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DP17172

**How might the UK's Debt-GDP ratio be
reduced? Evidence from the last 120
years**

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Abstract

The motivation for this paper is concerns in the UK with how to bring down the currently high level of the debt-GDP ratio. We consider whether anything can be learned from previous experience over the last 120 years by examining the contributions both to the increase in the debt-GDP ratio and to the reduction of the debt-GDP ratio of various components of the government budget constraint: the primary deficit, growth, inflation and interest rates and payments. We also examine the effectiveness of policy in influencing these components. We conclude by suggesting a combination of these components that might be economically and politically achievable.

JEL Classification: E62, H63

Keywords: Debt-GDP ratio, primary deficit, growth, inflation

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I am very grateful to Ryland Thomas for providing me with an updated version to 2020 of the Bank of England's "Three Centuries of Macroeconomic Data".

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The motivation for this paper is concerns in the UK with how to bring down the currently high level of the debt-GDP ratio. We consider whether anything can be learned from previous experience over the last 120 years by examining the contributions both to the increase in the debt-GDP ratio and to the reduction of the debt-GDP ratio of various components of the government budget constraint: the primary deficit, growth, inflation and interest rates and payments. We also examine the effectiveness of policy in influencing these components. We conclude by suggesting a combination of these components that might be economically and politically achievable.

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1 Introduction

The recent large increases in sovereign debt as a result of the 2008 financial crisis and the Covid-19 pandemic has raised the issue of how to reduce the debt-GDP ratio to normal levels. The problem has been brought into sharper focus by the ending of quantitative easing and the expected future normalisation of interest rates. This paper makes a small contribution to this discussion by detailing the behaviour of the UK debt-GDP ratio between 1900 and 2020. At the start of 2022 the UK's debt-GDP ratio was 94.9 per cent. This compares with its the lowest value since 1900 of 29.0 per cent which occurred in 1990, and 40.7 per cent in 2007, before the financial crisis. We establish how the various components that affect the debt-GDP ratio have contributed to its rise and fall. The emphasis is on the following components: government expenditures, tax revenues, primary deficits, output growth, inflation and the cost of debt. The last three affect debt interest payments. We also examine the role of residual monetary effects. The analysis is largely graphical.

Economic policy is concerned not just with the debt-GDP ratio, but also with economic growth, inflation and interest rates. As well as examining the effect on the debt-GDP ratio of the deficit, growth, inflation and interest rates we therefore also consider what how these components have affected each other. Two interesting questions that are central to economic policy formation (and to which our findings turn out to be unexpected) are the effects of deficit finance on growth and interest rates on inflation. We use a VAR analysis to examine these questions.

We conclude by summarising our main findings and by suggesting a combination of the components of the government budget constraint that would reduce the debt-GDP ratio to a target of 40 per cent of GDP, Gordon Brown's objective, and that might be economically and politically achievable.

2 The government budget constraint

The basic theoretical framework for our analysis is the government budget constraint (GBC) which can be expressed in nominal terms as

$$B_t = G_t - T_t + (1 + R_{t-1})B_{t-1} - \Delta Q_t \quad (1)$$

where B_t is nominal debt, T_t is tax revenues, G_t is government expenditure, R_t is the effective interest rate and ΔQ_t is a residual which includes changes in base money, changes in reserves and any other source of net revenue that are used to finance the deficit. The GBC can be written as ratios to nominal GDP as

$$\frac{B_t}{Y_t} = \frac{G_t}{Y_t} - \frac{T_t}{Y_t} + (1 + R_{t-1})\frac{Y_{t-1}}{Y_t}\frac{B_{t-1}}{Y_{t-1}} - \frac{\Delta Q_t}{Y_t} \quad (2)$$

implying that the change in the debt-GDP ratio is

$$\Delta \frac{B_t}{Y_t} \simeq \frac{G_t}{Y_t} - \frac{T_t}{Y_t} + (R_{t-1} - \pi_{t-1} - \gamma_{t-1})\frac{B_{t-1}}{Y_{t-1}} - \frac{\Delta Q_t}{Y_t} \quad (3)$$

where Y_t is nominal GDP, γ_t is the growth rate of real GDP and π_t is the inflation rate derived from the GDP price deflator. This can be rewritten in terms of the respective individual contributions from government expenditures, tax revenues, interest costs, growth, inflation and the residual as

$$\Delta \frac{B_t}{Y_t} \simeq \frac{G_t}{Y_t} - \frac{T_t}{Y_t} + R_{t-1}\frac{B_{t-1}}{Y_{t-1}} - \gamma_{t-1}\frac{B_{t-1}}{Y_{t-1}} - \pi_{t-1}\frac{B_{t-1}}{Y_{t-1}} - \frac{\Delta Q_t}{Y_t} \quad (4)$$

Thus $\gamma_{t-1}\frac{B_{t-1}}{Y_{t-1}}$ and $\pi_{t-1}\frac{B_{t-1}}{Y_{t-1}}$ are the contributions to the reduction of the debt-GDP ratio of growth and inflation, respectively, and $R_{t-1}\frac{B_{t-1}}{Y_{t-1}}$ is the contribution to the cost of debt of interest payments. The former arise from the growth of nominal GDP, but they are an underestimate of the contributions of growth and inflation as they do not include the effect of nominal growth on the residual term, for example, through seigniorage from the erosion of the real cost of monetary liabilities. Data on these liabilities are not available.

The change in the debt-GDP ratio can also be written as

$$\Delta \frac{B_t}{Y_t} = \frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_t} \simeq \frac{\Delta B_t}{Y_t} - (\gamma_t + \pi_t) \frac{B_{t-1}}{Y_{t-1}} \quad (5)$$

This shows the contributions of the change in nominal debt $\frac{\Delta B_t}{Y_t}$ and of nominal income growth $(\gamma_t + \pi_t) \frac{B_{t-1}}{Y_{t-1}}$.

3 Empirical evidence 1900-2020

We now present a graphical representation of the debt-GDP ratio and the contributions of the various components identified above for the period 1900-2020.

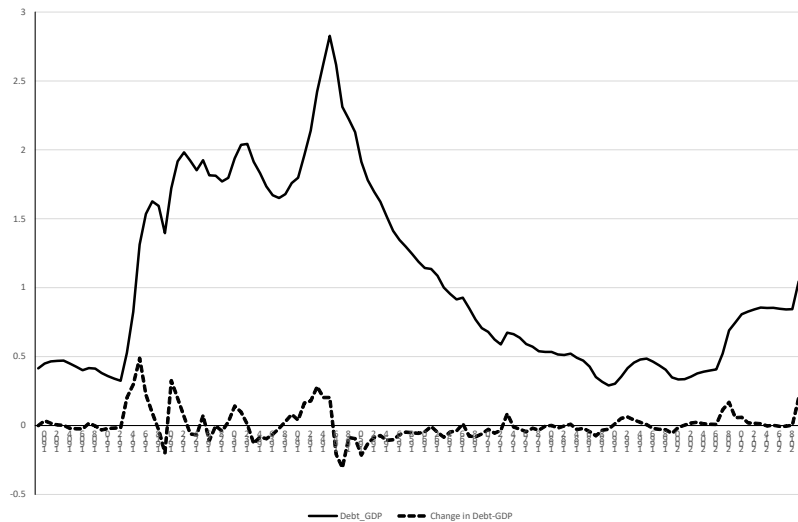


Figure 1. Level and Change in UK Debt-GDP Ratio, 1900-2020

Three distinct phases may be identified. First, there was the massive increase in debt due to WWI between 1914 and 1919 from 53 per cent of GDP in 1914 to 159 per cent in 1919, which reached a peak of 198 per cent in 1923. These levels were sustained until the Great Depression, when in 1932 and 1933 it rose again reaching 204 per cent. The second phase occurred with WWII when the debt-GDP ratio rose from 168 per cent in 1939 to 283 per cent in 1946 and stayed above 200 per cent until 1951. Thereafter there was a steady fall in the debt-GDP ratio until 1973

when it fell to 59 per cent. It rose again in 1974 and 1975 to 67 per cent before, once more, falling steadily until it reached 29 per cent in 1990, the lowest value through the whole period from 1900 to 2020. Third phase is the rise from 2007, before the financial crisis, to the present day: it was 41 per cent in 2007 and 105 per cent in 2020, the latest date when there are data on all of the variables in the budget constraint. At the time of writing (April 2022) it is 95 per cent. There are, therefore, two main periods when the debt-GDP ratio was reduced: from 1951 to 1973, and from 1976 to 1990. We are especially interested in how the various factors above contributed to this.

3.1 Contributions to changes in the debt-GDP ratio

Our principal concern in this paper is to examine the contributions of the various factors that influence the debt-GDP ratio as captured by the GBC. In Figure 2 we show the contributions of all of the factors. The components that tend to increase the debt-GDP ratio are, primarily, government expenditures $\frac{G_t}{Y_t}$, and debt-interest payments $R_{t-1} \frac{B_{t-1}}{Y_{t-1}}$. Those that tend to reduce the debt-GDP ratio are depicted as negatives; these are growth effects on debt-interest payments $\gamma_{t-1} \frac{B_{t-1}}{Y_{t-1}}$, inflation effects on debt-interest payments $\pi_{t-1} \frac{B_{t-1}}{Y_{t-1}}$, and monetary and related effects $\frac{\Delta Q_t}{Y_t}$. All contributions in each of the following graphs are expressed as proportions of nominal GDP. As it is not easy to determine from Figure 2 the role of individual factors, we look at them separately.

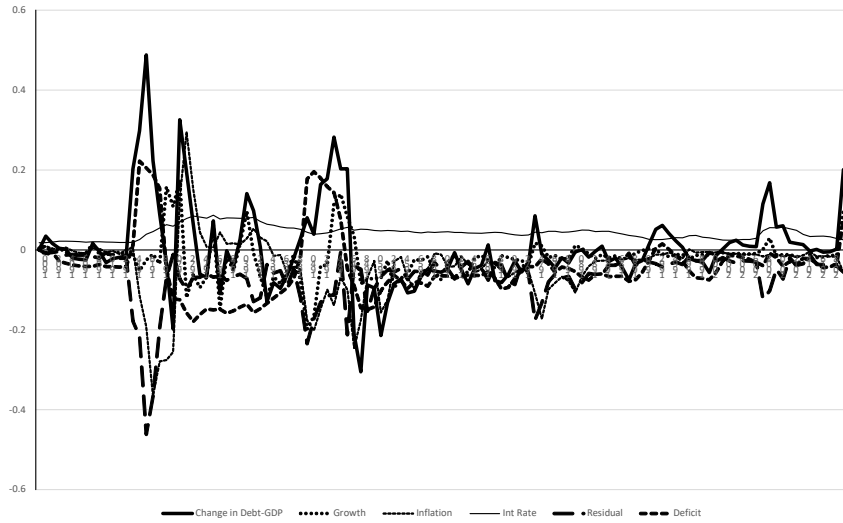


Figure 2. Change in UK Debt-GDP Ratio and Components, 1900-2020

3.1.1 The primary deficit

Figure 3 shows the change in the debt-GDP ratio together with government expenditures, tax revenues and the primary deficit as a proportion of GDP. It is clear from Figure 3 that a principal cause of changes in the debt-GDP ratio is the primary deficit. Tax revenues have generally exceeded government expenditures on goods and services, giving a primary surplus, though not a budget surplus. Notable exceptions are from 1920-1933 and in 2009 when the debt-GDP ratio increased but the deficit did not. Large changes in the debt-GDP ratio are due to the level of government expenditures, principally during the two world wars, and in 1974, 2009 and 2019-20. This leaves the question of what caused the debt-GDP ratio to increase if it wasn't the primary deficit.

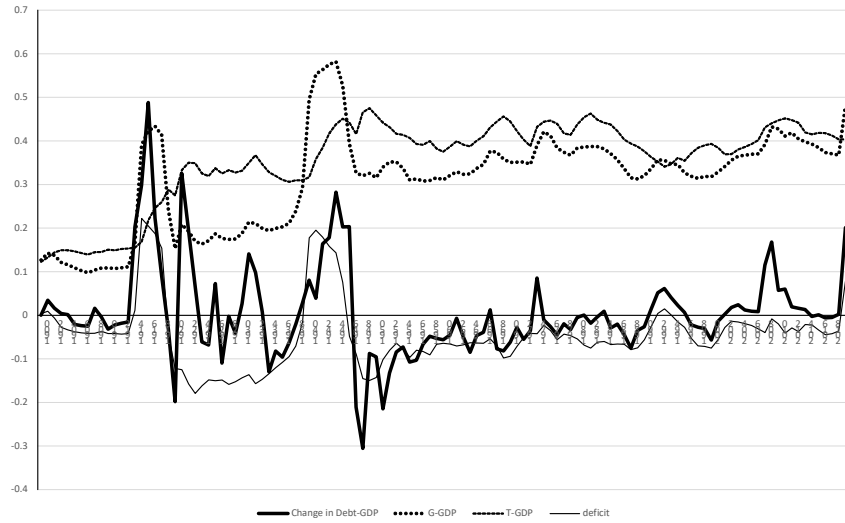


Figure 3. Change in UK Debt, Expenditure and Tax Revenue Ratios to GDP, 1900-2020

3.1.2 Growth, Inflation and interest rates

Figure 4 plots the rates of growth and inflation together with the effective rate of interest (nominal interest payments divided by nominal debt), Figure 5 shows the combined contributions of growth and inflation as the nominal growth rate of GDP and Figure 6 shows their individual contributions.

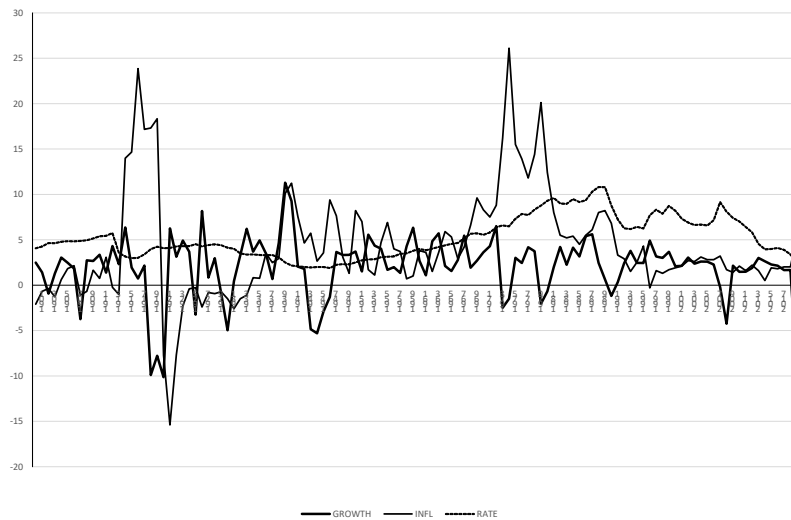


Figure 4. UK Growth, Inflation and the Effective Rate of Interest, 1901-2020

Figure 4 shows that inflation was very high during WWI, high in the 10 years following WWII and then very high in the years following the oil crisis from 1973 - 1975 when it rose to over 17 per cent (the RPI was 25 per cent). The fluctuations in growth have been much less than those in inflation. Negative growth occurred notably at the end of WWI, in 1933 during the Great Depression, in 1974 due to the oil crisis, in 2008 due to the financial crisis and lastly in 2020 due to the pandemic. All of these negative growth rates were temporary. In contrast the effective interest rate was fairly constant until around 1969 when the collapse of the Bretton Woods system removed the target exchange rate nominal anchor. They reached a peak of over 10 per cent in 1989 and fluctuated thereafter. These higher and more volatile rates might also reflect the removal of capital controls in 1984.

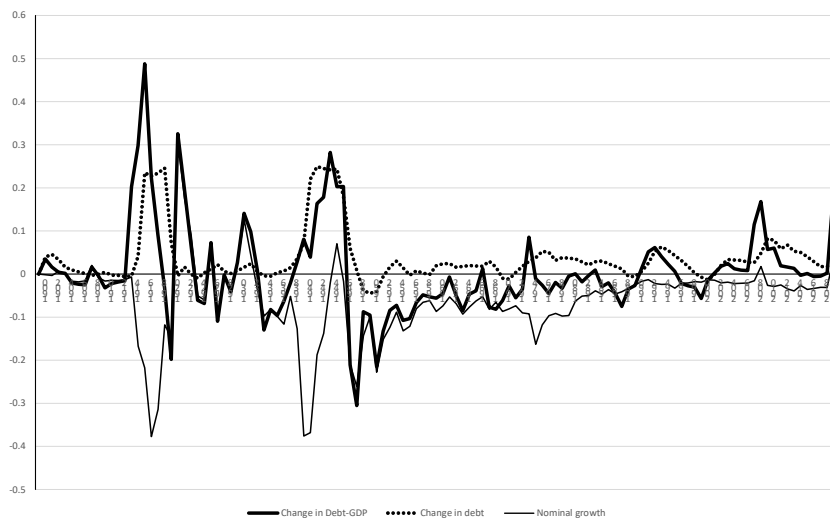


Figure 5. Change in UK Debt-GDP Ratio and Debt and Nominal Growth components, 1900-2020

Figure 5 is based on equation (5). It shows the combined contribution to changes in the debt-GDP ratio due nominal growth as well as the contribution of changes in nominal debt as a proportion of GDP, the other component of changes in the debt-GDP ratio in equation (5). Although nominal growth made very strong negative contributions to reducing the debt-GDP

ratio in WWI and WWII, the debt-GDP ratio rose so much due to the increases in nominal debt caused by the large primary deficits. From 1948 to 1970 nominal growth tracks the change in the debt-GDP ratio closely and so seems to have been the main determining factor. After this, nominal growth acts to reduce the debt-GDP ratio but does not seem to be the main cause of its fluctuations, especially its large increases in 1974, 1992 and 2009 and 2020

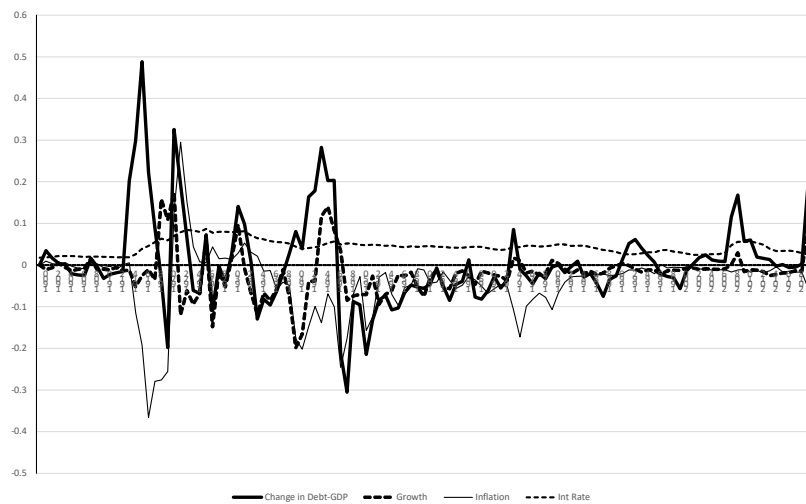


Figure 6. Change in UK Debt-GDP and the Contributions from Growth, Inflation and Interest Rates, 1900-2020

Figure 6 shows the individual contributions of growth, inflation and interest costs. Generally, inflation seems to have the dominant factor in the contribution of nominal growth to changes in the debt-GDP ratio. It is especially effective in WWI, WWII and in 1975, when inflation rose to over 17 per cent. Not surprisingly, throughout the data period, interest rates have made a positive contribution to the debt-GDP ratio, but surprisingly, apart from the 1920's when its contribution was around 8 per cent of GDP, its contribution has remained steady contributing just over 4 per cent of GDP.

It is clear from Figure 5 that nominal growth had a large negative impact on the debt-GDP ratio in 1917 and in 1940 even though the debt-GDP ratio was high in both periods due to the

large primary deficits shown in Figure 2. In the inter-war period nominal growth played little role. After WWII the persistent decreases in the debt-GDP ratio were almost entirely due to nominal growth, though its contribution, while initially large, declined steadily thereafter. The principal exception was 1975 when nominal growth caused a 16 percentage point fall in the debt-GDP ratio due to the high rate of inflation.

3.2 Total Contributions

What have been the total contributions to the debt-GDP ratio over time by these components?

Total debt is

$$\begin{aligned} B_t &= B_{t-n} + \sum_{s=0}^{n-1} \Delta B_{t-s} \\ &= B_{t-n} + \sum_{s=0}^{n-1} (G_{t-s} - T_{t-s}) + \sum_{s=0}^{n-1} R_{t-s-1} B_{t-s-1} - \sum_{s=0}^{n-1} \Delta Q_{t-s} \end{aligned}$$

Hence the debt-GDP ratio is

$$\begin{aligned} \frac{B_t}{Y_t} &= \frac{Y_{t-n}}{Y_t} \frac{B_{t-n}}{Y_{t-n}} + \frac{\sum_{s=0}^{n-1} (G_{t-s} - T_{t-s})}{Y_t} + \frac{\sum_{s=0}^{n-1} R_{t-s-1} B_{t-s-1}}{Y_t} - \frac{\sum_{s=0}^{n-1} \Delta Q_{t-s}}{Y_t} \\ &\simeq (1 - \sum_{s=0}^{n-1} \gamma_{t-s} - \sum_{s=0}^{n-1} \pi_{t-s}) \frac{B_{t-n}}{Y_{t-n}} + \frac{\sum_{s=0}^{n-1} (G_{t-s} - T_{t-s})}{Y_t} \\ &\quad + \frac{\sum_{s=0}^{n-1} R_{t-s-1} B_{t-s-1}}{Y_t} - \frac{\sum_{s=0}^{n-1} \Delta Q_{t-s}}{Y_t} \\ &= \frac{B_{t-n}}{Y_{t-n}} - \sum_{s=0}^{n-1} \gamma_{t-s} \frac{B_{t-n}}{Y_{t-n}} - \sum_{s=0}^{n-1} \pi_{t-s} \frac{B_{t-n}}{Y_{t-n}} + \frac{\sum_{s=0}^{n-1} (G_{t-s} - T_{t-s})}{Y_t} \\ &\quad + \frac{\sum_{s=0}^{n-1} R_{t-s-1} B_{t-s-1}}{Y_t} - \frac{\sum_{s=0}^{n-1} \Delta Q_{t-s}}{Y_t} \end{aligned} \tag{6}$$

The second to fifth terms on the right-hand side are the cumulative contributions of growth, inflation, the primary deficit, interest rates and the residual. Figure 7 displays the contribution to the change in the debt-GDP ratio since 1900 of these components.

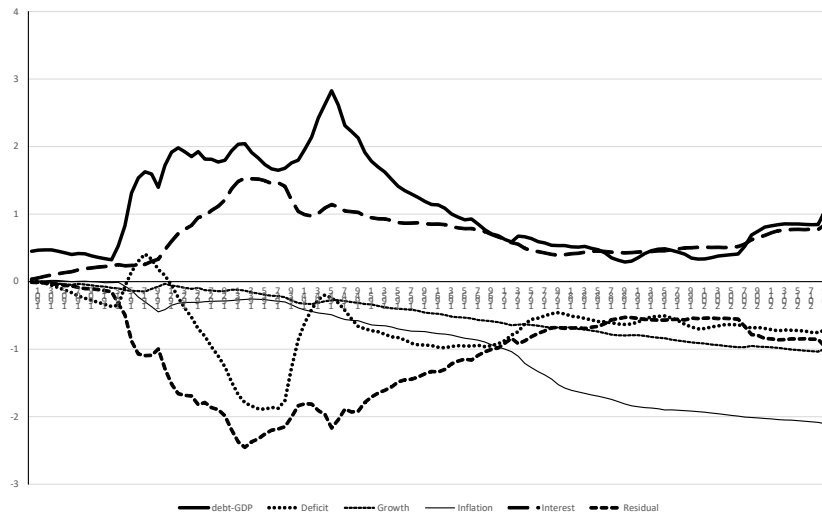


Figure 7. UK Debt-GDP Ratio and Cumulative Components, 1901-2020

Figure 7 shows that one of the largest contributors to the decline in the debt-GDP ratio in the interwar period was the primary deficit. Interest payments were the largest positive contributor. Growth and inflation caused only small reductions. The residual, which we can interpret as the effect of monetary and related factors, also made large contribution to bringing down the debt-GDP ratio over the interwar period. The second period of interest that we identified earlier was from 1946 -, when the debt-GDP ratio peaked - to 1990 when it was at its lowest. Figure 7 shows that growth and inflation played a more prominent role in reducing the debt-GDP ratio over this period. Taken together, nominal growth had a larger impact than the reduction in the primary deficit while inflation became a major factor from 1973, and especially after 1990 and again after the financial crisis. Interest rates continued to be make a positive, but declining, contribution and monetary factors had a steadily reducing influence over time.

4 Four sub-periods in more detail

We consider the four sub-periods 1913-1932, 1939-1973, 1973-1990 and 2007-2020 in more detail. This involves re-setting the start date to the beginning of each sub-period to obtain the contributions of growth and inflation in equation (6).

1913-1932

Over this period the debt-GDP ratio rose dramatically during WWI and did not decline much for the next 40 years. The debt-GDP ratio rose from 32 per cent in 1913 to 159 per cent in 1919. This was due to government expenditures rising from 11 per cent of GDP before the war to over 40 per cent per annum during WWI, while tax revenues were around 25 per cent per annum during the war. After the war government expenditures fell below 20 per cent per annum until 1931, when the Great Depression started, while tax revenues averaged around 35 per cent per annum. The resulting primary deficit over this period did not, however, have a big impact on the debt-GDP ratio. Inflation was a large influence on the debt-GDP ratio. Its contribution reached 37 per cent of GDP in 1917 and remained at around 28 per cent until 1922. Thereafter it contributed little to reducing the debt-GDP ratio. Of equal importance was monetary and related factors (the residual). It contributed 40 percentage points in 1916, and over the war 94 percentage points. Apart from the period 1919-1921, when its contribution raised the debt-GDP ratio by between 11 and 17 per cent, growth had only a small effect in reducing the debt-GDP ratio. Over the period 1919-1932, when the debt-GDP ratio rose by 44 percentage points, the total percentage point contribution to its reduction were: primary deficit, 201; monetary factors 126; growth, 5. Inflation raised the debt-GDP ratio by 39 percentage points, and interest payments raised the debt-GDP ratio by 119 percentage points.

1939-1973

During WWII the debt-GDP ratio increased from 168 per cent of GDP in 1939 to a peak of 283 per cent in 1946. Thereafter it declined steadily until 1973 when it reached 59 per cent.

As in WWI, the cause of the increase in the debt-GDP ratio in WWII was increased government expenditures which rose from 29 per cent in 1939 to a peak of 58 per cent, while tax revenues stayed below 45 per cent. From 1946-1973 there was a persistent primary surplus. In the 1950's and 1960's it averaged around 7 per cent of GDP. As in WWI, inflation contributed more to reducing the debt-GDP ratio than growth. Their total contributions from 1939 to 1946 were 76 and 19 percentage points, respectively. Monetary factors contributed 2 percentage points to increasing the debt-GDP ratio. The period 1946-1973 has seen the greatest fall in the debt-GDP ratio. It fell by 224 percentage points which was contributed to by: the primary deficit, 55; inflation, 373; growth, 251; monetary factors 133 percentage points. Interest payments raised the debt-GDP ratio by 46 percentage points.

1973-1990

In 1974 the debt-GDP ratio peaked at 67 per cent. It then fell steadily until 1990, when it reached a low point for the whole of the period 1900-2020, of 29 per cent. Throughout there was a primary surplus varying between 2 and 8 per cent of GDP with expenditures ranging between 31 and 42 per cent of GDP and tax revenues between 38 and 46 per cent of GDP. However, the contribution of the primary surplus to reducing the debt-GDP ratio between 1974 and 1990 was only 16 percentage points. For the period 1974-76, inflation was over 10 per cent and its contribution to reducing the debt-GDP ratio was in total 34 percentage points. Monetary factors contributed 2 percentage points to increasing the debt-GDP ratio. The contribution of inflation between 1974 and 1990 was 87 percentage points, which was the largest contribution. Monetary factors contributed to increasing the debt-GDP ratio by 39 percentage points. That of growth was only 25 percentage points. The contribution of the primary surplus between 1974 and 1990 was only 16 percentage points. The contribution of falling interest payments to reducing the debt-GDP ratio between 1974 and 1990 was only 15 percentage points.

2007-2020

Following the financial crisis the debt-GDP ratio rose steadily from 41 per cent in 2007 to 84

per cent in 2019, and then increased again in 2020 to 105 per cent due to the pandemic. There was a primary surplus of around 3 per cent of GDP until 2020 when it became an 8 per cent primary deficit due to an increase in government expenditures of over 11 per cent of GDP. Over the period 2007-2011 monetary factors contributed 29 percentage points. The total contribution of the primary surplus over the period 2007-2019 was 11 percentage points. The total contributions of inflation and growth to reducing the debt-GDP ratio between 2007 and 2019 were 9 and 6 percentage points, respectively. Interest payments contributed an increase of 41 percentage points. In 2020 growth increased the debt-GDP ratio by 10 per cent and interest payments did so by 2.5 per cent; inflation reduced the debt-GDP ratio by 6 per cent and monetary factors contributed 9 percentage points.

Each of these four periods began with a rise in the debt-GDP ratio. We have discussed the factors that contributed to these increases, We also discussed the contributions of the factors in the subsequent decline of the debt-GDP ratio. In Tables 1 we summarise the contributions of these factors to increasing the debt-GDP ratio and to reducing it. Our aim is to examine whether any general patterns emerge.

Period	Debt-GDP	Deficit	Growth	Inflation	Interest	Residual
1901-2020	0.60	-0.73	-0.99	-2.11	0.80	-0.95
		Increase in Debt-GDP ratio				
1913-1919	1.27	0.70	-0.01	-0.28	0.07	-0.94
1939-1946	1.15	1.52	-0.19	-0.76	-0.27	-0.02
1973-1976	0.05	0.23	0.01	-0.34	-0.12	0.02
2007-2010	0.28	-0.05	0.02	-0.02	0.10	-0.23
		Decrease in Debt-GDP ratio				
1919-1932	0.44	-2.01	-0.05	0.39	1.19	-1.29
1946-1973	-2.24	-0.55	-2.51	-3.73	-0.57	1.33
1976-1990	-0.35	-0.07	-0.25	-0.87	-0.03	0.29
2009-2020	0.15	-0.07	-0.08	-0.07	0.15	-0.07

**Table 1. Contributions to Increasing and Reducing the Debt-GDP ratio
(percentage points)**

Over the whole period 1901-2020 inflation had the biggest impact in reducing the debt-GDP ratio, followed by growth. Fiscal policy via the deficit made a smaller contribution, while debt interest payments increased the debt-GDP ratio. A similar pattern emerges during the four sub-periods. The fiscal deficit dominated the build up in the debt-GDP ratio, except during the financial crisis which was not due to fiscal policy. In 1973-1976, the debt-GDP ratio did not increase, staying at just over 60 per cent of GDP; the largest contributors - inflation and the deficit - almost exactly offset each other. In 2007-2010, the increase in the debt-GDP ratio was almost exactly offset by the residual. This reflects the role of money financing during the financial crisis.

5 Economic Policy Responses

The focus of economic policy is not just on what the implications are for the debt-GDP ratio, but also on the consequences for economic growth, inflation and interest rates. One way to address these questions is through a VAR analysis. We therefore compute impulse responses from a VAR in six variables: the change in the debt-GDP ratio (DDebt_GDP), the primary deficit as a proportion of GDP, the rate of economic growth, inflation, the effective rate of interest and the residual (DQ_GDP), which we interpret as mainly money financing. We find that on these annual data a first-order VAR is adequate. The impulse responses that are computed from the VAR are to one standard deviation shocks. A Choleski decomposition of the shocks is not employed as a causal ordering of the variables is not justified and the correlations between the shocks are not large. Only the results for the whole period 1901-2020 are reported as those for the four sub-periods were almost identical. This indicates the persistence over time of the economic structure of the UK economy. The results are shown in Figures 8 and 9 where each panel shows the responses of a variable to the six shocks.

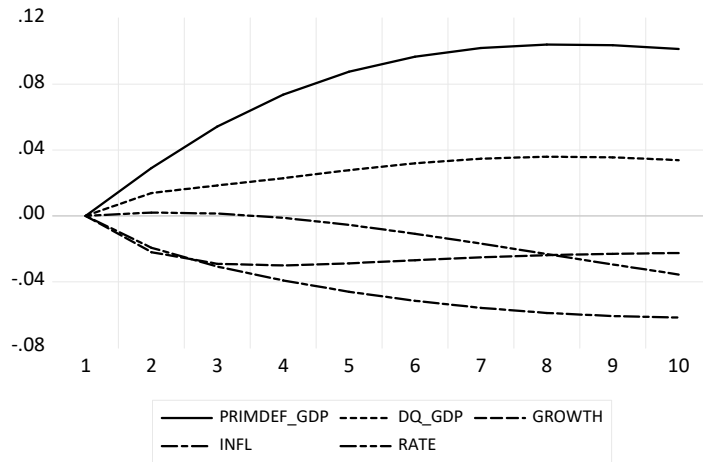


Figure 8. Impulse response of the Debt-GDP Ratio to Shocks

Figure 8 shows the impulse response of the debt-GDP ratio to shocks in the other variables. Only the responses to the primary deficit, growth and inflation are significant. The primary deficit has the largest positive impact: a one standard deviation shock causes the debt-GDP ratio to increase by 10 percentage points after 6 years. Inflation reduces the debt-GDP ratio by 6 percentage points after 6 years. Growth only has a significant impact for 2 years, and reduces the debt-GDP ratio by 3 percentage points. These responses reflect the variability of the shocks: the larger they are the greater the impact. An alternative measure of the impact of a shock is to consider the effect of a 100 percentage point shock to each variable. These have the following percentage point impacts on the debt-GDP ratio: primary deficit, 269 after 6 years; inflation, 1.5 after 6 years; growth, 1 after 2 years; the effective interest rate, 4 after 7 years; monetary residual, 71 after 6 years. Hence, although inflation and growth make substantial contributions to reducing the debt-GDP ratio, in order to reduce the debt-GDP ratio by 10 percentage points would need an increase in inflation of 6.7 percentage points and in the growth rate of 10 percentage points. Given the average growth rate over the whole period is only 2 per cent with a standard deviation of 3.4, it would take a 2 standard deviation shock in growth to achieve a 10 percentage point

decrease in the debt-GDP ratio. This indicates the limitations of relying on growth to reduce the debt-GDP ratio.

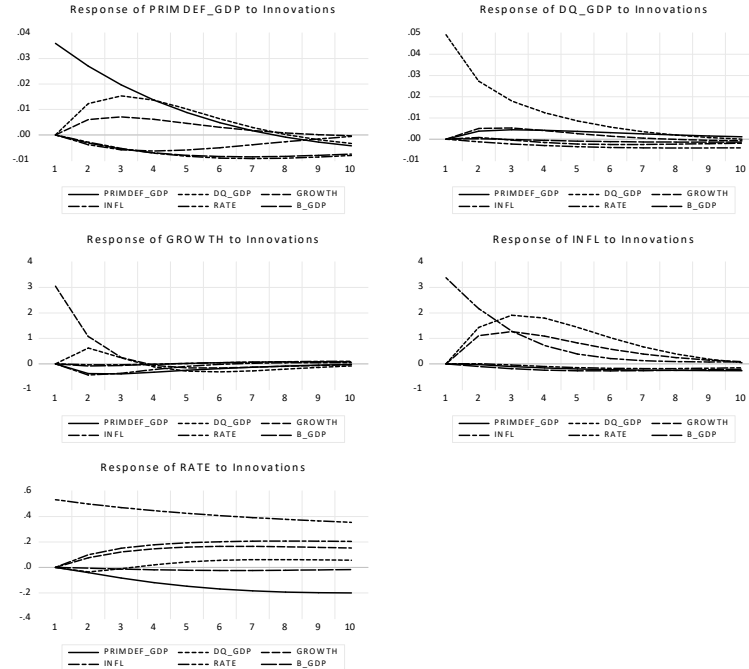


Figure 9. Impulse Responses of Factors to Shocks

Figure 9 shows the impulse responses of the other variables to each shock. The debt shock is that to the change in the debt-GDP ratio. Only the shocks to the debt-GDP ratio and the monetary residual have a significant effect on the primary deficit. Shocks to the debt-GDP ratio have a negative effect on the primary deficit, suggesting a policy of leaning against the wind; the deficit responds positively to monetary shocks. Inflation responds positively to the primary deficit, growth and especially money, but negatively to the debt-GDP ratio. The implication for controlling inflation is that only economic restraint, notably of demand, works; higher interest rates have no significant effect. Growth is not significantly affected by any of the shocks, except that of the debt-GDP ratio, which has a small but significant negative effect on growth. It is particularly interesting that growth does not respond to the primary deficit which, if anything, has a negative effect after four years. There is, therefore, no support in these results for using

budget deficits to stimulate the economy. The effective rate of interest responds positively to growth, inflation and the debt-GDP ratio, and negatively, but not significantly, to the primary deficit. While the monetary residual responds little to any of the other shocks, it has positive impacts on all variables (especially inflation) except the interest rate which, after falling a little, then increase over time, but these movements are not significant. In summary, these responses are broadly what one would expect. The notable exceptions are the lack of response of inflation to interest rates and of growth to a fiscal stimulus.

6 Conclusions

Although the debt-GDP ratio is currently high, and higher than it has been since 1964, looked at from a longer perspective, it is very much smaller than it has been over the last 120 years. Moreover, previous high levels have been reduced to relatively low levels, though this has taken many years. For example, from the highest point in 1946 to the lowest point in 1990 it took 45 years, and occurred at an annual rate of 12.6 per cent. The cause of the earlier peaks in the debt-GDP ratio were the two world wars and the massive primary deficits generated by government expenditures. The next peak in the debt-GDP ratio was for completely different reasons: the bail out of the banks in the financial crisis and the support of the economy in the Covid-19 pandemic. In the financial crisis it wasn't a primary deficit that caused the rise in debt but government borrowing to finance the banks. In the pandemic an 8 percentage point increase in the primary deficit-GDP ratio was financed by government debt which was sold to the central bank, and hence monetised, as shown in the residual term.

The main period where the debt-GDP ratio was reduced (1946-1990) was due to largely to inflation which reduced the real value of debt by around 90 percentage points, but at the cost of an average rate of inflation of over 7 per cent; growth, the next largest contributor, made a reduction of 25 percentage points. The primary deficit has been the main factor in increasing the

debt-GDP ratio but not in reducing it. Since the Great Depression, interest payments, did not play a substantial role until the financial crisis when they added about 6 percentage points per annum to the debt-GDP ratio and 23 percentage points in total over the crisis.

The main conclusions to emerge from this study are not especially comfitting. The first is that a much higher inflation rate than is the current target is required if it is to reduce the debt-GDP significantly. It implies that a target of 2 per cent is only feasible if the debt-GDP ratio does not require substantial reduction. We have also found that the higher is the debt-GDP ratio, the lower is inflation, implying no automatic stabilisation of the debt-GDP ratio via inflation. Second, although growth is a more desirable way to reduce the debt-GDP ratio, the problem is that UK growth rates are very low. They average 2 per cent over the whole period, rarely exceed 4 per cent for long, and have done so only once since 1990. Moreover, growth shows no response to policy instruments apart from monetary effects. Third, while in theory they are able to do so, in practice primary surpluses have not contributed much to reducing the debt-GDP ratio since 1900,. There have been primary surpluses every year since 1946 with the exception of 1992-1994 and 2020. Their average was 8 per cent of GDP between 1946-1973, but only under 4 per cent since then.

We conclude by considering what package of measures might be achievable to bring the debt-GDP ratio down from 95 to 40 per cent (Gordon Brown's target) over a 10 year period, assuming that debt interest payments are constant. Using only one means, would entail running a primary surplus of around 5.5 per cent of GDP, or nominal growth rates of close to 6 per cent. Shortening the time horizon would almost certainly be politically unachievable if a single instrument were used. This suggests using a combination of surpluses and nominal growth. Assuming a growth rate of 2 per cent, an inflation rate of 2 per cent and a primary surplus of 3.3 per cent (the average over the period 2010-2019) would reduce the debt-GDP ratio to 40 per cent in 7.5 years. Whilst, on past evidence, this seems feasible, we note that currently inflation is close to 10 per cent, growth is around 1 per cent and there is a primary deficit of just under 8 per cent. If this

were maintained there would be no reduction in the debt-GDP ratio.