Using Inflation to Erode the U.S. Public Debt

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Abstract

Projections indicate the U.S. Federal debt held by the public may exceed 70-100 percent of GDP within ten years. In many respects, the temptation to inflate away some of this debt burden is similar to that at the end of World War II. In 1946, the debt ratio was 108.6 percent. Inflation reduced this ratio by more than a third within a decade. Yet there are some important differences –shorter debt maturities today reduce the temptation to inflate, while the larger share of debt held by foreigners increases it. This paper lays out an analytical framework for determining the impact of a large nominal debt overhang on the temptation to inflate**.** It suggests that when economic growth is stalled, the U.S. debt overhang may induce an increase in inflation of about 5 percent for several years that could significantly reduce the debt ratio.

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1. Introduction

Since the start of 2007, the financial crisis has triggered over $1.62 trillion of write-downs and credit losses at U.S. financial institutions, sending the American economy into its deepest recession since the Great Depression and the global economy into its first recession since World War II. The Federal Reserve has responded aggressively. In an effort to hold down borrowing costs and boost lending, it has kept the target rate for overnight loans between banks at zero to 0.25 percent since December, 2008, and it has pursued unconventional monetary easing.[1] Fiscal policy became expansionary as well. The $700 billion Troubled Asset Relief Program and the $787 billion Economic Recovery and Reinvestment Act were signed into law. In all, Federal spending increased 18 percent in FY2009, to 25 percent of GDP, the highest level in over fifty years. Revenues fell almost 17 percent below receipts in 2008, to about 15 percent of GDP, the lowest level in over fifty years.[2]

The United States is now facing large Federal deficits and growing public debt. In FY2009, the Federal deficit was $1.4 trillion, or 10% of GDP, the highest deficit-to-GDP ratio since 1945.[3] In FY2010, the deficit was 8.9% of GDP. The Federal debt held by the public grew to $7.5 trillion, or 53% of GDP, at the end of FY2009, the highest debt-to-GDP ratio since 1955.[4] The estimated debt ratio for FY2010 is an even higher 63.6%. The total outstanding

[1] Federal Reserve Press Releases, various dates.

[2] Daily Treasury Statement (various dates) and Monthly Treasury Statement (various dates).

[3] U.S. Treasury.

[4] Congressional Budget Office (2009) estimates. The Office of Management and Budget (2009) estimates public debt to be 55.7 percent of GDP in 2009, while the IMF(2009) projects it to be 58.2 percent.

Federal debt for FY2009 was $11.9 trillion, or 83.4% of GDP.[5] The gross Federal debt is estimated to be $13.8 trillion in FY2010, nearly 95% of GDP. If economic recovery is slow to take hold, large deficits and growing debt are likely to extend into future years. Not surprisingly, concerns about government deficits and public debt now dominate the policy debate.

Many observers worry that the debt/GDP ratios projected over the next ten years are unsustainable.[6] Given that concern, and assuming that deficits can be reined in, how might the debt/GDP ratio be reduced? There are four basic mechanisms. First, GDP can grow rapidly enough to reduce the ratio. This scenario requires a robust economic recovery from the financial crisis. Second, inflation can rise, eroding the real value of the debt held by creditors and the effective debt ratio. With foreign creditors holding a significant share of the dollar-denominated U.S. Federal debt, they will share the burden of any higher U.S. inflation along with domestic creditors.[7] Third, the government can use tax revenue to redeem some of the debt. Fourth, the government can default on some of its debt obligations. Over its history, the United States has

[5] The Budget of the United States Government, FY2009, p. 230, states: The Federal Government issues debt securities for two principal purposes. First, it borrows from the public to finance the Federal deficit. Second, it issues debt to Government accounts, primarily trust funds that accumulate surpluses. By law, trust fund surpluses must generally be invested in Federal securities. The gross Federal debt is defined as the sum of debt held by the public and the debt held by Government accounts. Borrowing from the public is normally a good approximation of the Federal demand on credit markets. Borrowing must be financed out of the saving of households and businesses, the State and local sector, or the rest of the world. Borrowing from the public thus affects the size and composition of assets held by the private sector and the amount of saving imported from abroad. It also increases the amount of future resources required to pay interest to the public on Federal debt. Borrowing from the public and the growth of the publicly-held Federal debt are therefore important policy concerns.

[6] For example, see Alan Auerbach and William Gale (2009).

[7] The real depreciation of the dollar also erodes the value of U.S. public debt held by foreigners. See Rogoff (2009).

relied on each of these mechanisms to reduce its debt/GDP ratio.[8] In this paper, we examine the role of inflation in reducing the Federal government's debt burden.

We start in Section 2 by laying out some stylized facts. We examine Federal debt held by the public since World War II and show how publicly-held debt as a percentage of GDP has evolved. We also provide time-series evidence on average maturity length of the public debt. We observe that very little of the debt is indexed to inflation, despite the introduction of Treasury inflation-protected securities (TIPS) in 1997, and all debt is denominated in dollars.

The distributional impact of inflation depends on the allocation of debt between domestic and foreign creditors, so we next show how the share held by foreigners has grown over time. We end this section by estimating the impact of various inflation scenarios on the debt/GDP ratio, and we calculate how the inflation burden would be shared between domestic and foreign creditors.

In Section 3, we develop a model that shows the impact of a nominal debt overhang on the temptation to inflate. The model illustrates that the optimal inflation rate is also positively related to the share of the debt held by foreign creditors, the cost of tax collection, and the share of non-indexed debt. For sensible parameter values, the model indicates that when economic growth is stalled**,** the U.S. debt overhang may trigger inflation about 5 percent higher than expected for several years. This additional inflation would significantly reduce the debt overhang.

In Section 4, we conclude by comparing the current period with a past period in U.S. history when the debt overhang was high. We argue that today's temptation to inflate away some

[8] Many people do not realize that the United States defaulted early in its history. In 1785, the U.S. suspended interest payments on debt to France, and in 1787 defaulted on payment of principal as well. Eventually it repaid its debt in specie at par. In 1933, the U.S. abrogation of the gold clause constituted a debt restructuring since nearly all public debts were repaid in fiat currency rather than gold. For a brief discussion of debt management after the American Revolution and Civil War, see the Appendix.

of the debt burden is similar in some respects to that in the immediate post-World War II era, when inflation eroded part of the debt burden. Yet there are important differences –shorter debt maturities today reduce the temptation to inflate, while the larger share of debt held by foreign creditors increases it.

2. The Stylized Facts

Figure 1 depicts trends in gross Federal debt and Federal debt held by the public from 1939 to the present.[9] In 1946, just after the end of World War II, gross Federal debt reached 121.7 percent of GDP and the share held by the public was 108.6 percent. Over the next 30 years, debt as a percentage of GDP decreased almost every year, due primarily to an expanding economy as well as inflation. The end result was noteworthy. By 1975, gross Federal debt had declined to 34.7 percent of GDP, and the share of debt held by the public had fallen to 25.3 percent.

The immediate post-World War II period is especially revealing. Figure 2 shows that between 1946 and 1955 the debt/GDP ratio was cut almost in half. Hall and Sargent (2010) argue that GDP growth played an important role in bringing down this ratio after the war.[10] Inflation was also a factor in reducing the debt ratio, even though inflation was relatively moderate over the decade, averaging just 4.2 percent.[11]

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[9] Recall that the difference between gross Federal debt and debt held by the public is the debt held in government accounts, primarily trust funds. Debt held by the Federal Reserve is included in debt held by the public.

[10] Hall and Sargent (2010) examine the decline in the *market value* of publicly-held debt as a share of GDP over the longer 1946-1974 period. They estimate that about 20 percent of the decline came from using inflation, while the remaining 80 percent was split about equally between GDP growth and running primary budget surpluses.

[11]Inflation was higher in the immediate aftermath of World War II. Price controls were dismantled and, in 1947, inflation spiked to 14.4 percent.

Returning to Figure 1, we see that debt/GDP ratios stopped declining by the mid-1970s, when the economy was hit by oil shocks and fiscal deficits increased. In the early 1980s, the debt/GDP ratio grew sharply as the economy faced recession and a re-emerging fiscal deficit. Legislated tax cuts and increased government defense expenditures fueled even greater fiscal deficits and higher debt.

By the mid-1990s, however, the debt/GDP ratio again began falling. Gross debt fell steadily from 66.2 percent of GDP in 1993 to 57.4 percent in 2001, while the debt held by the public fell by about a third, from 49.4 percent of GDP in 1993 to 33.0 percent in 2001. Over the period 1993-2001, average inflation was about 2.5 percent and the average maturity of the publicly-held debt was about 5.75 years, so inflation contributed very little to the erosion of the debt/GDP ratio. Most of the decline in the debt/GDP ratio was due to robust GDP growth.

The downward trend in the debt/GDP ratio ended in 2001. With a recession, a slow recovery that reduced tax receipts, legislated tax cuts and increased spending due to the War on Terror, a government budget surplus turned to deficits and debt began to rise in 2002, both in nominal terms and as a percentage of GDP. However, a growing economy led to a small decline in the debt ratio between 2005 and 2007.

With the onset of the financial crisis, government deficits and the debt/GDP ratio increased dramatically. In FY 2009, the debt-to-GDP ratio reached a level not seen since 1955. Figure 3 shows 10-year projections made by the International Monetary Fund, the Congressional Budget Office, and the Office of Management and Budget. These projections indicate debt held by the public could be 70-100 percent of GDP in ten years.

A government that has lots of nominal debt denominated in its own currency has an incentive to try to inflate it away so as to decrease the debt burden. It will resist the urge to inflate if the benefits are small and the costs are high. The average maturity of the debt and the share that is indexed to inflation affect the ability of the government to inflate away its value. In the extreme cases of zero maturity or fully-indexed debt, the government is unable to reduce its debt burden through inflation.

Figure 4 illustrates the average maturity length in months for U.S. marketable interest-bearing public debt held by private investors, along with the debt held by the public as a share of GDP.[12] As noted by a number of authors, the United States exhibits a positive relation between maturities and debt/GDP ratios in the post-World War II period.[13] Most developed countries show little correlation between maturities and debt/GDP ratios. The United States appears to be an exception.[14] Maturity length on U.S. public debt in the post-World War II era went from a high of 113 months (9.4 years) in 1947 to a low of 31 months (2.6 years) in 1976. It then climbed again, with some ups and downs, reaching a peak of 74 months (6.2 years) in 2000 before falling back to 49 months (4.1 years) in both 2008 and 2009. In June, 2010 it rose somewhat, to 55 months (4.6 years).[15]

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[12]Prior to 1971, maturity length applies to interest-bearing public debt. Since 1971, maturity length applies to interest-bearing public debt held by private investors. Debt held by private investors was 82% of debt held by the public in 2008. The public includes the Federal Reserve Banks whereas the private-investors category does not. Inflation-indexed securities are excluded from the calculation of maturity length.

[13]See, for example, Calvo and Guidotti (1992).

[14]When we regress log maturity on the log debt/GDP ratio and correct for serial correlation, we find that the correlation between maturity length and debt/GDP over the period 1946-2008 is 0.7 and highly significant. The same holds for the early period 1946-1991. Interestingly, the correlation is insignificant over the more recent period of 1992-2008.

[15] Garbade (2007) observes that the decline in average maturities until the end of the 1950s reflected the reluctance of Treasury officials to issue longer term debt. Issuing longer term debt when the economy was strong and interest rates were high would commit the Treasury to paying high rates for a long time, and issuing longer debt when the economic activity was weak could hurt a recovery. By the end of the 1950s, Treasury officials began to worry that the increasing concentration of debt at shorter maturities was contributing to price inflation and attempted to lengthen maturities. The Third Liberty Bond Act of

In the past few years, the portion of Treasury debt at the shortest maturity has risen markedly. Figure 5 shows that the share of debt maturing in less than a year has jumped from about 30 percent in FY2006 and FY2007 to over 40 percent in FY2008 and FY2009 , reaching a proportion last seen in the mid-1980s.

Treasury inflation-protected securities, or TIPS, were first introduced in 1997 for notes and in 1998 for bonds. In nominal terms, they have increased from $24.4 billion in 1997 to $551.3 billion in FY2009. However, as a share of total public debt, they are still quite small. Figure 6 shows that TIPS have grown in importance over the last 12 years but still account for less than 10 percent of total public debt issues.

Figure 7 show the share of U.S. public debt held by foreign creditors. The foreign share was essentially zero up until the early 1960s. Even by the late 1960s, the foreign share accounted for less than 5 percent of total public debt. It then started rising, reaching 19.9 percent in 1978, in part because of recycled OPEC surpluses. The foreign share has risen dramatically in recent years, particularly after the 1997-98 Asian financial crisis, and accounted for 48.2 percent of publicly-held debt in 2008 and 46% in 2009.[16] Mainland China held 12.4% of U.S. public debt at the end of 2009, while Japan held about 10 percent.

Figure 8 illustrates that Mainland China and Japan are the major foreign holders of U.S. public debt. Together they held about 44 percent of total foreign holdings of U.S. public debt at

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1918, which established a 4.25 percent ceiling on coupon rates for Treasury bonds, also influenced average maturities. Garbade (2007) notes that between 1965 and 1973, rising nominal interest rates on long-term securities along with this coupon ceiling kept the Treasury from issuing bonds and led to a further decline in average maturities. Congress provided some exemptions from the 4.25 percent ceiling in 1971, but the decline in maturities was not reversed until Congress extended the maximum maturity of a Treasury note to ten years in 1976. For more details, see Garbade (2007).

[16] Analytical Perspectives, Budget of the United States Government, FY2011; U.S. Treasury Bulletin, October, 2010; Major Foreign Holders of Treasury Securities (www.ustreas.gov/tic/mfh.txt).

the end of June, 2009. China held \$776.4 billion of U.S. public debt, 23 percent of total foreign holdings, while Japan held \$711.8 billion, or 21 percent of total foreign holdings. In 2009, about 76 percent of all foreign holdings were at foreign central banks.

The effect of inflation on the real value of the publicly-held U.S. Federal debt or on the debt ratio depends on the debt's Macaulay duration. Duration measures the weighted average time to maturity of the debt, using as weights the relative present values of the cash flows from the debt obligations as weights. In the case of discount bonds, where no payments are made to holders before maturity, duration and average term to maturity are the same. For U.S. Treasury notes and bonds, coupon payments are made before maturity, so their duration is less than the average maturity. Duration takes into account that coupon payments will be reinvested at interest rates that reflect expected future inflation.[17]

Calculating duration requires detailed information about the par value, coupon rate and maturity of each outstanding government debt instrument.[18] To simplify the analysis, we shall use average maturity as an approximation for duration.[19]

Suppose creditors purchase X dollars of government debt with a nominal interest rate of i percent and the debt has m years until maturity. Suppose n is the number of times the interest rate is compounded per year, and let the compounding period be infinitesimally small, so that $n \to \infty$. If the annual inflation rate is π, then the real value of the debt after m years is

[17] Macaulay duration thus internalizes the Fisher equation by assuming expected inflation translates immediately into higher nominal rates.

[18] The CRSP U.S. Treasury Database, developed by the Center for Research in Security Prices at the Graduate School of Business, University of Chicago, provides monthly market data on Treasury notes and bonds, with some data going back to 1925. Data on bills can be found in the U.S. Treasury's *Monthly Statements of the Public Debt* and its Annual Reports.

[19] Missale and Blanchard (1994) also use average maturity to approximate the impact of inflation on government debt.

$V = Xe^{(i-\pi)m}$. It follows that the percentage change in the real value of the debt associated with a 1 percent increase in inflation over the life of the debt is $\partial \log V / \partial \pi = -m$. The percentage change in the debt/GDP ratio over the period is also $-m$.[20] Hence debt maturity (m) can be used to approximate the inflation impact. The approximation is an over-estimate because it assumes coupon payments are reinvested at a constant nominal interest rate. More likely, inflation will cause investors to revise their expectations and demand a higher nominal rate for reinvesting coupon payments. The approximation also assumes maturity is invariant to inflation. This assumption need not always hold, but we assume it does when inflation is below some threshold. We later test the validity of this assumption for U.S. data in the post-World War II period.

Figure 9 illustrates the percentage decline in the debt/GDP ratio (or the real value of the debt) of a one-, three-, and five-percent increase in inflation, assuming inflation stays at the higher rate for the life of the debt. Figure 10 pictures the impact of these three inflation scenarios on the share of publicly-held debt over the period 1946-2008. Table A1 in the Appendix shows the actual values of these shares under the three inflation scenarios.

A few observations are worth noting. Inflation yielded the most dramatic reduction in the debt/GDP ratio—and the real value of the debt—in the immediate post-World War II period.[21] The sizeable inflation impact is not that surprising. Not only was there a large debt overhang when the war ended (the publicly-held share of Federal debt was 106 percent of GDP in 1945), but inflation was low (2.3%) and debt maturity was high (over 9 years). Thus there was room to

[20] In the discrete version also, the percentage change in the real value of the debt (or the debt/GDP ratio) associated with a 1 percent increase in inflation over the life of the debt can be approximated by –*m*, since $V = X[(1+i)/(1+\pi)]^m$ and $\partial \log V / \partial \pi = -m/(1+\pi) \approx -m$.

[21] A five-percent inflation increase starting in 1946, for example, would have reduced the debt/GDP ratio from 108.6 percent to 59.3 percent, a decline in the debt ratio of 45 percent.

let inflation rise.[22] Although average inflation over the decade was a moderate 4.2 percent, inflation was high in the early part of the decade -- 8.3 percent in 1946, 14.4 percent in 1947, and 8.1 percent in 1948 -- before dropping considerably.[23] Moreover, long maturities allowed inflation to erode the debt burden. Maturities were over 9 years in years 1945-48 and then fell gradually to 8.75 years in 1949 and 8.17 years in 1950.

In contrast, inflation would have had little impact on reducing the debt burden in the mid-1970s after the initial oil price shocks. That period was characterized by a lower debt overhang (the share of publicly-held share of Federal debt was 23.9 percent of GDP in 1974), inflation was higher (11 percent in 1974), and debt maturities were shorter (under 3 years by 1974 and a mere 2.67 years in 1975).[24]

The estimated impact of inflation on today's debt/GDP ratio is larger than in the mid-1970s but not as large as in the mid-1940s. Had inflation been 3 percent higher in FY2009 and stayed at that higher level over the average life of the debt (3.9 years in 2009), the effective debt/GDP ratio would be about 12 percent lower. Had inflation been 5 percent higher, the debt/GDP ratio would be about 20 percent lower, a debt ratio of 43.4 percent instead of 53.8 percent.[25]

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[22] Figures and computations use the par value of debt as a share of GDP. Using the market value in place of the par value in debt ratios does not matter that much—the difference is generally less than 2 percent—but debt ratios using market values exceed ratios with par values by 3 or 4 percent in 1945-46, in about half of the 1990s, and in 2007-8. See the Dallas Fed website for the series on the market value of the debt.

[23] Price controls were imposed during World War II. Most controls were lifted by the fall of 1946.

[24] As a result, in 1975 a 5 percent inflation increase would have reduced the debt/GDP ratio from 25.3 percent to 21.9 percent, less than 15 percent. The 4.25 percent ceiling on coupon rates for Treasury bonds in effect between 1918 and 1988 distorts the impact of inflation on the debt ratio, particularly during high inflation periods. The ceiling also affects the correlation between inflation and average maturity length.

[25] This estimated impact of inflation is an upward bound. It assumes that coupon payments are reinvested at the nominal interest rate in effect before the increase in inflation. It also assumes that inflation erodes

Figure 11 shows how a 3 percent increase in inflation would be shared between domestic and foreign holders of U.S. federal debt. In the 1960s, foreigners held so little debt that essentially the entire burden of higher inflation would fall on U.S. creditors. By the end of 2008, foreigners held almost half of the debt, so higher inflation would be shared about equally between domestic and foreign creditors. [26]

Our computations of the impact of inflation on the debt overhang assume that all debt is denominated in domestic currency, none is indexed, and the maturity is invariant to inflation. While the first two assumptions are sensible (U.S. public debt is 100 percent dollar-denominated and over 90 percent non-indexed), the latter assumption about the responsiveness of maturities to inflation needs further investigation.[27]

Over the period 1946-2008, the simple correlation between U.S. debt maturities and consumer price inflation is -0.296, suggesting higher inflation is associated with lower debt maturities. However, regression results do not support this view.

Table 1 reports the results of linear regressions that examine the relationship in U.S. data between debt maturity and inflation, taking into account that debt maturity may also be influenced by the amount of debt held by the public as a share of GDP, the share of government

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the real value of government liabilities that mature before the average maturity length of 9 years in the same way that it erodes the value of government bonds with maturity equal to or greater than 9 years. Finally, it does not take into account that some government liabilities (under 10 percent) are inflation-protected TIPS.

[26] Doepke and Schneider (2006b) document the inflation-induced redistribution of wealth across sectors in the United States in the 1990s. They consider redistribution across household types as well as among all households, the government and the rest of the world.

[27] The effect of increased inflation on the real value of existing debt is the product of average debt maturity and the increase in inflation. But if over the maturity period some of the debt must be rolled over, the computation will overstate the fall in the debt's real value if maturity declines with increased inflation. See Persson et al (1998). Thus it is important to investigate the relationship between maturity length and inflation in U.S. data.

spending in GDP, and the GDP growth rate. Over the period 1946-2008, there is a robust positive and significant relationship between debt maturity and the debt/GDP ratio, but there is no significant relationship between debt maturity and inflation. Even when we experiment with various inflation lags, inflation does not influence the maturity of U.S. debt.[28] In the table, we report an example with inflation and one-period lagged inflation as regressors; both inflation variables are insignificant. Thus, the assumptions invoked to compute the impact of inflation on the debt overhang seem to be reasonable.[29]

3. Model and Sensitivity Analysis

We describe a stylistic model that illustrates both costs and benefits associated with inflating away some of the debt burden. The model shows that the size of the debt/GDP ratio is an important determinant of the optimal inflation rate. So is the share of debt held by foreigners, the maturity of the debt, the share of debt indexed to inflation, the government's expenditure share of GDP, and the deadweight loss associated with collecting taxes.[30]

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[28]Missale and Blanchard (1994) found that during the 1960-1989 period, the debt/GDP ratio dominated inflation, both quantitatively and statistically, in its influence on debt maturity in three countries, Ireland, Italy, and Belgium; inflation only significantly decreased maturity for two of them, Ireland and Italy.

[29] Figure 4 suggests that the positive and significant correlation between debt maturities and the debt/GDP ratio may have broken down after the early 1990s, raising the question of whether the relationship between maturities and inflation may also have changed. Indeed, there is no significant correlation between maturities and either debt ratios or inflation when the regression is run over the sub-sample 1992-2008. However, the sample size is small. When we regress over the full period 1946-2008, interacting a dummy variable for the 1992-2008 sub-period with both the debt ratio and inflation and also including it as a shift parameter, we find that the strong positive and significant relationship between maturities and the debt ratio is maintained, though reduced by a small 1.5 percent in the more recent period, and there is no significant difference in the relationship between maturities and inflation across periods.

[30] Doepke and Schneider (2006a) develop a different but complementary analytical framework to assess the welfare effects of a wealth redistribution in the U.S. induced by an inflationary shock. Their model also emphasizes the role of debt maturity and the share of debt held by foreigners.

We consider an infinite-horizon economy that starts in period one with a public debt overhang. Previous inflation was low, say zero, such that a significant share of the public debt is not indexed to inflation. The average debt maturity is long enough to allow the authorities to contemplate unanticipated inflation as a way to erode the real debt. Using inflation will reduce the need for taxes to service the debt and will avoid the deadweight losses associated with those taxes. Using inflation may also have appeal if some of the inflation tax can be shifted to foreigners. An inflation-inducing policy is costly, however. Consumers hold government debt, so inflation reduces their real wealth. In addition, inflation will trigger in the next period the full indexation of the remaining public debt, and it will be associated with a drop in output during the inflationary-disinflationary cycle. The period length coincides with the duration of a business cycle and/or an inflationary-disinflationary cycle (say four years for the U.S.).

To simplify, we assume away growth. Output in the absence of an inflationary-disinflationary cycle is $\bar{Y}$. The initial outstanding debt in period one (the first period debt overhang) is $b\bar{Y}$. A fraction θ of the debt is de-facto indexed to inflation -- either due to formal indexation (like TIPS) or to having almost instantaneous maturity.

The real interest rate in the absence of unanticipated inflation is determined by global conditions and is assumed to be exogenously given at level r.[31] The rate is also the real interest rate on the indexed bonds. Hence, an unanticipated inflation rate of $\pi > 0$ in period one will reduce the real value of outstanding debt at the end of period one to $b\frac{(1-\theta)\bar{Y}}{1+\pi}$.

[31] The assumption of a constant real interest rate rules out the possibility, even in the presence of short debt maturities and devaluation incentives, that nominal non-indexed bonds can be liquidated by changing the real interest rate. As discussed in Calvo (1989), this mechanism is potentially potent for a small open economy trying to stabilize from an initial position of high inflation and limited credibility.

A fraction (1-*f*) of the initial debt is held by economic domestic actors, *f* by foreign economic actors. To simplify, we assume a symmetric ownership share of the indexed debt between domestic and foreign economic actors.

The penalty on attempts to inflate the debt in period one is that the remaining value of debt becomes real debt in period two and throughout the indefinite future – inflation in period one will induce private lenders to demand formal indexation or a sharp shortening of the maturity.

Output depends negatively on inflation:

$$(1) \qquad Y = \bar{Y}(1 - h\pi^{\phi}); \quad \phi \geq 1.$$ [32]

The output is taxed at a rate t. For simplicity, the tax rate is set in period one and stays fixed for the indefinite future. Taxes are associated with deadweight losses, modeled in reduced form as a tax collection cost, τ. A tax rate *t* provides the authorities with net tax revenue of $Y(t - 0.5\tau t^2)$.[33] These assumptions imply that if the authorities inflate in period one, they have the incentive to return to zero inflation for the indefinite future.

The consumer's utility is

[32] Recalling that the period length coincides with the duration of an inflationary-disinflationary cycle, the values of *h* and ϕ capture the average output cost and indirectly the welfare cost of such a cycle. While, to our knowledge, there are no recent estimates of these values, Friedman (1985) estimated that the cost of 5 percentage points of disinflation over the 1980-1988 period was 20 point-years of unemployment, for a final trade-off of 4-to-1, toward the pessimistic end of Okun's range. He noted that it was possible to construct a more favorable picture on the basis of more optimistic assumptions, for a final trade-off of 2-1, about at the optimistic end of Okun's range.

[33] Like Barro (1979), we model these tax collection costs as a non-linear share of output and let them depend positively on the tax rate.

(2) $$U_1 = \log C_1 + \beta \log C_2 + ...\beta^{s-1} \log C_s + ... $$

The domestic consumer's financial wealth at the beginning of period one is

(3) $$(1-f)\, b\overline{Y} = A_1$$

The second period initial asset position of the domestic consumer is:

(4) $$\left[(1-f)b\overline{Y}(\theta + \frac{1-\theta}{(1+\pi)^m}) + \overline{Y}(1-h\pi^{\phi})(1-t) - C_1\right](1+r) = A_2 .$$

Assuming that anticipated first-period inflation is zero, a positive inflation in period one implies that all debt in the future will be indexed. The budget constraint in period s, s > 1, will be:

(5) $$\left[A_s + Y_s(1-t) - C_s\right](1+r) = A_{s+1} .$$

Forward iterations imply that the intertemporal budget constraints can be reduced to:

(6) $$(1-f)b\overline{Y}(\theta + \frac{1-\theta}{(1+\pi_1)^m}) + \overline{Y}(1-h\pi_1{}^{\phi})(1-t) + \sum_{s=1}^{\infty} \frac{\overline{Y}(1-t)}{(1+r)^s} = \sum_{s=1}^{\infty} \frac{C_s}{(1+r)^{s-1}} .$$

The left-hand side of Equation (6) is first-period wealth. The representative consumer maximizes utility subject to the intertemporal budget constraint, where the net present value of the consumption stream equals the consumer's first period wealth:

$$W_1 = (1-f)b\bar{Y}(\theta + \frac{1-\theta}{(1+\pi_1)^m}) + \bar{Y}(1 - h\pi_1^{\phi} + \frac{1}{r})(1-t)$$

Assuming an exogenously given interest rate, it follows that the resulting utility is proportional to initial wealth.

The policy maker will set the inflation rate and the tax rate in order to maximize the representative consumer's first-period wealth, subject to the fiscal intertemporal budget constraint. We assume an exogenous fiscal expenditure of $g\bar{Y}$ each period. Hence, the fiscal intertemporal budget constraints are:

(7)
$$\left[b\bar{Y}(\theta + \frac{1-\theta}{(1+\pi_1)^m}) + g\bar{Y} - \bar{Y}(1 - h\pi_1^{\phi})(t - 0.5\tau t^2) \right](1+r) = D_2^g;$$
$$\left[D_s^g + g\bar{Y} - \bar{Y}(t - 0.5\tau t^2) \right](1+r) = D_{s+1}^g; \quad s > 1$$

where D_s^g is the real public debt at the beginning of period s. Forward iterations provide the following intertemporal fiscal constraint:

(8)
$$b\bar{Y}(\theta + \frac{1-\theta}{(1+\pi_1)^m}) + g\bar{Y}(1 + \frac{1}{r}) = \bar{Y}(1 - h\pi_1^{\phi} + \frac{1}{r})(t - 0.5\tau t^2).$$

Alternatively,

$$(9) \qquad t - 0.5\tau t^2 = \Gamma \text{, where } \Gamma = \frac{b(\theta + \frac{1-\theta}{(1+\pi_1)^m}) + g(1+\frac{1}{r})}{1 - h\pi_1^{\phi} + \frac{1}{r}}$$

The left-hand side of (9) is the flow of taxes per dollar income net of collection costs. It should cover the "long run" fiscal expense share of the GDP, namely Γ. In the absence of inflation and debt overhang, the right-hand side of (9) is simply g. If g is zero, then in the absence of inflation the right-hand side is the annuity value of the public debt overhang as a fraction of permanent output, $\frac{r}{1+r}b$.

The fiscal budget constraint provides the tax Laffer curve:

$$(10) \qquad t(\pi_1; \theta, g, r, h, \tau) = \frac{1 - \sqrt{1 - 2\tau\Gamma}}{\tau}.$$

The policy maker sets the inflation rate so as to maximize the consumer's wealth, (W_1), subject to the Laffer curve constraint, (10). Specifically, the policy maker's problem is:

$$\underset{\pi_1}{MAX} \left[(1-f)b\bar{Y}(\theta + \frac{1-\theta}{(1+\pi_1)^m}) + \bar{Y}(1 - h\pi_s^{\phi} + \frac{1}{r})\{1 - t(\pi_1)\} \right]$$

It follows that for an internal equilibrium -- one with positive inflation -- we get:

$$\pi^* = \pi(b,\ f, \tau, g, \theta, m); \quad \pi_b^{'} > 0, \pi_f^{'} > 0, \pi_\tau^{'} > 0, \pi_g^{'} > 0, \pi_\theta^{'} < 0, \pi_m^{'} < 0$$
$$t^* = t^*(b,\ f, \tau, g, \theta, m); \quad t_b^{'} > 0, t_f^{'} < 0, t_\tau^{'} < 0, t_g^{'} > 0, t_\theta^{'} > 0, t_m^{'} < 0 \quad .$$

Higher debt overhang (a higher debt/GDP ratio, *b*) increases the incentive to inflate in the first period in order to reduce the deadweight losses associated with conventional taxes. A greater foreign share of the debt overhang (f) increases the attractiveness of the inflation tax since it increases the share of the tax paid by foreign lenders. Less efficient tax collection (bigger τ) increases the gain associated with the inflation tax. Higher fiscal expenditure (*g*) is associated with a higher tax rate *t* as well as higher inflation. Higher indexation (θ) reduces the efficacy of inflation as an implicit tax, thereby increasing the explicit tax rate, *t*. A higher average maturity on the debt implies that a given inflation imposes a larger capital tax on the bond holders, hence it reduces the optimal inflation and the associated tax rate.

Figure 12 summarizes a sensitivity analysis of the model for parameter values comparable to today's experience. The initial debt overhang is set at b =0.5, the share held by foreign creditors is f = 0.5, and fiscal expenditures as a share of GDP is g = 0.25. In addition, average annual debt maturities are set at m = 4, the share of indexed bonds at θ = 0.10, and the annual real interest rate at r = 0.01.[34] Finally, we (somewhat arbitrarily) set the tax collection

[34] Recall that the period length coincides with the duration of a business cycle and/or an inflationary-disinflationary cycle, assumed to be four years for the U.S. This implies that the effective gross real interest rate applied in the calculation is $(1+r)^4$, which for small interest rates is about 1+ 4r. The duration *m* in the expression $b\overline{Y}(1-\theta)/(1+\pi_1)^m$ approximates the impact of inflation on the nominal debt.

cost at τ =0.25 (implying that 4 cents of each dollar in gross tax payments covers collection costs when the tax rate is t =0.30).[35]

The optimal inflation and the tax rate solved by the model reflect the optimal trade-off between two possible adjustments. The first is surprise inflation, triggering capital losses on debt holders in the first period and a costly decline in average output due to the inflation-disinflation cycle in the first period. The second adjustment is setting a tax rate *t* at a level needed to service the post-inflation debt/GDP. The marginal social cost of such a tax is $t\tau$ and increases with the tax rate and with the parameter measuring the cost of tax collection and enforcement, τ .[36]

The sensitivity analysis in Figure 12 reflects this trade-off. A higher share of debt held by foreigners increases the optimal inflation because domestic consumers then bear a smaller share of the capital losses (a 'tax- thy- neighbor' effect). The optimal inflation increases with the GDP share of government. Higher government expenditures increase the average tax rate and thus the marginal cost of public funds ($t\tau$), raising the inflation as a mechanism to reduce the distortions associated with the tax. Similarly, a higher tax collection cost parameter implies that a given tax rate *t* is associated with a higher marginal cost of public funds, $t\tau$, thus increasing the reliance on inflation as a mechanism to reduce the needed tax revenue. A higher debt overhang, *b*, calls for a higher tax rate *t*, increasing the marginal cost of collecting taxes and the first-period inflation. A higher share of indexed debt reduces the effectiveness of inflation as a capital tax, reducing the optimal inflation and increasing the optimal tax. Not surprisingly, higher costs of inflation (higher h and lower ϕ) reduce the optimal inflation.

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[35] Some studies suggest that the deadweight loss from taxes is much higher for the United States, on the order of 30-50 percent per marginal tax dollar collected. For example, see Browning (1987) and Feldstein (1999). A higher value of τ increases optimal inflation.

[36] Thus, raising an extra dollar of net tax revenue requires raising gross taxes by $1+t\tau$.

The optimal inflation for our benchmark case is about 6%, and the corresponding tax rate is about 27.5%. The outcome of the inflation episode is that the post-stabilization debt/GDP ratio is about 0.40. The surprise arrival of a moderate inflation episode significantly reduces the debt overhang within four years. The output cost of the resultant inflation/disinflation cycle is $h\pi_s^{\phi}$, about four percentage points of GDP in our parameterization of the benchmark case.

A key assumption of our model is that the political process is efficient. In other words, the tax rate adjusts instantaneously to the level needed to meet the government's intertemporal budget constraint [the reduced form of which is equation (8)]. This assumption, combined with a time period equal to the duration of the inflation/disinflation cycle, implies that the economy reaches the long-run debt/GDP ratio within one period. In the benchmark case defined above, within four years the debt/GDP reaches the long-run level of about 40 percent. In period 2, the economy runs a primary surplus of 2.5 percent [the difference between the tax rate, 27.5 percent, and government GDP share, 25 percent]. This level of the primary surplus funds debt servicing for the indefinite future.[37]

Applying parameter values to the base model that duplicate the 1946 experience (b = 1.1, g = .25, f = 0, θ = 0, r = 0.01, and m =9) results in an inflation rate around 3 percent. This inflation rate is below the 4.2 percent average inflation observed over the decade 1946-1955, but not by much.

The accuracy of our analysis is hampered by not having precise values for deadweight losses associated with income taxes and inflation, and these costs may differ today compared to

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[37] Applying our model, it follows that the resulting debt/GDP ratio, denoted d^*, equals $\dfrac{t^* - 0.5\tau t^{*2} - g}{r}$, and it depends positively on the equilibrium tax rate, t^*. Applying our analysis, it follow that $d^* = d^*(b,\ f, \tau, g, \theta, m);\quad (d^*)'_b > 0, (d^*)'_f < 0, (d^*)'_\tau < 0, (d^*)'_g > 0, (d^*)'_\theta > 0, (d^*)'_m < 0.$

the 1940s.[38] To illustrate, suppose the cost of inflation was lower in the aftermath of World War II. Figure 13 shows the relationship between projected inflation after World War II and the cost of inflation, ϕ, where a higher ϕ is associated with a lower inflation cost. The earlier sensitivity analysis assumed $\phi = 1.15$. Increasing ϕ to 1.4 would increase predicted inflation in the aftermath of World War II to about 6 percent, above the average inflation for the decade 1946-1955 but about equal to the rate observed over the shorter 1946-1952 period. Of course, this example suggests that if the cost of inflation and other structural parameters are not stable over time, intertemporal comparisons are problematic.

To put the model results into perspective, it is important to remember that the model is designed to provide a simple framework for identifying factors that influence the use of surprise inflation. Since key parameters of the model (e.g., the cost if inflation/disinflation, the welfare cost of taxes) are hard to estimate precisely, the optimal surprise inflation cannot be determined with great precision. Furthermore, the assumption that the political process is efficient in delivering the optimal tax adjustment is surely too optimistic.

In our model, an unanticipated inflation rate of π in the first period delivers an ex-post real interest rate of $r - \pi$. For our benchmark case, a 6 percent inflation rate implies a negative real interest rate of 5 percent for about four years. While spells of negative real interest rates on U.S. government bonds materialized from the late 1940s to the 1970s, one might argue that negative real rates over several years are not feasible today.

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[38] In the model, the cost of inflation is $1 - h\pi^{\phi}$. If $h = 1$ and $\phi = 1.15$, an inflation of 5 percent is associated with an output cost during the inflation-disinflation cycle of about 3 percent of GDP. The inflation rate predicted by the model depends critically on the assumed inflation cost. Above some threshold inflation, these costs may arguably accelerate. In another context, Bruno and Easterly (1998) show that the cost of inflation increases above some threshold.

Yet one should not be too quick to rule out such a possibility. Reinhart and Sbrancia (2011) show that the United States and other advanced economies achieved a high incidence of negative real interest rates from the late 1940s to the 1970s through a mix of modest inflation and financial repression that kept nominal interest rates low. They estimate that the annual liquidation of U.S. federal debt via negative interest rates averaged 3 to 4 percent of GDP over the 1945-80 period, or 30 to 40 percent of GDP over a decade. Today's large debt overhang might tempt policy makers to introduce a mix of modest inflation and financial repression once again. Repression could be achieved with new prudential regulations or a requirement that captive financial institutions accept public debt at below market interest rates.

If negative real rates over several years are not feasible, then the cost of inflation/disinflation is higher than the one assumed in our benchmark case, leading to a lower optimal inflation and a higher optimal tax. The model and the sensitivity analysis reported in Table 12 provide a convenient way of tracing these trade-offs.

If the Federal Reserve decided to generate higher inflation for several years, could it do so? One view is that higher inflation may be difficult to achieve if an economy is possibly in a liquidity trap. A contrary view is that aggressive monetary expansion by the U.S. authorities in response to the Great Recession of 2008-2009 may yet deliver higher inflation. If not, the U.S. could repay the sizable U.S. debt without inflation by printing money, an unlikely outcome.

Another possible obstacle to generating more inflation is that the Federal Reserve seems committed to a lower inflation target of about two percent. Hence, an inflation rate above five percent for several years would diminish the credibility of the Fed and possibly trigger inflationary expectations. Olivier Blanchard, chief economist at the IMF, has argued the two-percent inflation target may be too low. He recommends targeting a higher inflation rate of about four percent.[39] More recently, Ken Rogoff, a former chief economist at the IMF, has suggested a moderate inflation for several years may have some merit.[40] Not only would a moderate inflation lead to some erosion of the public debt, it would help mitigate the deflation in house prices, thereby reducing the rate of foreclosures and supporting an earlier recovery. While we do not take a position on these concerns, the framework outlined above could be adapted to incorporate these issues.

4. Conclusion

A lesson to take from the model and the sensitivity analysis is that eroding the debt through inflation is not farfetched. The model predicts that a surprise arrival of a moderate inflation episode on the order of 6 percent could reduce the debt/GDP ratio by up to 20 percent within 4 years. That inflation rate is only slightly higher than the average observed after World War II. Of course, inflation projections would be much higher than 6 percent if the share of publicly-held debt in the U.S. were to approach the 100 percent range observed at the end of World War II. Hence, while moderate inflation may help reduce today's debt burden, it is a much less powerful tool for addressing long-term fiscal challenges.

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[39] "At a 4% inflation rate," Mr. Blanchard says, "short-term interest rates in placid economies likely would be around 6% to 7%, giving central bankers far more room to cut rates before they get near zero, after which it is nearly impossible to cut short-term rates further." *Wall Street Journal*, February 12, 2010.

[40] "If direct approaches to debt reduction are ruled out by political obstacles, there is still the option of trying to achieve some modest deleveraging through moderate inflation of, say, 4 to 6 per cent for several years. Any inflation above 2 per cent may seem anathema to those who still remember the anti-inflation wars of the 1970s and 1980s, but a once-in-75-year crisis calls for outside-the-box measures." *Financial Times*, August 8, 2011.

The current period shares two features with the immediate post-war period. It starts with a large debt overhang and low inflation. Both factors increase the temptation to erode the debt burden through inflation.

Even so, there are two important differences between the periods. Today, a much greater share of the public debt is held by foreign creditors—48 percent instead of zero. This large foreign share increases the temptation to inflate away some of the debt.[41] This temptation may be reduced, however, should the implicit repudiation of debt obligations through inflation come at the cost of higher risk premia on newly-issued debt. Another important difference is that today's debt maturity is less than half what it was in 1946—3.9 years instead of 9. Shorter maturities reduce the temptation to inflate. These two competing factors appear to offset each other, and the net result in a simple optimizing model is a projected inflation rate slightly higher than that experienced after World War II, but for a shorter duration.

In the sensitivity analysis, we raised a concern about the stability of some parameters across periods, particularly the parameters that capture the cost of inflation. It may be that the cost of inflation is higher today because globalization and the greater ease of foreign direct investment provide new options for producers to move activities away from countries with greater uncertainty. Inflation above some threshold could generate this uncertainty, reducing further the attractiveness of using inflation to erode the debt.

Moreover, history suggests that a modest inflation may increase the risk of an unintended inflation acceleration to double digit levels, as happened in 1947, and in 1979-1981.

[41] Figure 12 suggests that if all debt today were held by domestic creditors ($f = 0$), projected inflation would be zero. Thus, 'tax your neighbor' is a key feature of the inflationary bias suggested by the model. Of course, with a higher debt/GDP ratio approaching IMF estimates of $b = 1$, inflation could be positive even with $f = 0$.

Such an outcome often results in an abrupt and costly adjustment down the road.[42] Accelerating inflation had limited global implications at a time when the public debt was held domestically and the U.S. was the undisputed global economic leader. In contrast, unintended acceleration of inflation to double digit levels in the future may have unintended adverse effects, including growing tensions with global creditors and less reliance on the dollar.[43]

[42] Such a cycle is also politically costly because U.S. savers are exposed to another volatile cycle in their retirement and savings accounts.

[43] For the threat to the dollar from the Euro, see Chinn and Frankel (2008).

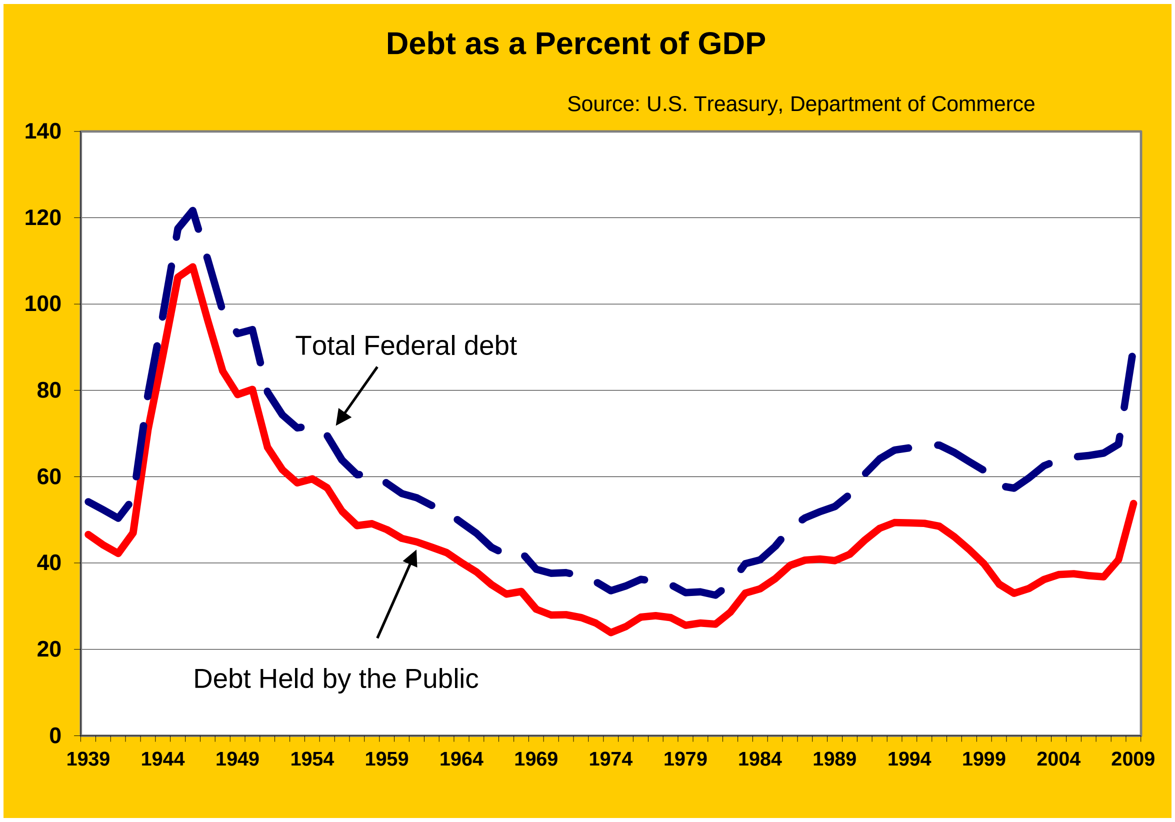


Figure 1: Debt as a Share of GDP

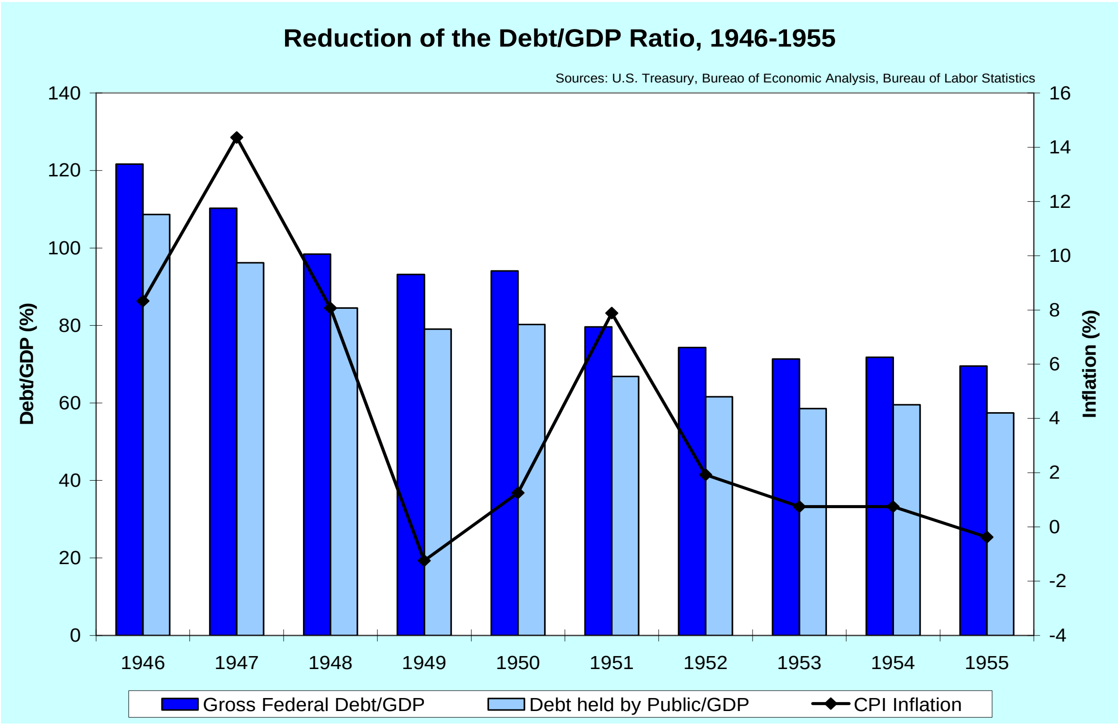


Figure 2: U.S. Debt Reduction, 1946-1955

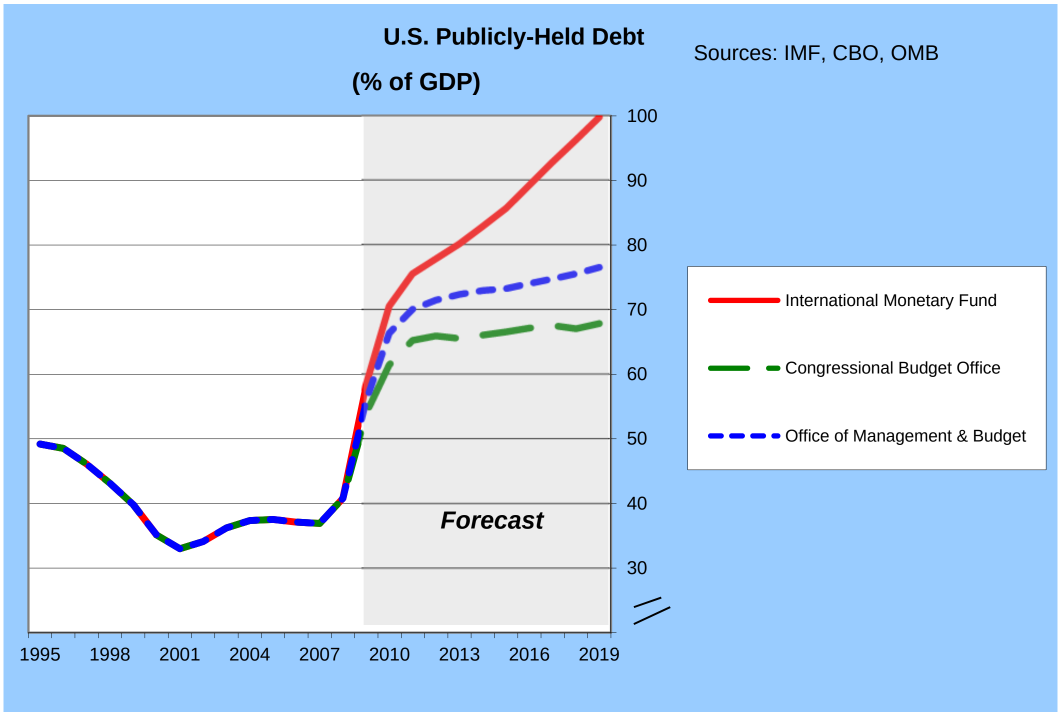


Figure 3: America’s Projected Debt Burden

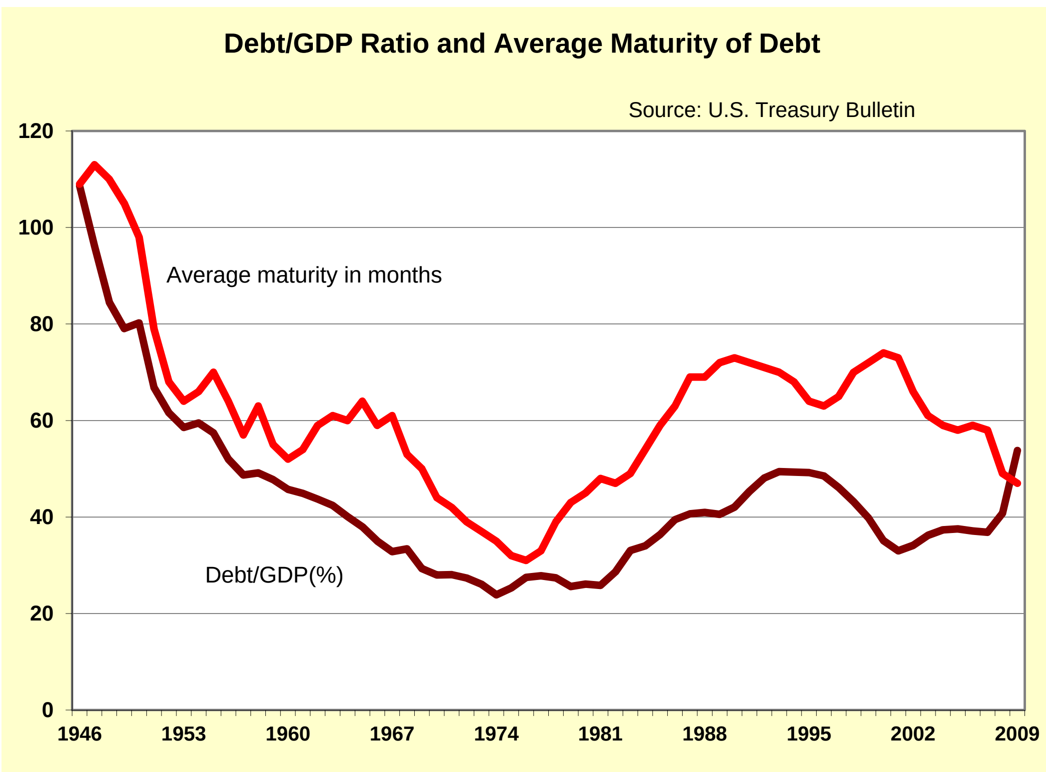


Figure 4: Average Maturity Length and Share of Debt Held by the Public

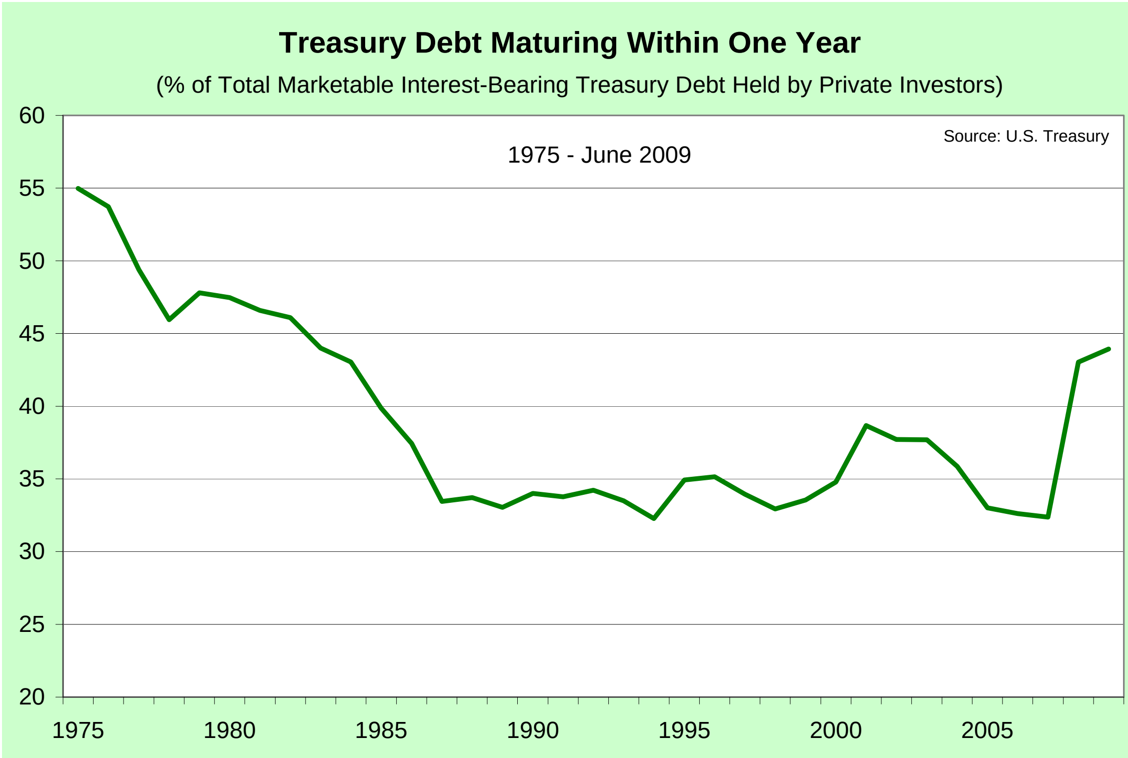


Figure 5: Debt Maturing Within One Year

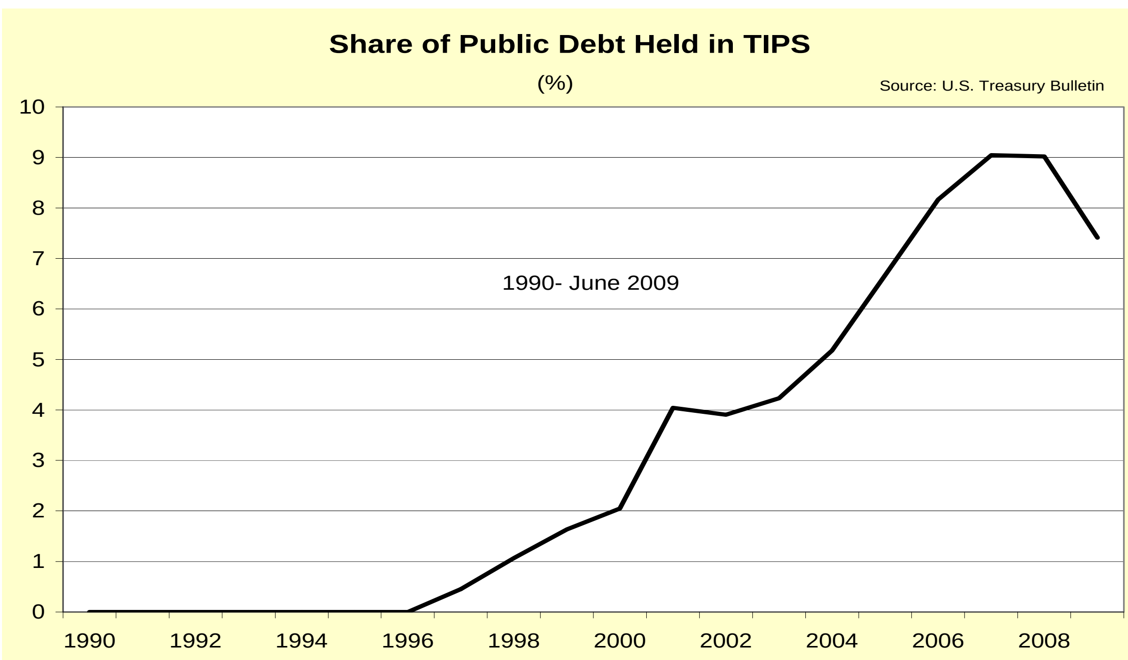


Figure 6: Share of Public Debt Held in TIPS (Treasury Inflation-Protected Securities)

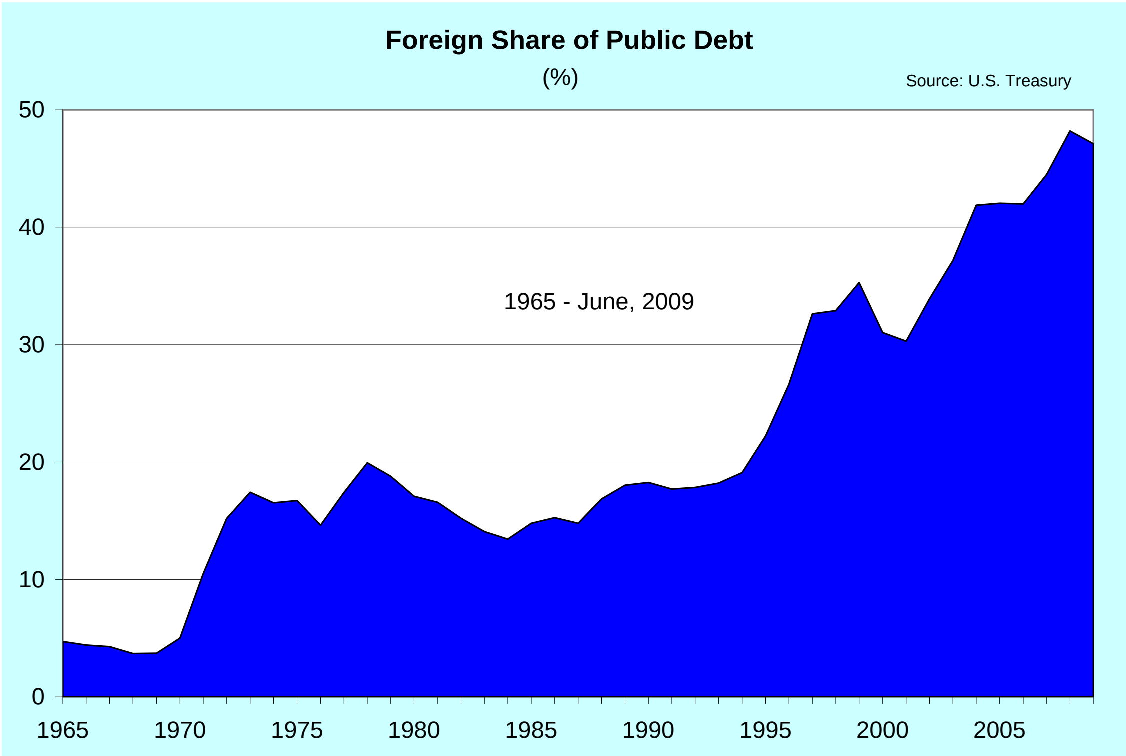


Figure 7: Foreign Share of Publicly-Held Federal Debt

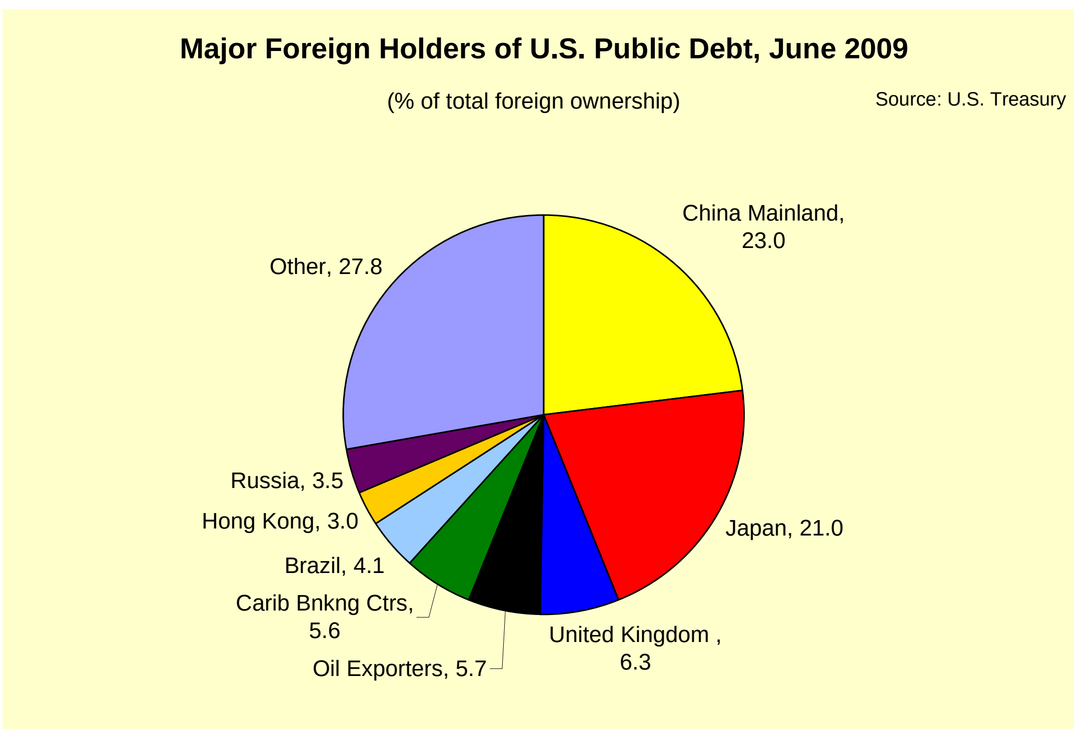


Figure 8: Major Foreign Holders

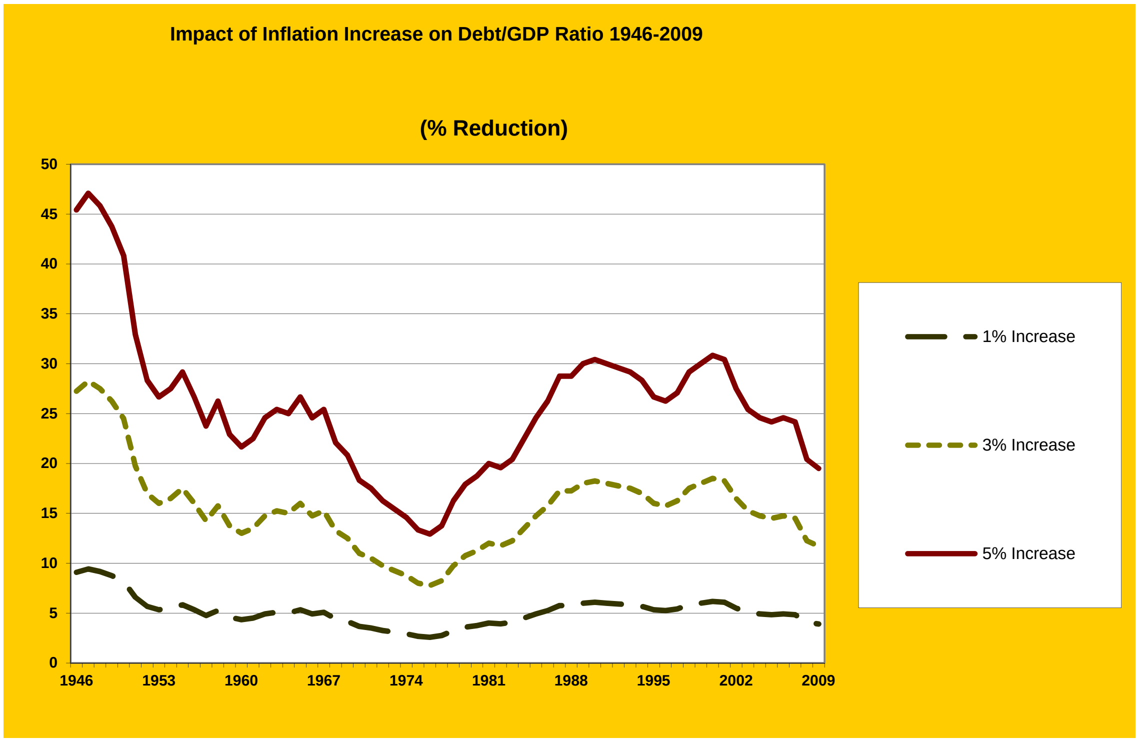


Figure 9: Impact of Inflation on Publicly-Held Debt as a Share of GDP

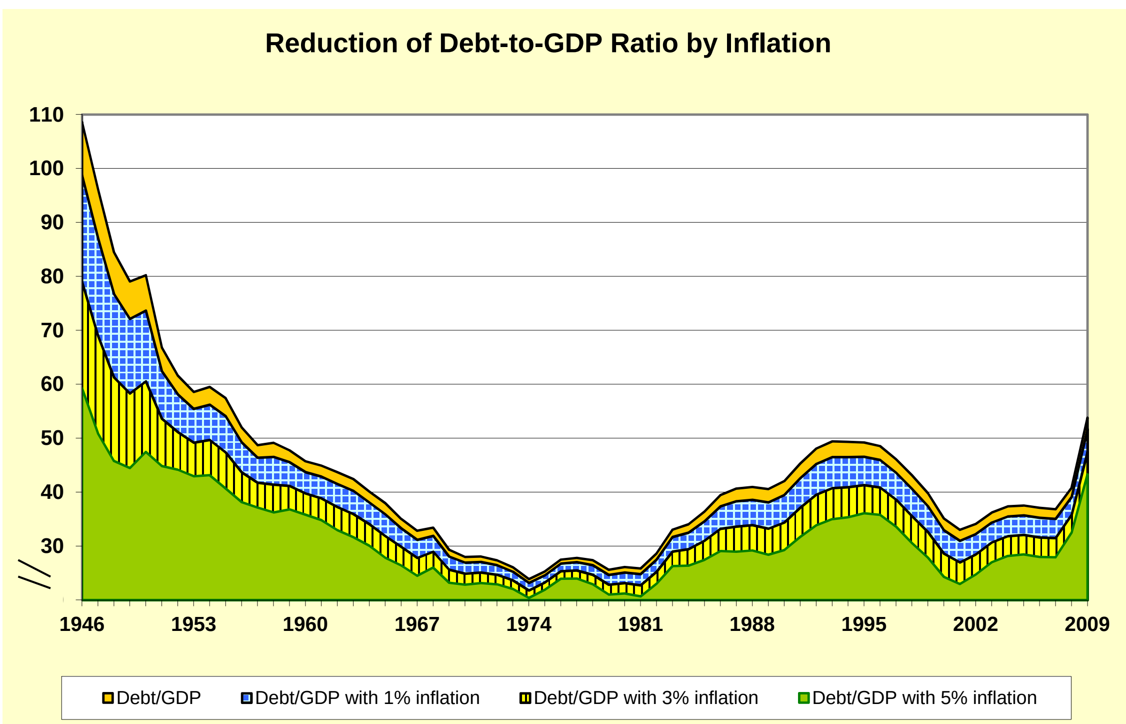


Figure 10: Share of Debt held by Public under Various Inflation Scenarios

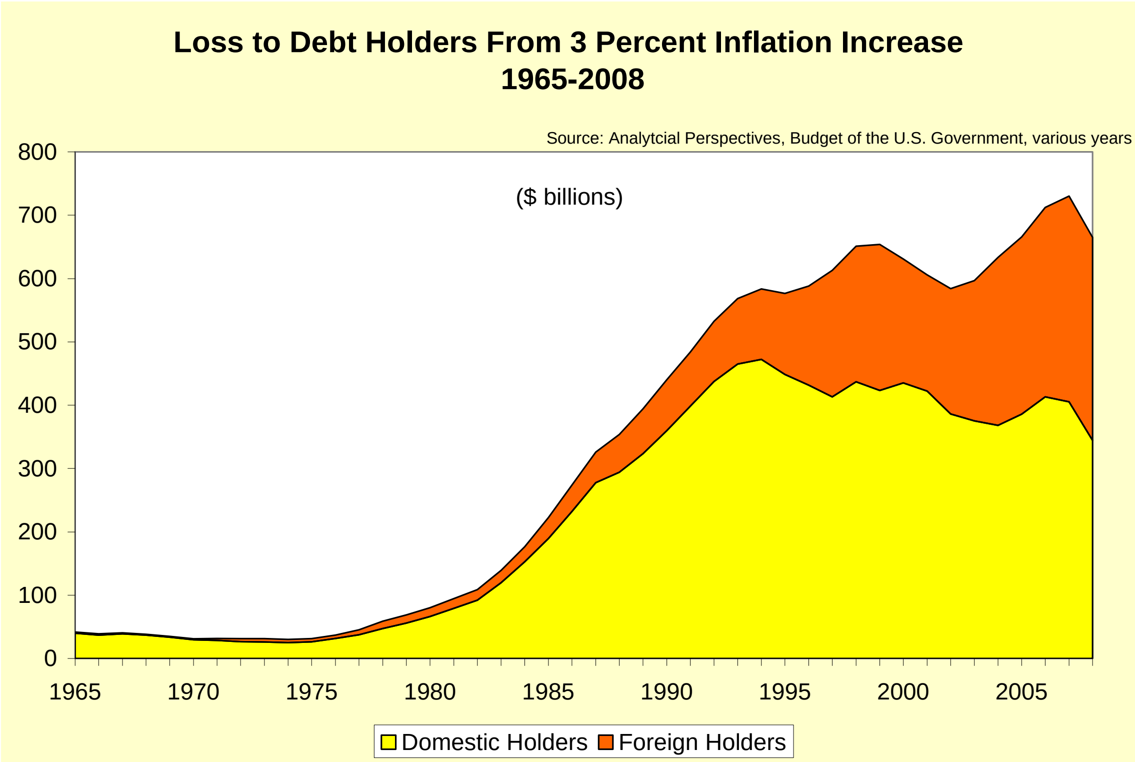
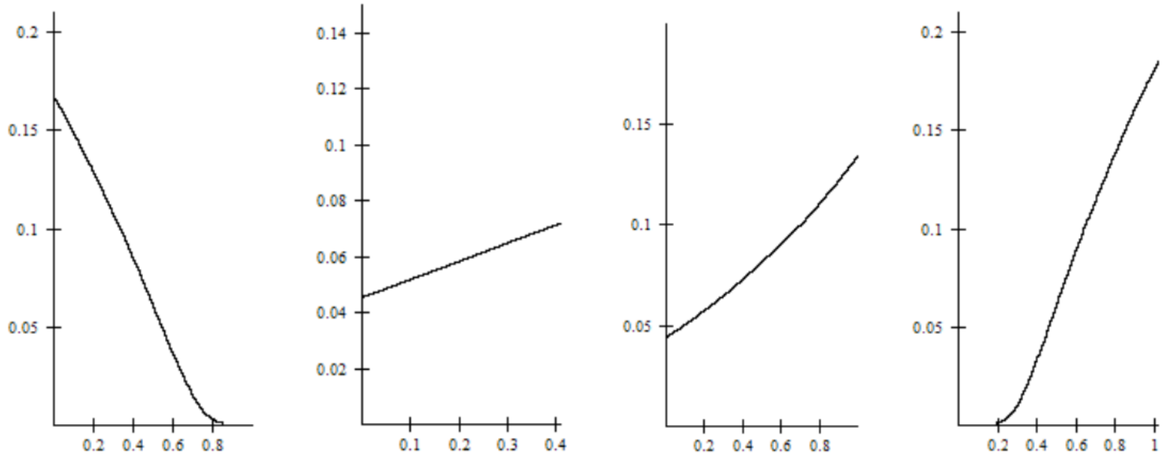
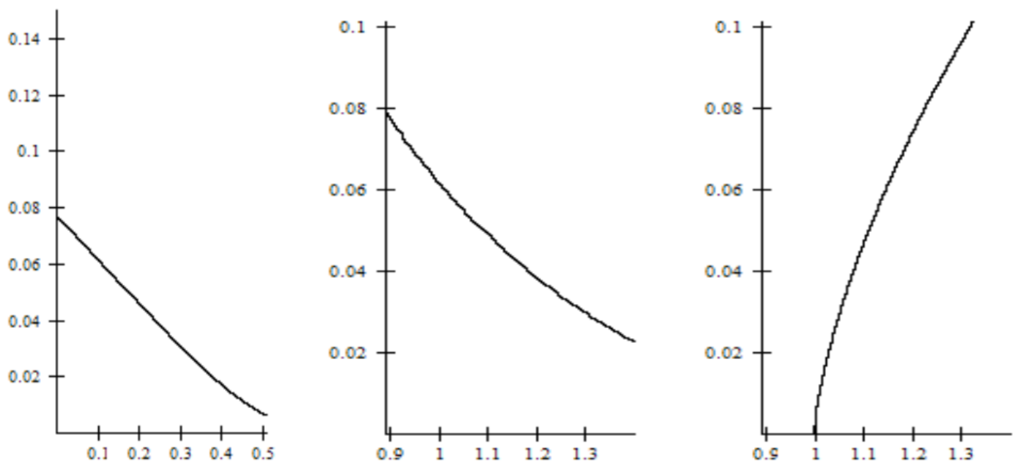


Figure 11: Loss to Domestic and Foreign Debt Holders



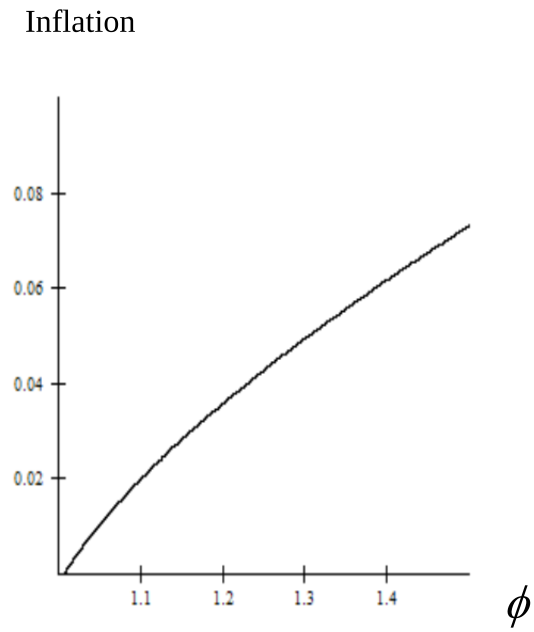
Domestic share, 1 – f; Fiscal expenditure share, g; Collection cost, τ ; Public Debt/GDP, b



Share of indexed debt, θ ; Inflation cost parameter, h; Inflation cost parameter, ϕ

The baseline assumptions are: $m = 4$, $b = 0.5$, $f = 0.5$, $g = 0.25$
$r = 0.01$, $\theta = 0.1$, $\tau = 0.25$, $\phi = 1.15$, and $h = 1$.

Figure 12: Association Between Predicted Inflation and Parameter Values



Note: Inflation rate calibrated for 1946. Lower inflation cost increases cost parameter ϕ.

Figure 13: Association between Inflation and Inflation Cost Parameter ϕ

Table 1: Debt Maturity and Inflation, 1946-2008

VARIABLES	(1) maturity	(2) maturity	(3) maturity	(4) maturity	(5) maturity	(6) maturity
debt/GDP	0.711*** [0.134]	0.710*** [0.144]	0.680*** [0.152]	0.694*** [0.122]	0.694*** [0.124]	0.740*** [0.115]
inflation		-0.000610 [0.0461]	0.0242 [0.0419]	-0.0451 [0.0398]	-0.0454 [0.0437]	-0.0183 [0.0366]
infla lagged			-0.0459 [0.0406]			
g/GDP				0.594* [0.350]	0.593 [0.356]	0.0165 [0.345]
growth					-0.000409 [0.00912]	-0.00320 [0.00771]
trend						0.00545*** [0.00182]
Constant	-1.036** [0.496]	-1.032* [0.558]	-0.897 [0.601]	-2.705** [1.334]	-2.697* [1.367]	-1.445 [1.120]
Observations	55	55	55	55	55	55

Newey-West standard errors with second-order autocorrelation correction in brackets.
*** p<0.01, ** p<0.05, * p<0.1. All variables in logs except trend and GDP growth.

Appendix

Table A1: Impact of Inflation on the Share of Publicly-Held Debt

Year	Debt/GDP Actual	Debt/GDP 1% inflation	Debt/GDP 3% inflation	Debt/GDP 5% inflation
1946	108.6	98.8	79.0	59.3
1947	96.2	87.1	69.0	50.9
1948	84.5	76.7	61.3	45.8
1949	79.0	72.1	58.3	44.5
1950	80.2	73.7	60.6	47.5
1951	66.8	62.4	53.6	44.8
1952	61.6	58.1	51.1	44.2
1953	58.6	55.4	49.2	42.9
1954	59.5	56.2	49.7	43.1
1955	57.4	54.1	47.4	40.7
1956	52.0	49.2	43.7	38.1
1957	48.7	46.4	41.8	37.1
1958	49.1	46.6	41.4	36.2
1959	47.8	45.6	41.2	36.8
1960	45.7	43.7	39.8	35.8
1961	44.9	42.9	38.9	34.8
1962	43.7	41.5	37.2	33.0
1963	42.4	40.3	36.0	31.6
1964	40.1	38.1	34.1	30.1
1965	38.0	35.9	31.9	27.8
1966	35.0	33.3	29.9	26.4
1967	32.8	31.2	27.8	24.5
1968	33.4	31.9	29.0	26.0
1969	29.3	28.1	25.7	23.2
1970	28.0	27.0	24.9	22.8
1971	28.1	27.1	25.1	23.1
1972	27.4	26.5	24.7	22.9
1973	26.1	25.3	23.7	22.1
1974	23.9	23.2	21.8	20.4
1975	25.3	24.6	23.3	21.9
1976	27.5	26.8	25.4	23.9
1977	27.8	27.0	25.5	24.0
1978	27.4	26.5	24.7	22.9
1979	25.6	24.7	22.9	21.0
1980	26.1	25.1	23.2	21.2
1981	25.8	24.8	22.7	20.7
1982	28.6	27.5	25.3	23.0
1983	33.1	31.7	29.0	26.3
1984	34.0	32.5	29.4	26.4
1985	36.4	34.6	31.0	27.4
1986	39.4	37.4	33.2	29.1
1987	40.7	38.3	33.7	29.0

1988	41.0	38.6	33.9	29.2
1989	40.6	38.1	33.3	28.4
1990	42.0	39.5	34.4	29.3
1991	45.3	42.6	37.2	31.7
1992	48.1	45.2	39.5	33.9
1993	49.4	46.5	40.8	35.0
1994	49.3	46.5	40.9	35.3
1995	49.2	46.6	41.3	36.1
1996	48.5	46.0	40.9	35.8
1997	46.1	43.6	38.6	33.6
1998	43.1	40.6	35.6	30.5
1999	39.8	37.4	32.6	27.9
2000	35.1	33.0	28.6	24.3
2001	33.0	31.0	27.0	23.0
2002	34.1	32.2	28.5	24.7
2003	36.2	34.4	30.7	27.0
2004	37.4	35.5	31.8	28.2
2005	37.5	35.7	32.1	28.5
2006	37.1	35.3	31.6	28.0
2007	36.8	35.1	31.5	27.9
2008	40.8	39.1	35.8	32.5
2009	53.8	51.7	47.5	43.3

A.2 Debt Reduction After the American Revolution and the Civil War

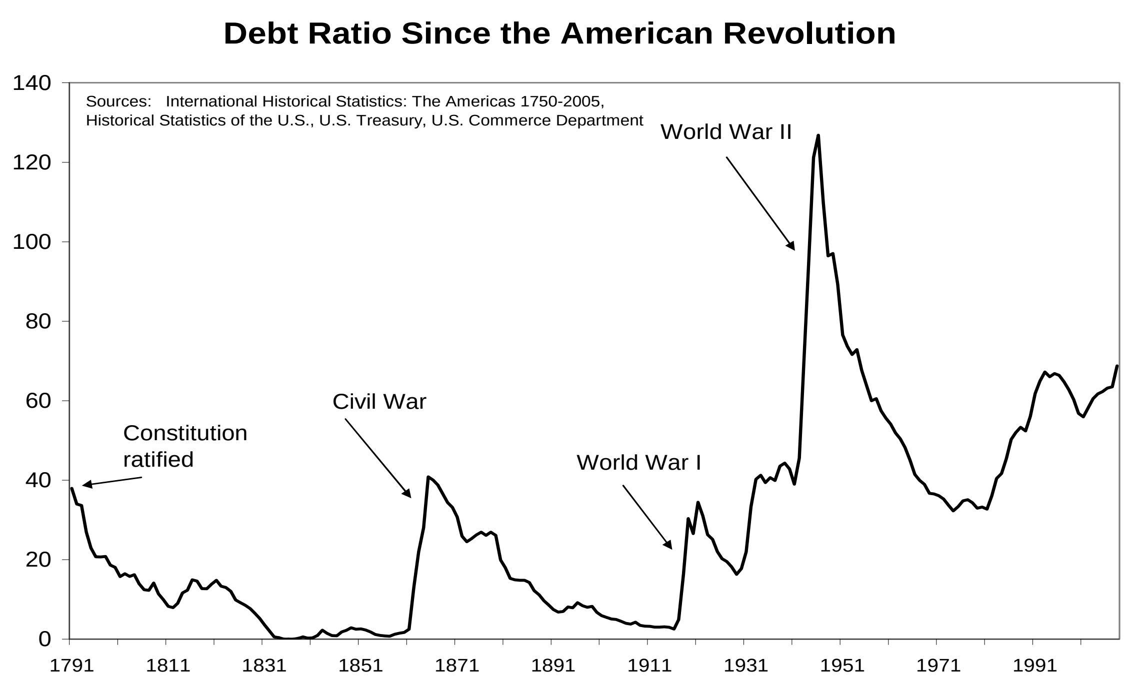


Figure A.1: Government Debt Ratio Since the American Revolution

Figure A.1 shows the growth of Federal debt as a share of GNP from 1790 to 2008. Although GNP figures are suspect before 1840, the date of the first census, the graph clearly illustrates the large increases in the debt/GNP ratio during wartime and the large declines afterwards.

In this Appendix, we briefly examine the American Revolutionary War (1776-1781) and the Civil War (1861-1865) periods. We find that inflation played virtually no role in eroding the debt/GNP ratio in the aftermath of these wars. Instead, GNP growth and specie tariff revenue applied to redeeming debt principal and interest reduced the debt ratio in the aftermath of these major conflicts.

Revolutionary War Period (1775-1801). The Congress and the states financed most of The War of Independence (1776-1781) by issuing paper money, resulting in a rapid inflation and currency depreciation. Although the war was about 85 percent financed by money printing, the government also borrowed funds, mostly from its own citizens. The French government and Dutch investors also provided some loans.

The U.S. Congress first started borrowing in October, 1776. The interest rate offered was 4 percent, payable in specie or its equivalent in foreign bills of exchange, and the certificates had a 3-year maturity. In February, 1777, to attract investors, the interest rate was raised to 6 percent and the new securities had no fixed maturity dates. The 3-year certificates previously issued were not retired on schedule, since redemption funds were nonexistent; instead, they were converted into open-ended obligations as well. In March 1778, the offer to pay interest in specie was withdrawn and holders were promised interest payments merely in currency.[44] In the 1780s, holders received interest payments in IOUs. Since no one knew when congressional debts would be repaid, or when and in what form interest payments would be forthcoming, the securities traded at large discounts. Even in the mid-1780s, sellers of federal securities received very low prices, often ten to fifteen cents on the dollar.

In 1789, after the ratification of a new Constitution and the inauguration of the first President, Alexander Hamilton was appointed Secretary of the Treasury. He reported to Congress in January, 1790. He stated that the federal domestic debt was

[44] During the brief period when interest payments were made in a (depreciating) currency, inflation was able to erode some value to debt holders.

roughly $40 million, consisting of $27 million in original principal plus $13 million in accrued interest. Another $12 million was owed to foreign creditors.

Hamilton made several recommendations to Congress. He proposed federal assumption of the remaining wartime debts of the states, which would increase the size of the debt by another $18 to $25 million (ultimately it was $18 million, bringing the total federal debt to $70 million, about 27 percent of GNP). He proposed converting all outstanding debt securities into specie-denominated securities at the official par of exchange. The essence of Hamilton's proposal was to defer repayment of debt principal indefinitely but resume interest payments (the $13 million in arrears) in specie.

Hamilton believed that it would make little difference to investors that the bonds had no fixed maturity dates as long as the government pledged to maintain regular interest payments. His calculation that funding interest payments would drive up bond prices (close to par) and reduce yields proved correct. To generate the revenues to cover the interest on the national debt, Hamilton proposed a tax program that relied primarily on an import tariff. After much heated debate, Congress passed the Funding Act of 1790 and Hamilton's plan was enacted.[45] The U.S. did not use inflation to reduce its Revolutionary War debt.

The Civil War Period (1861-1900). When the Civil War broke out in 1861, Congress authorized the Treasury to issue Treasury notes (called greenbacks) as legal tender for payment of all public and private debts and also authorized the sale of bonds. Later, it increased taxes on specific goods, but as these taxes were inadequate to raise the necessary funds to fight the war, a continued reliance on money printing and borrowing was unavoidable. Between 1860 and 1865, when the Civil War ended, prices almost doubled. At the end of 1865, interest-bearing debt stood at $2.7 billion, about 30 percent of GNP, all of it owed to domestic creditors.[46]

With the war over, Congress gave the Secretary of the Treasury authority to convert short-term notes into long-term bonds and begin retiring greenbacks (Bolles,

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[45] For more on war financing and debt management during the American Revolutionary War period, see Calomiris (1988), Myers (1970), Perkins (1994) and Stabile and Cantor (1991).

[46] After the Civil War, foreigners began purchasing U.S. government debt. By the end of 1866, they held 13 percent of the public debt. By 1869, they held about 48 percent (Stabile and Cantor, 1991).

1886). In 1869, it authorized the payment of all interest-bearing obligations in “hard money”—specie. Tax revenue generated primarily through the import tariff was used to pay interest on the debt and a certain amount of the principal each year. By 1880, the public debt had been reduced substantially (the debt/GNP ratio was under 20 percent), through a combination of economic growth and tax revenue targeted at paying interest and principal on the debt. The U.S. did not rely on inflation to reduce its Civil War debt ratio.

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