $t-1-j$.

Finally, we compute our counterfactual history of $\hat{D}_t$ from 1947 up to 2021 by using equation (2). The key variable is the counterfactual non-distorted average effective interest rate $\hat{i}_t$, defined in equation (15) under Assumption 1. To compute it, we need to compute the actual average effective interest rate i_t, the interest rate adjustment x_t^{j+1} defined in equation (21), and the reverse maturity structure of debt held by the public w_{t-1}^j defined in equation (12).

C Appendix - Data

For replication purposes, this section describes the source of our data and any treatment applied to the original data in order to perform our analysis.

C.1 Public Debt Database

Pre-1960

For the pre-1960 period, our source is Hall, Payne, and Sargent (2018). In particular, we use their BondQuant and BondList databases[39] which provide, respectively, quantities and descriptions of all securities issued by the U.S. Treasury between 1776 and 1960[40]. More specifically, we use the following procedure to construct our dataset:

1. Use the BondQuant database and filter the "Series" data (column B) to keep "Public Holdings" rows only as we are interested in publicly-held debt.

2. Reshape wide to long and keep one month only (June, i.e. the end of FY) for every year.

3. Use the L1 ID numerical ID, which uniquely identifies debt securities, to match public holdings data to the security's characteristics (notably its first issue date, its payable date, and its coupon rate) contained in the BondList database.

4. For each security and Year, use the information contained in the variables FirstIssueDate and PayableDate to compute the variables InitialMaturity[41] and CurrentMaturity[42]. (Perform some checks to compare the FirstIssueDate and PayableDate to the first and last occurrence of the security in the database. Replace missing values for FirstIssueDate and PayableDate with, respectively, the first and last occurrence of the security in the database.)[43]

Post-1960

For the post-1960 period, our source is the CRSP Monthly US Treasury Database which provides quantities and descriptions of marketable securities held by the public, excluding Treasury bills, issued by the U.S. Treasury between 1925 and 2021. In particular, we use the TFZ_MTH, TFZ_ISS, and TFZ_MAST data-sets[44]. The CRSP database reports quantities of publicly held marketable bonds and notes back to 1960. The CRSP database does not

[39] Data are available at https://github.com/jepayne/US-Federal-Debt-Public. Screenshots below.

[40] Both the CRSP and Hall et al. (2018) databases provide a monthly snapshot of the outstanding public debt by using information originally contained in the Monthly Statement of the Public Debt (MSPD).

[41] Defined as PayableDate - FirstIssueDate

[42] Defined as PayableDate - Year

[43] Code available upon request.

[44] More information can be found in the CRSP US Treasury Database Guide.

contain data for non-marketable debt and Treasury bills. More specifically, we use the following procedure to construct our dataset:

1. Merge the TFZ_MTH, TFZ_ISS, and TFZ_MAST data-sets (which contain, for each security, information regarding the coupon rate, and the first and last monthly observation) using the variable CRSPID which is the issue identification number.

2. Keep one month only (June before 1976, October after 1977) for every year.

3. For each security and Year, use the information contained in the variables TMFSTDAT, TCALDT and TMATDT, respectively the date of the first monthly observation, the calendar date, and the maturity date, to compute the variables InitialMaturity and CurrentMaturity[45].

Other Fiscal Data

OMB: The nominal GDP data, the outstanding aggregate debt held by the public, the gross interest paid on Treasury debt securities, the interest received by trust funds, net interest payments data, and the total fiscal balance.
Hall: The aggregate outstanding marketable and non-marketable debt held by the public.
Treasury Bulletin: The aggregate amounts of Treasury bills and TIPS securities.
Global Financial Database: Data on nominal yields by maturity.

C.2 Inflation Database

GDP deflator - NIPA. For the GDP deflator inflation rate, we use Line 1 of NIPA Table 1.1.9 ("Implicit Price Deflator for Gross Domestic Product"), which is the quarterly time series for the GDP price index. The quarterly time series begins from the 1st quarter of 1947. We take these quarterly GDP deflator index values $P_{t,q}^{GDP}$ for year t and quarter q. This time series data is also listed in the FRED database, listed below as GDP-BEA.

GNP/GDP/PCE deflator - NBER/NIPA. The sources are the following:
1942-1947: GNP-NBER.
1947-2021: GNP-BEA, GDP-BEA, PCE-BEA.

CPI inflation - BLS. For the CPI inflation rate, we use the time series for "All items in U.S. city average, all urban consumers, not seasonally adjusted" (CUUR0000SA0), from the U.S. Bureau of Labor Statistics. This time series beginning on January 1913 is on a monthly basis, so we take quarterly average values for each quarter to get quarterly CPI values $P_{t,q}^{CPI}$ for Fiscal year t and quarter q. This time series data is also listed in the FRED database under the time series CPIAUCNS.

[45]Code available upon request.

Short-term expectations - Livingston survey. For short-term inflation expectations for Fiscal Years 1951 to 1969, we use median growth rate forecasts of CPI inflation from the semiannual Livingston Survey. Specifically, we use the Excel file for "Growth of Median Forecast for the Levels of Survey Variables" at the Livingston Survey website at the Federal Reserve Bank of Philadelphia.

1. Look under the "CPI" sheet of the Excel file for "Median Forecast Data for Levels".
2. Take the variable $G\_BP\_To\_12M$ values for observations beginning with "6" from 1948 to 1969, i.e. "648", "649", and so on. For example, the June 1951 survey observation is listed under 651, and corresponds to 1-year CPI inflation expectations at Fiscal Year 1951 of Fiscal Year 1952, or $\pi^{eS}_{1951} = \mathbb{E}_{1951}[\pi_{1952}]$.

Short-term expectations - SPF. For short-term inflation expectations for Fiscal Years 1970 to 1976, we use median level forecasts of the GNP/GDP price index (i.e. forecasts of the GNP/GDP deflator inflation rate) from the Survey of Professional Forecasters[46]. In the Survey of Professional Forecasters, the current quarter value for the GDP price index in the quarter in which the survey is taken is under the variable $PGDP2$. The 4-quarter ahead median forecast for the GDP price index is under the variable $PGDP6$, and the 1-quarter ahead median forecast under variable $PGDP3$.

1. Look under the "PGDP" sheet of the Excel file for "Median Forecast Data for Levels".
2. For Fiscal Years 1970 to 1976:
   (a) Take the observations from the 2nd quarter of calendar years 1970[47] to 1976.
   (b) Compute the percentage change between the $PGDP6$ values and the $PGDP2$ values. This is done by dividing the $PGDP6$ value with the $PGDP2$ value (then subtracting by 1 and multiplying by 100 to get the expected inflation rate in percentage points).
3. For the Transition Quarter:
   (a) Take the observations from the 2nd quarter at calendar year-quarter 1976:Q3.
   (b) Divide the $PGDP3$ value with the $PGDP2$ value, then subtract by 1 and multiply by 100 to get the expected inflation rate in percentage points during the Transition Quarter.
4. For Fiscal Years 1977 to 2021:
   (a) Take the observations from the 3rd quarter of calendar years 1977 to 2021.

[46] Data are available at the Survey of Professional Forecasters at the Federal Reserve Bank of Philadelphia.
[47] While the Survey of Professional Forecasters began in the 4th quarter of calendar year 1968, the first 2nd quarter forecasts of 1-year inflation rates is in 1970.

(b) Compute the percentage change between the $PGDP6$ values and the $PGDP2$ values, as done in Fiscal Years 1970-1976.

Long-term expectations - FRB/US[48]. For long-term inflation expectations for Fiscal Years 1968 to 2021, we use the FRB/US 10-year PCE inflation forecasts starting from the 1st quarter of calendar year 1968, available at the Federal Reserve's FRB/US Model website. This quarterly time series begins from the 1st quarter of calendar year 1968. As in short-term inflation expectations, we use the 2nd calendar quarter values for fiscal years 1968 to 1976, the 3rd quarter value of calendar year 1976 divided by 4 for the Transition Quarter, and then the 3rd calendar quarter values for fiscal years 1977 to 2021.

In order to extend the long-term inflation expectations series back to 1951, we regress the difference between the long-term and the HP filtered short-term GDP deflator expectations, denoted respectively by $\pi_t^{GDP,eL}$ and $\tilde{\pi}_t^{GDP,eS}$, on the change in the HP filtered short-term GDP deflator expectation $\Delta\tilde{\pi}_t^{GDP,eS}$ for period between 1968 and 1997, and obtain the fitted values for long-term GDP deflator expectation for the period from 1951 to 1967. We apply the HP filter on short-term expectations for the entire sample from 1950 to 2021. The smoothing parameter λ is set to 100.

Table 3 Long-term and HP Filtered Short-term Expectations

VARIABLES	$\pi_t^{GDP,eL} - \tilde{\pi}_t^{GDP,eS}$
$\Delta\tilde{\pi}_t^{GDP,eS}$	-1.549***
	[0.217]
Observations	30
R-squared	0.637

Standard errors in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

[48] Historical values of PTR come from several sources. Since 1991Q4, the source is the Survey of Professional Forecasters (SPF), first for expected CPI inflation and then, when it becomes available in 2007, for expected PCE price inflation. PTR data from 1981Q1 to 1991Q3 is primarily from a survey conducted by Richard Hoey. The Hoey and SPF CPI observations are reduced by 40 basis to account for the average difference between CPI and PCE inflation. Values of PTR before 1981 are constructed in a manner similar to the one described in Kozicki and Tinsley (2001, section 3.3), "Term Structure Views of Monetary Policy under Alternative Models of Agent Expectations," Journal of Economic Dynamics and Control, 25: 149-184.

C.3 Inflation and Inflation Expectations

This subsection describes our procedure to obtain inflation expectations for different horizons, using both the 1-year or short-term inflation forecasts π_t^{eS} and 10-year annual average or long-term inflation forecasts π_t^{eL} as defined in the main text. To obtain our estimates, we make two assumptions; we first assume that inflation expectations adjust linearly for the first 5 years, then stay constant for all years $j > 5$.

Given a linear increment k_t for adjusting inflation expectations for years $2 \leq j5$:

$$\mathbb{E}_t[\pi_{t+j}] = \mathbb{E}_t[\pi_{t+1}] + (j-1)k_t \text{ for } 2 \leq j \leq 5 \quad (22)$$

$$\mathbb{E}_t[\pi_{t+j}] = \mathbb{E}_t[\pi_{t+5}] \text{ for } j > 5 \quad (23)$$

We also assume that the annual average of expected inflation rates for the first 10 years equals long-term inflation expectations:

$$\pi_t^{eL} = \frac{1}{10} \sum_{i=1}^{10} \mathbb{E}_t[\pi_{t+i}] \quad (24)$$

Given these assumptions, we solve for k_t:

$$\begin{aligned} \pi_t^{eL} &= \frac{1}{10} \sum_{i=1}^{10} \mathbb{E}_t[\pi_{t+i}] \\ &= \frac{1}{10} \sum_{i=1}^{10} [10\mathbb{E}_t[\pi_{t+1}] + (1+2+3+4)k_t + (4+4+4+4+4)k_t] \\ 10\pi_t^{eL} &= 10\pi_t^{eS} + 30k_t \end{aligned}$$

We obtain:

$$k_t = \frac{\pi_t^{eL} - \pi_t^{eS}}{3} \quad (25)$$

Thus, we can use those measures of expectations to calculate inflation forecast errors at different time horizons. This procedure works well for forecasts made during fiscal years 1951 to 1971, and fiscal years 1977 to 2021.

However, computing the path of inflation expectations is more tedious when the Transition Quarter lies within five years after the quarter during which the inflation expectations are made. This is because starting from the 3rd quarter of 1976, the fiscal year shifts by one quarter. Thus, to obtain the inflation expectation for a fiscal year after TQ which was made before TQ, we have to adjust all forecasts by one quarter. For example, a 1-year ahead forecast, which would normally corresponds to the average forecast over the next 4 quarters, will in this case correspond to the average forecast over the 2nd to 5th quarters ahead. Similarly, a 2-year ahead forecast, which would normally corresponds to the average forecast over the 5th to 8th quarters ahead, will in this case correspond to the average forecast over the 6th to 9th quarters ahead. In practice, this issue arises for the expectations made in fiscal years 1972 to 1976. We describe our procedure to obtain expectations made during those fiscal years in the next section, and find that it provides estimates which are similar to the ones obtained from the above procedure.

C.4 Inflation and Inflation Expectations: Quarterly Procedure

In this section, we compute inflation expectations for different horizons made in the last quarter of each fiscal year from 1972 to 1976. We denote by $\mathbb{E}_t[\pi_{t,q}]$ the q-quarter ahead expected inflation rate made in the last quarter of fiscal year t, with $1 \leq q$. For example, $\mathbb{E}_{1976}[\pi_{1976,5}]$ denotes the 5-quarter ahead expected inflation rate made in the last quarter of 1976.

The Survey of Professional Forecasters provides data for the 1-quarter to 4-quarter ahead inflation expectations for the fiscal years from 1972 to 1976. Put differently, the Survey of Professional Forecasters already provides the data for $\mathbb{E}_t[\pi_{t,q}]$ for $1972 \leq t \leq 1976$ and $1 \leq q \leq 4$. We will also use the 10-year annual average of long-term inflation forecasts π_t^{eL} as defined in the main text.

To obtain our estimates, we make the assumption that inflation expectations adjust linearly from the 4th to 20th quarters, and then stay constant for all quarters $q > 20$. Given a linear increment k_t for adjusting inflation expectations for quarters $4 \leq q20$:

$$\mathbb{E}_t[\pi_{t,q}] = \mathbb{E}_t[\pi_{t,4}] + (q-4)k_t \text{ for } 4 \leq q \leq 20 \tag{26}$$

$$\mathbb{E}_t[\pi_{t,q}] = \mathbb{E}_t[\pi_{t,20}] \text{ for } q > 20 \tag{27}$$

This linear adjustment is set such that annual average inflation expectation for the first 40 quarters equals long-term inflation expectation:

$$\pi_t^{eL} = \frac{1}{40}\sum_{q=1}^{40} \mathbb{E}_t[\pi_{t,q}] \tag{28}$$

Given these assumptions, we solve for k_t:

$$40\pi_t^{eL} = \sum_{q=1}^{3} \mathbb{E}_t[\pi_{t,q}] + 37\mathbb{E}_t[\pi_{t,4}] + 456k_t \tag{29}$$

We obtain:

$$k_t = \frac{1}{456}\left[40\pi_t^{eL} - \sum_{q=1}^{3} \mathbb{E}_t[\pi_{t,q}] - 37\mathbb{E}_t[\pi_{t,4}]\right] \tag{30}$$

Finally, we combine quarterly expected inflation rates over each fiscal year to obtain a measure of inflation expectations by fiscal year:

$$\mathbb{E}_t[\pi_{t+j}] = \left[\prod_{q=4j+1}^{4(j+1)} (1 + \mathbb{E}_t[\pi_{t,q}])\right]^{1/4} - 1 \tag{31}$$

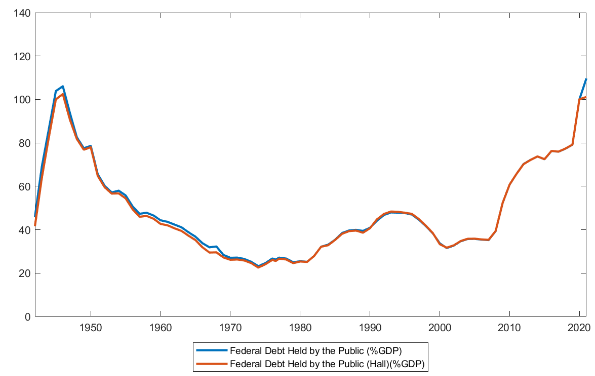
where, as in the main text, $\mathbb{E}_t[\pi_{t+j}]$ is the expectation of the GDP deflator in fiscal year $t + j$ made in the last quarter of fiscal year t.

We use this procedure to obtain the term structure of inflation expectation for fiscal years t from 1972 to 1976, and use the procedure described in the previous subsection for expectations made in all fiscal years before 1972 or after 1976.

D Additional Charts

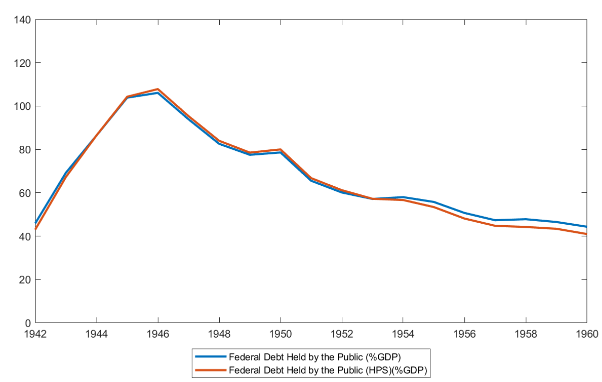
D.1 Debt Held by the Public

Figure 18 FEDERAL DEBT
HELD BY THE PUBLIC AS A PERCENT OF GDP



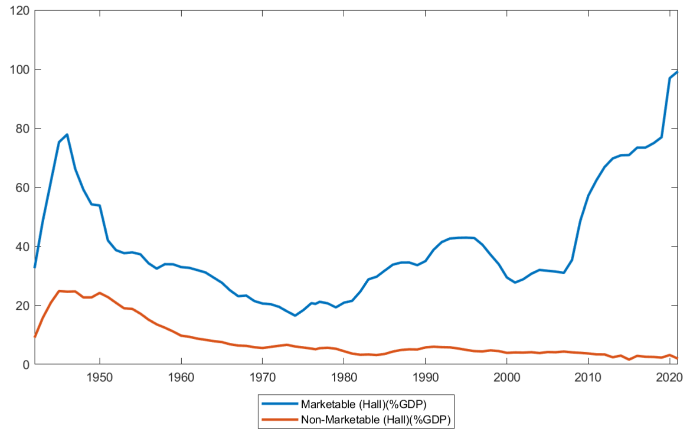
NOTE. The lines represent the ratio of the par value of outstanding Treasury securities held by the public to GDP. Source: OMB for GDP, OMB and Hall for Federal Debt held by the public.

Figure 19 PRE-1960 FEDERAL DEBT
HELD BY THE PUBLIC AS A PERCENT OF GDP



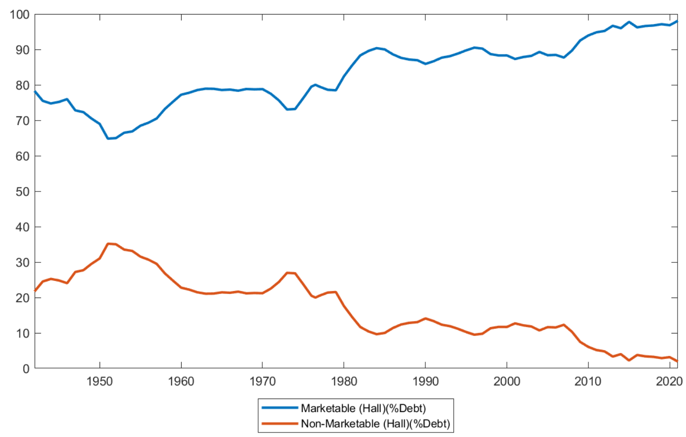
NOTE. The lines represent the ratio of the par value of outstanding Treasury securities held by the public to GDP. Source: OMB for GDP, OMB and Hall, Payne, and Sargent (2018) for Federal Debt held by the public.

Figure 20 Marketable and Non-Marketable Federal Debt Held by the Public as a Percent of GDP



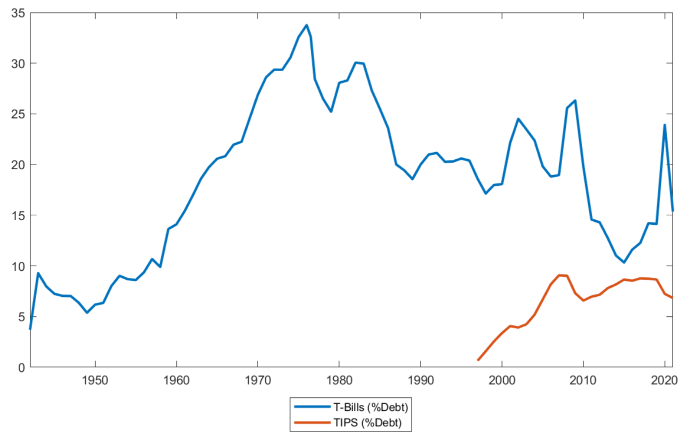
Note. The lines represent the ratio of the par value of marketable and non-marketable outstanding Treasury securities held by the public to GDP. Source: OMB, Hall.

Figure 21 Marketable and Non-Marketable Federal Debt Held by the Public as a Percent of Federal Debt



Note. The lines represent the ratio of the par value of marketable and non-marketable outstanding Treasury securities held by the public to Federal Debt. Source: Hall.

Figure 22 Share of Treasury Bills and TIPS in Outstanding Public Debt



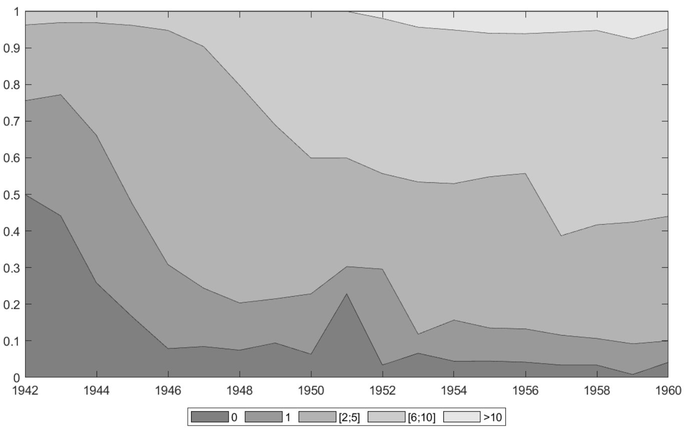
Note. This chart represents the share of Treasury bills and TIPS in total outstanding debt held by the public. Source: Treasury Bulletin.

D.2 Reverse Maturity Structure

Figure 23 Reversed Maturity Structure of Marketable Public Debt Pre-1960

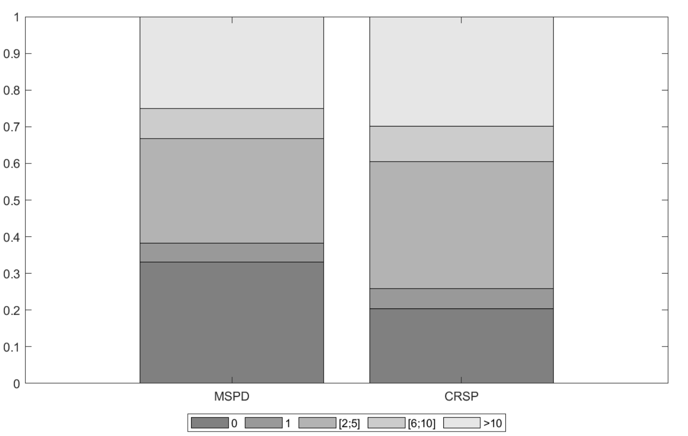
Note. This chart represents the reverse maturity structure of the total debt held by the public between 1942 and 1960, computed using equation (9). The different shades represent the share of the outstanding debt held by the public at the end of fiscal year t which was issued in the same year, last year, 2 to 5 years ago, 6 to 10 years ago, and more than 10 years ago. Lighter shades are associated with longer reverse maturity. Source: Authors' calculations.

Figure 24 Reversed Maturity Structure of Non-Marketable Public Debt



Note. This chart represents the reverse maturity structure of the non-marketable debt held by the public between 1942 and 1960, computed using equation (10). The different shades represent the share of the outstanding debt held by the public at the end of fiscal year t which was issued in the same year, last year, 2 to 5 years ago, 6 to 10 years ago, and more than 10 years ago. Lighter shades are associated with longer reverse maturity. Source: Authors' calculations.

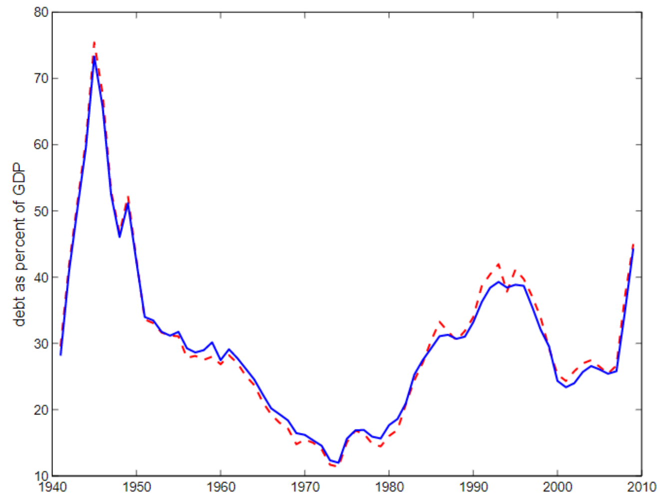
Figure 25 Reverse Maturity Structure of Marketable Non-Bills in 1960: MSPD and CRSP



Note. This chart represents the reverse maturity structure of the marketable non-bills debt held by the public in 1960, both according to MSPD (left bar) and CRSP (right bar) datasets. The different shades represent the share of the outstanding debt held by the public at the end of fiscal year t which was issued in the same year, last year, 2 to 5 years ago, 6 to 10 years ago, and more than 10 years ago. Lighter shades are associated with longer reverse maturity. Source: Authors' calculations.

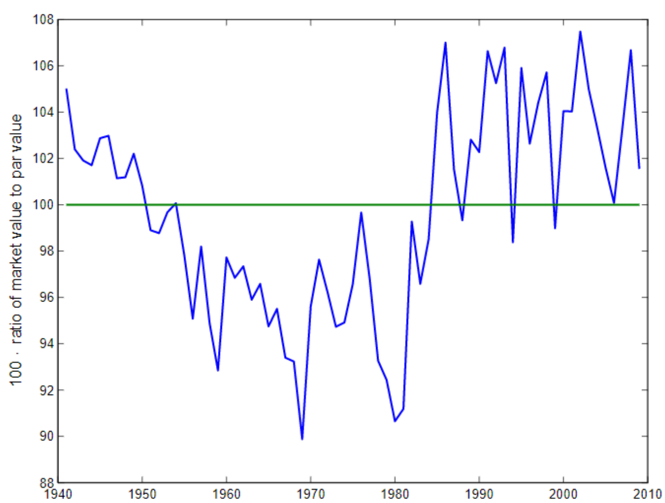
D.3 Par Versus Market Value

Figure 26 Par Value and Market Value of Marketable Debt Held by the Public as a Percent of GDP



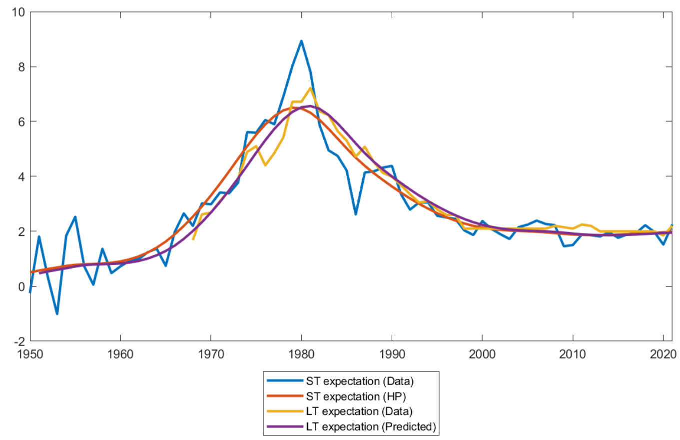
Note. The solid blue line is the ratio of the par value of marketable Treasury securities held by the public to GDP. The dashed red line is ratio of the market value of marketable Treasury securities held by the public to GDP. Source: Borrowed from Hall and Sargent (2011).

Figure 27 Ratio of the Market Value of Marketable Debt Held by the Public to its Par Value



D.4 Inflation and Inflation Expectations

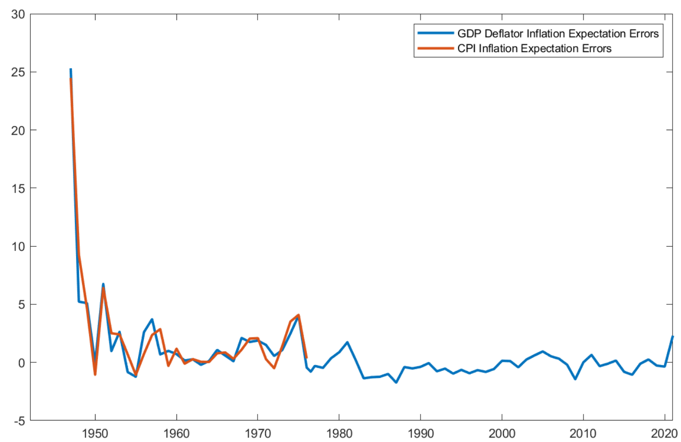
Figure 28 Short-term and Long-term Inflation Expectations Time Series



Note. Sources: Livingston Survey, Survey of Professional Forecasters, Federal Reserve Bank of New York FRB/US Model, authors' calculations.

D.5 GNP Deflator and CPI Inflation Expectations Errors

Figure 29 GNP Deflator and CPI Inflation Expectations Errors



Note. The line for CPI inflation expectation errors is computed as the actual CPI inflation rate (FRED) minus the expected CPI inflation rate (Livingston Survey), from FY 1947 to FY 1976. The line for the GDP inflation expectation errors is computed as the GDP deflator inflation rate (FRED) minus the expected GDP deflator inflation rate (Survey of Professional Forecasters). The GDP deflator inflation rate time series, as used in this graph, is composed of the GNP deflator inflation rate (NBER American Business Cycle dataset) from FY 1942 to FY 1947, then the GDP deflator inflation rate (FRED) from FY 1948 to FY 2021. The GDP deflator inflation expectations time series is composed of GNP deflator inflation expectations from FY 1970 to FY 1991 (Survey of Professional Forecasters), then the GDP deflator inflation expectations from FY 1992 to FY 2021 (Survey of Professional Forecasters). Sources: FRED, NBER Ameriacan Business Cycle dataset, Livingston Survey, Survey of Professional Forecasters, Federal Reserve Bank of New York FRB/US Model, authors' calculations.