BANK OF ENGLAND

Staff Working Paper No. <*draft*>

Three Centuries of Debt Management

David Ronicle[(1)] and Ryland Thomas[(2)]

Abstract

The UK has issued what we would recognise as public debt since the late 17th century. We use the Bank of England's "Three Centuries" dataset, alongside a range of other sources, to explore that history. Over those three hundred years, the UK experienced two sustained periods of debt accumulation and consolidation, around the conflicts of the 18th century and the early 20th century. A standard decomposition of these episodes reveals their composition to be strikingly different, with primary balances and real growth more important in the earlier episode, inflation in the latter. We test the sustainability of the UK fiscal policy over this period, and look for evidence of fiscal fatigue, by estimating fiscal reaction functions. We find policy to have been sustainable on average, with little evidence of fatigue; indeed, the government has been more responsive to debt the higher the debt stock. Our most striking finding is how differently large debt stocks can be managed.

Key words: < >.

JEL classification: < >.

(1) Bank of England. Email: david.ronicle@bankofengland.co.uk
(2) Bank of England. Email: ryland.thomas@bankofengland.co.uk

This is an initial draft. **All results are preliminary and should not be cited without the prior permission of the authors.** The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England or its committees. We are grateful to Alan Castle, Steven Millard and Peter Sinclair for providing comments on this draft and for fruitful discussions at an earlier stage.

Information on the Bank's working paper series can be found at
www.bankofengland.co.uk/research/Pages/workingpapers/default.aspx

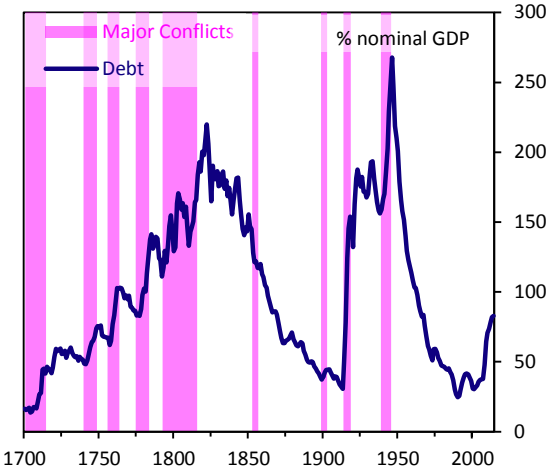
Publications Group, Bank of England, Threadneedle Street, London, EC2R 8AH
Telephone +44 (0)20 7601 4030, Fax +44 (0)20 7601 3298, email publications@bankofengland.co.uk.

© Bank of England 2015
ISSN 1749-9135 (on-line)

Introduction

Public sector net debt in the UK rose to 84% of GDP in financial year 2014-15. This is not a UK-specific phenomenon; high levels of public debt have proliferated across advanced economies in recent years. That in turn has spawned a revival of interest in questions about the causes and consequences of large public debt stocks, notably the pioneering (and comprehensive) work of Reinhart & Rogoff (2009).

Chart 1: UK public debt since 1700



Source: Bank of England "Three Centuries" dataset

We exploit the UK's long history of public debt to explore some of the issues that have become central in this literature. The UK has operated what we would recognise as a public or national debt for roughly three hundred years. In only two periods over that time has public debt attained such high levels; following the wars of the 18th and early 19th centuries and, following the turmoil of the early 20th century (**chart 1**). We use the Bank of England's "Three Centuries" dataset[1] (Hills & Thomas, 2010), along with official data and projections, to ask: what drove debt up, and; how was it managed back down?

We are not the first to consider a time series of this length: Bohn (2008) considered the US case from 1792 onwards and Mauro et al (2015) consider a broad panel, with some countries' data starting as early as 1800. Nevertheless, we feel our approach offers two advantages. Firstly, we go further back in time than most studies have been able to to date; secondly, focusing on a single country allows us to develop a more nuanced picture of developments.

We take two approaches to looking at the UK's experience of public debt. Firstly, we use a common accounting decomposition to identify which factors accounted for changes in the debt stock. Secondly, we follow the "fiscal reaction function" literature initiated by Bohn (1998), allowing us to more formally test our interpretation of the debt dynamics.

Data

Before getting into the detail of our analysis, it is useful to quickly summarise the data we use (full details of which can be found in the appendix). The Three Centuries dataset contains data on a broad range of macroeconomic aggregates, starting in many instances in the late 17th century. We draw on this widely for measures such as nominal and real GDP, inflation and population.

Our public sector statistics are sourced from a range of additional data sources; where possible, we use the official ONS estimates, using our historical data in earlier periods. In this paper we focus on aggregates at the central government level[2], since we have a more complete and higher quality series available. Our flow measures include receipts, non-interest spending and interest spending, as well as a supplementary series on defence spending as a share of GDP. We have two measures of debt, one at par value[3] (starting in 1700) and one at market value, starting slightly later in 1729. In general we use the latter of these two since its dynamics are closer to those implied by the flows data (as we would expect, since the flows data are cash measures).

[1] http://www.bankofengland.co.uk/research/Pages/onebank/threecenturies.aspx
[2] This is a slightly narrower measure then general government, which also includes local government. Typically, debt issuance in the UK has primarily been conducted by the central government.
[3] That is, the total face value of bonds in issue

Finally, we also compare our historical episodes with more recent decades. This exercise relies on using the Office for Budget Responsibility's (OBR) long-term projections, published each year in their *Fiscal Sustainability Report*. To do this, we combine data from that report with the OBR's "Public Finances Databank"[4]. These metrics are all on a public sector basis[5], rather than central government only.

Our historical data is based on calendar years, while data sourced from the OBR is in financial or fiscal years, which run from April to March in the following year (eg. 2014-15 covers the period from April 2014 to March 2015).

Decomposing movements in the debt to GDP ratio

Intuitively, the evolution of the debt to GDP ratio must depend on: interest owed on outstanding debt; the extent to which non-interest spending exceeds tax revenues (and so generates additional borrowing), and; growth in nominal GDP, which itself can be decomposed into growth in prices and growth in real GDP. More formally:

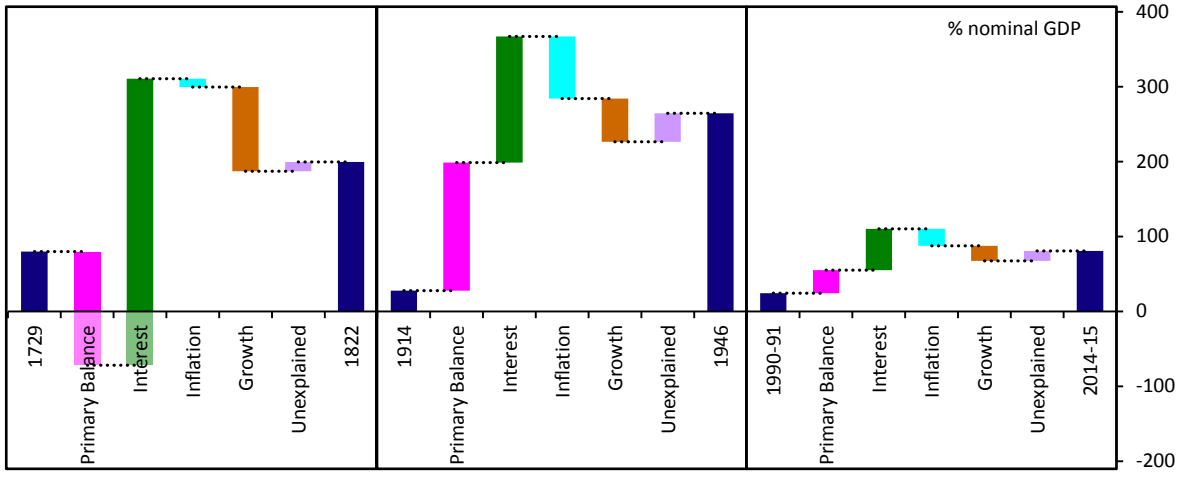
$$d_t - d_{t-1} = \frac{i_t}{1+\gamma_t} d_{t-1} - \frac{\pi_t}{1+\gamma_t} d_{t-1} - \frac{g_t}{1+g_t} d_{t-1} - s_t$$

Where: d_t is the debt to GDP ratio at time t; i_t is the nominal interest rate; γ_t is the rate of nominal GDP growth; π_t is inflation; g_t is real growth, and; s_t is the primary balance as a share of GDP (tax receipts less non-interest spending). See, eg. Escolano (2010) for a full derivation. The interest rate and inflation terms here are often simplified to a ratio of real interest rates to real growth – but for reasons that will be seen, we find it helpful here to report these terms separately.

We use this decomposition to compare three debt episodes, which we divide into periods of accumulation (from local trough to local peak) and consolidation (from local to peak to local trough). For the sake of convenience we name each episode after the year in which debt peaked; 1822, 1946 and 2014-15. First we compare the periods of accumulation of debt across each episode, then the periods of consolidation.

Periods of debt accumulation

Chart 2: Three episodes of debt accumulation (debt as a share of nominal GDP)



Sources: Three Centuries; ONS; OBR

[4] http://budgetresponsibility.org.uk/data/

[5] This is a wider measure than general government, which also includes publically owned corporations.

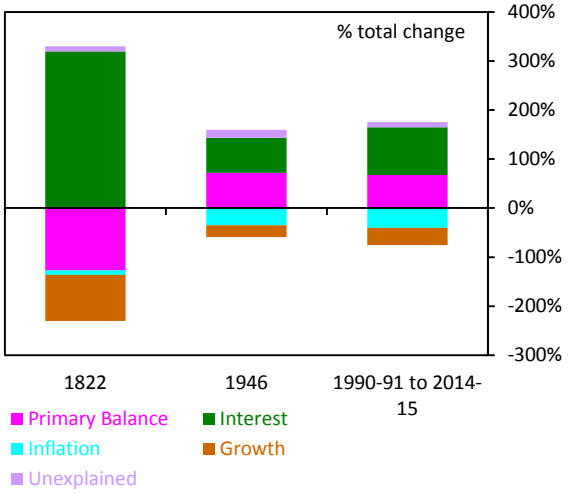
Chart 2 shows the results of this decomposition over our three periods of interest. Each window within the chart shows the initial debt stock, the contributions to the overall increase from each component of our decomposition and the end of period debt stock. In addition to the contributions from the components of the decomposition, there is also an "unexplained" component, which is calculated as a residual. In part it reflects discrepancies in our data, but it also reflects transactions not captured in our flow measures, such as the proceeds of asset sales.

The basic features of debt accumulation are similar across all three periods. Inevitably, in each episode spending, either primary spending or debt interest, exceeded taxes, with only a partial offset from growth in nominal GDP.

But each period also betrays some of the characteristics we might expect, given the wider stance of economic policy. The 1822 episode took place in a period of limited government, under the Gold Standard and against a backdrop of rising population growth and the beginnings of the Industrial Revolution. Accordingly, we see aggressive primary surpluses, albeit not large enough to offset debt interest payments, a strong negative contribution from real growth and almost no effect from inflation.

In addition to the two World Wars, the 1946 episode also coincides with the mass unemployment of the interwar years, the collapse of the Gold Standard and volatile growth, including the Great Depression. Accordingly, there was a large positive contribution from primary spending, as well as interest payments[6], and a significant offset from inflation.

Chart 3: Composition of debt accumulation



Sources: Three Centuries; ONS; OBR

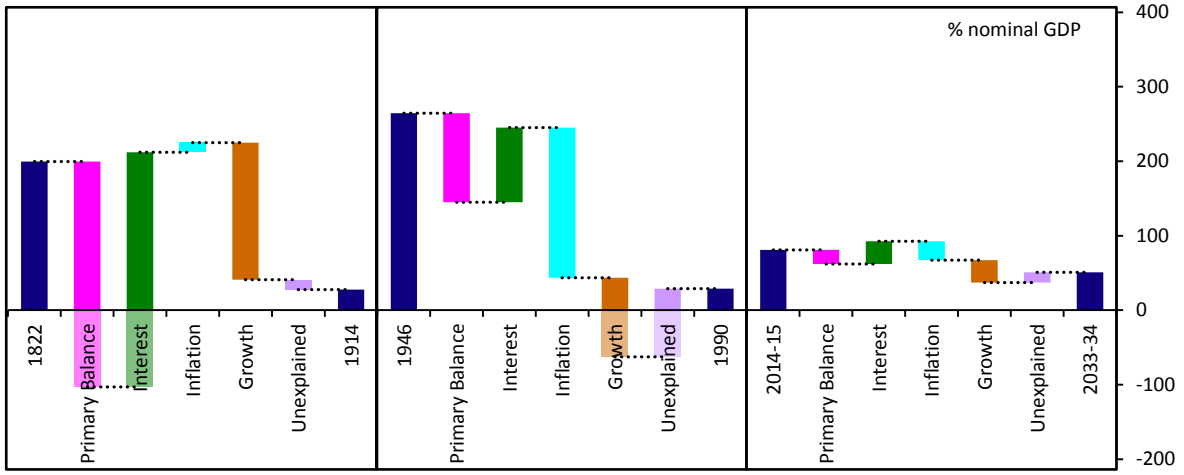
The 2014-15 episode involved a smaller overall rise in debt, although in its decomposition it looks similar to the 1946 episode. **Chart 3** abstracts from these different scales to concentrate on the contribution of each component to the total change. The similar composition of the 1946 and 2014-15 episodes is striking, especially given their very different origins and policy settings. The most notable difference is the smaller role for inflation in nominal growth – as we might expect under an inflation-targeting monetary policy regime.

We should not ignore the fact that within these periods efforts were made to tackle rising debt levels, albeit those efforts were overtaken by events. The effect of the large primary surpluses of the 18th century, between periods of conflict, are evident in the see-sawing path of debt in that period in **chart 1**; debt falls somewhat after each period of conflict, only to shoot up again as fighting is renewed. We observe something similar in the early 20th century, with debt having fallen somewhat by the eve of the Second World War.

[6] Interest payments were somewhat lower than might otherwise have been the case as a result of the War Loan conversion in 1932, which saved about 0.7% of GDP in debt interest per year, see Allen (2012).

Periods of debt consolidation

Chart 4: Three episodes of debt consolidation (debt as a share of nominal GDP)

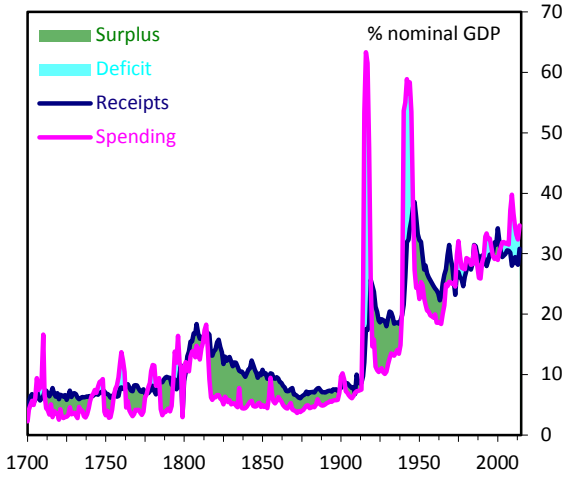


Sources: Three Centuries; ONS; OBR

The peaks in debt observed in 1822 and 1946 were both followed by periods of sustained debt reduction. The debt built up over the 18th century was finally eliminated by 1914, a period of 90 years; that built up in the early 20th century was eliminated in half that time, by 1990. On average, debt was reduced by 1.9% of GDP per year in the 19th century and by 5.4% per year in the mid-20th century. How were these large reductions in debt achieved? There are striking differences between the episodes.

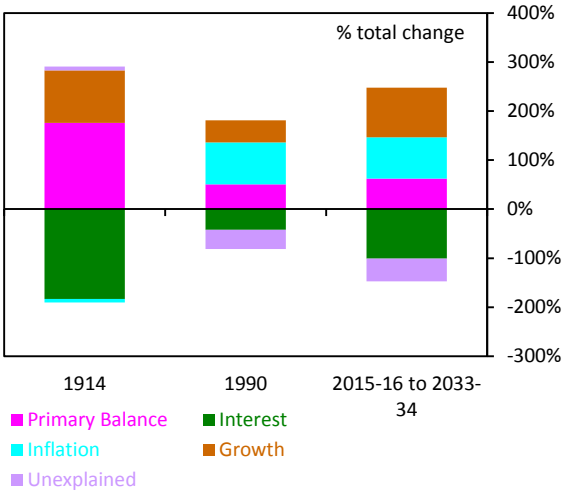
Chart 4 presents the decomposition of debt consolidation over our three episodes. Each period has some features in common; primary surpluses and growth help to reduce the debt, while rising debt interest payments push the opposite way. The key difference between the 1822 and 1946 episodes is in the composition of nominal growth and the primary surpluses.

Chart 5: Tax & spend, 1700 to 2014



Sources: Three Centuries; ONS

Chart 6: Composition of debt consolidation



Sources: Three Centuries; ONS; OBR

Chart 5 compares primary surpluses over time. This helps reveal the difference between the 1822 consolidation, and that of 1946. In the 19th century, the state played a small role in the economy; spending was rapidly reduced following periods of conflict, facilitating primary surpluses. By contrast, in the 20th century the levels of both taxation and primary spending increased – the state expanded while at the same time running primary surpluses.

As noted above, the contribution from nominal growth can be split into contributions from inflation and real growth. In the 1822 episode, under the Gold Standard, the inflation contribution was actually slightly positive; that is, inflation pushed up the debt stock relative to GDP. But real growth, driven by population growth and the Industrial Revolution, played a very significant role in reducing the stock.

The 1946 episode looks very different. Although productivity growth was at its all-time peak over this period, population growth was lower than in the 19th century. As a result, although real growth did help reduce the debt stock, it played a noticeably smaller role.

A bigger difference between these two periods is in the role for inflation. The period from 1946 to 1990 saw inflation reach unprecedented levels. Inflation frequently ran at double digits, peaking at over 25% on a year ago in 1975; it was only really brought under control by the introduction of inflation targeting in 1992. This made a substantial contribution to the erosion of the 1946 debt stock, possible because of the capital controls and "financial repression" that operated over this period (Allen 2012).

The 2014-15 episode of consolidation presented here is based on the OBR's 2015 *Fiscal Sustainability Report*, which projects the public sector finances out for the next 50 years, under an assumption of unchanged policy. Based on their high migration variant[7], a trough in public sector debt is reached in fiscal year 2033-34, after which demographic effects lead debt to rise again (not shown). Throughout the projections inflation is maintained at its 2% target and productivity grows at a 2.2% trend. Combining this with the demographic assumptions leads nominal GDP growth to reduce the debt stock, supported by a primary surplus and with a large offset from debt interest. In this scenario, the debt stock falls by 1.6% GDP per year, on average.

Chart 6 abstracts from the scale of the total consolidation to compare the relative contributions. As with debt accumulation, the 20th and 21st century episodes have much in common, though the contribution of real growth in the 2014-15 episode more closely resembles that of the 19th century.

Fiscal reaction functions

To test our interpretation of the debt dynamics decomposition more formally, we follow the "fiscal reaction function" strand of literature, that starts with the work of Bohn (1998, 2008), who examined 200 years of US data. Recent further work in this vein includes that of Mendoza & Ostry (2008), who applied the approach to a short panel of advanced and emerging economies; Ghosh et al (2013) who test for non-linear specifications and the concept of "fiscal fatigue", and; Mauro et al (2015), who tackle a panel stretching back over two centuries.

The fiscal reaction function essentially consists of a regression of the primary balance on the lagged stock of debt:

$$s_t = \rho d_{t-1} + \mu_t + \varepsilon_t$$

Where s_t is the primary balance relative to GDP, d_{t-1} is the stock of debt at the end of the previous period (also measured relative to GDP), μ_t represents a range of additional controls and ε_t is a well-behaved error term. In this set up, a positive value of ρ is a sufficient condition for a government to respect its inter-temporal budget constraint; that is, a positive value of ρ indicates sustainable fiscal policy (See, eg. Mendoza & Ostry 2008 for a full derivation).

The controls employed in μ_t typically comprise two terms, controlling for deviations from trends in spending and GDP; in some of our specifications we expand on this, notably to accommodate periods of

[7] We choose this variant given its migration projections most closely resemble observed migration rates in recent years.

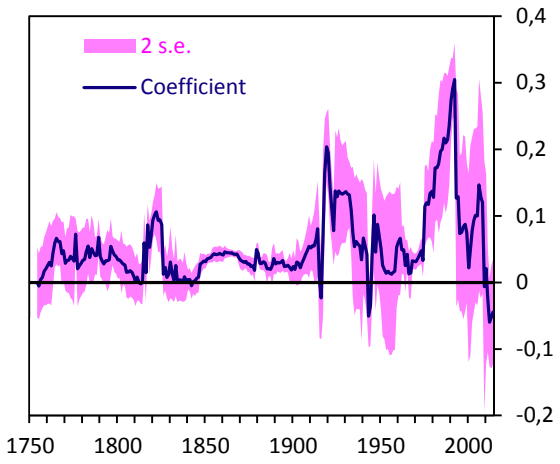
conflict. The error term is normally allowed to contain an AR(1) term to control for serial correlation, something we employ here. Finally, we estimate using Newey-West robust standard errors.

Table 1 presents results across a range of specifications estimated across the full sample, where the chief difference is in how episodes of temporary deviations from trend spending are controlled for, a key issue given the role conflicts play in our data in driving spending. The key finding is that the coefficient on lagged debt is significant across all specifications and relatively stable.

Our preferred model is model VI, which scores most strongly across all three reported information criteria. In addition to lagged debt, major conflicts, the cyclical position of the economy, inflation and marked deviations from trend spending all have significant effects on the primary balance. Perhaps as we might expect, the coefficient on the output gap is negative, suggesting UK fiscal policy has, on average, been counter-cyclical, rather than pro-cyclical. On this basis, the primary balance increases by 3.8 percentage points of GDP for a 100 percentage point increase in the debt level, while the long-run expected debt stock is 46.5% of GDP, this latter being calculated via. the approximation $E[dbt]=-\mu^*/[\rho(1+r^*)-r^*]$ (Mendoza & Ostry, 2008), where μ^* is the average effect of the control variables over the sample and r^* is the average effective interest rate on government debt.

Of course, these estimates are essentially a description of the average behaviour of the UK government over a nearly 300 year period. What is less clear is the extent to which that behaviour has been consistent over time. To get a feel for this question we follow Ghosh et al (2015) in taking our preferred specification (model VI in **table 1**) and estimating it recursively across short sub-samples. We can then track how the coefficient on debt evolves over time.

Chart 7: Debt coefficient over time



Source: Authors' estimates

Chart 7 plots the results of this exercise, using a 25 year estimation window. Using such a short window naturally leads to less precision around estimates and greater volatility. Nevertheless, the results are striking, and consistent with our earlier observations based on the data. We see that the debt coefficient is nearly always positive, if not always significant. Furthermore, the coefficient is often (much) larger in the 20th century than in earlier periods, consistent with the faster pace of debt reduction in the post-war period that we observe in the data. While the coefficient turns negative towards the end of the series, this in part reflects the impact of the 2008 recession; our sample does not include the planned consolidation beyond 2014.

Table 1: Estimation results for baseline specification, 1729-2014

	I		II		III		IV		V		VI		VII	
c	-3.628	(0.198)	-2.940	(0.132)	-4.575	(0.028)**	-2.408	(0.366)	-2.906	(0.292)	-1.488	(0.398)	-1.762	(0.354)
dbt(-1)	0.041	(0.012)**	0.070	(0.000)***	0.063	(0.000)***	0.040	(0.008)***	0.046	(0.002)***	0.038	(0.000)***	0.039	(0.000)***
y_gap	-0.132	(0.013)**	-0.186	(0.058)*	-0.242	(0.053)*	-0.109	(0.032)**	-0.098	(0.022)**	-0.070	(0.083)*	-0.072	(0.078)*
real_g_gap	-0.204	(0.000)***					-0.179	(0.000)***	-0.182	(0.000)***	-0.160	(0.000)***	-0.162	(0.000)***
defence			-0.463	(0.000)***			-0.151	(0.068)*	-0.149	(0.058)*	-0.170	(0.011)**	-0.170	(0.012)**
war					-1.173	(0.011)**							0.735	(0.218)
wwar					-12.334	(0.000)***					-7.199	(0.000)***	-7.831	(0.000)***
cpi									-0.071	(0.000)***	-0.062	(0.002)***	-0.063	(0.002)***
ar(1)	0.930	(0.000)***	0.813	(0.000)***	0.809	(0.000)***	0.915	(0.000)***	0.918	(0.000)***	0.886	(0.000)***	0.886	(0.000)***
Stable ratio	69.5		85.2		72.4		142.1		149.8		46.5		43.9	
Obs	284		284		284		284		284		284		284	
Adj. R^2	0.921		0.871		0.857		0.925		0.931		0.942		0.942	
s.e.	2.017		2.583		2.716		1.965		1.892		1.732		1.729	
AIC	4.258		4.753		4.857		4.210		4.137		3.964		3.964	
HQ	4.284		4.779		4.888		4.241		4.173		4.005		4.010	
SIC	4.322		4.818		4.934		4.287		4.227		4.067		4.079	

*The dependent variable in all cases is the central government primary balance relative to GDP. P-values are reported in brackets, with *, ** and *** representing significance at the 10%, 5% and 1% levels respectively.*

dbt(-1): one period lag of the market value of central government debt as at the end of the period, relative to GDP

y_gap: deviation of real GDP from trend, estimated using a HP-filter with smoothing parameter of 100

real_g_gap: deviation of real government spending from trend, estimated using a HP-filter with smoothing parameter of 100

defence: nominal government defence spending relative to GDP

war: a dummy to control for periods of major conflict

wwar: a dummy controlling for the first (1914-1918) and second (1939-1945) world wars

cpi: annual rate of consumer price inflation

Stable ratio: the long-run expected level of debt, calculated via. the approximation $E[dbt]=-\mu^*/[\rho(1+r^*)-r^*]$ (Mendoza & Ostry, 2008), where μ^* is the average effect of the control variables over the sample and r^* is the average effective interest rate on government debt.

AIC, HQ and SIC represent the Akaike, Hannan-Quinn and Schwarz information criteria respectively.

This result, that the responsiveness of the primary balance to the debt stock has been higher as debt has been higher is suggestive. Ghosh et al (2013) have posited that countries may face "fiscal fatigue": as the debt stock rises, a government's willingness to undertake corrective actions diminishes, leading to a point beyond which default becomes inevitable. Our results so far suggest that this may not be a good characterisation of fiscal policy in the UK – but we also test this more formally by estimating our preferred specification with square and cubic debt terms, to try to capture these non-linearities.

Table 2: Estimation results for baseline specification

	Baseline		Cubic	
c	-1.488	(0.398)	-5.38503	(0.123)
dbt(-1)	0.038	(0.000)***	0.140063	(0.073)*
dbt(-1)^2			-0.00072	(0.202)
dbt(-1)^3			1.47E-06	(0.262)
y_gap	-0.070	(0.083)*	-0.06939	(0.085)*
real_g_gap	-0.160	(0.000)***	-0.15873	(0.000)***
defence	-0.170	(0.011)**	-0.17707	(0.010)**
cpi	-0.062	(0.002)***	-0.06153	(0.003)***
wwar	-7.199	(0.000)***	-7.16321	(0.001)***
ar(1)	0.886	(0.000)***	0.883076	(0.000)***
Obs	284		284	
Adj. R^2	0.942		0.942	
s.e.	1.732		1.730	
AIC	3.964		3.968	
HQ	4.005		4.020	
SIC	4.067		4.097	

*The dependent variable in all cases is the central government primary balance relative to GDP. P-values are reported in brackets, with *, ** and *** representing significance at the 10%, 5% and 1% levels respectively.*
*Variable definitions and estimation as per notes to **table 1.***

Our results are presented in **table 2**, alongside those for our preferred baseline specification. The first thing to note is that the additional non-linear terms are not significant. Furthermore, they don't generate the s-shaped profile hypothesised by Ghosh et al (2015), where governments initially react strongly to rising debt, before waning enthusiasm leads them to relax the pace of adjustment, generating a "debt limit" beyond which the government defaults. On this basis, it is hard to argue that the concept of fiscal fatigue helps in our interpretation of UK fiscal policy.

Conclusions

What can we take away from all of this? One thing comes across clearly: the UK has run up large debt stocks in the past, but has found ways to manage them. Indeed, the larger the stock of debt, the more aggressive the management. It seems fair to conclude that, at least on average, UK fiscal policy was conducted sustainably over a three hundred year period, with little evidence of "fiscal fatigue".

But the two historical episodes are very different in their composition and in the wider macro context. That in turn leads to a second clear conclusion, that there are many ways to manage the debt stock.

In both historical episodes, debt was accumulated "reluctantly", in the sense that outside periods of conflict, substantial efforts were made to reduce debt accumulation. In the 18th century, this was attempted via. large primary surpluses and strong real growth; in the 20th century, inflation played a larger role. That distinction also applies in unwinding the debt stock; 19th century primary surpluses were considerably larger than in the 20th century and inflation played a larger role in nominal growth in that second period.

But the differences in the wider context are also striking. Debt consolidation in the 19th century happened under the gold standard and limited government. That in the 20th century took place

alongside an expanding role for the state, the fastest productivity growth in the UK's history and a flurry of different macro regimes – in which fiscal policy was frequently used as a tool for demand management – from the inter-war gold standard, to Bretton Woods, a period of floating exchange rates and ultimately to the ERM and inflation-targeting.

References

Allen, W. A. (2012), *"Quantitative Monetary Policy and Government Debt Management in Britain since 1919"*, Oxford Review Of Economic Policy, 28(4)

Bohn, H. (1998), *"The Behavior of U.S. Public Debt and Deficits"*, The Quarterly Journal of Economics, (3). 949

Bohn, H. (2008), 'The sustainability of fiscal policy in the United States', in: R. Neck and J.E. Sturm, (eds.), *Sustainability of Public Debt*, pp. 15–49

Escolano, J. (2010), *A Practical Guide to Public Debt Dynamics, Fiscal Sustainability, and Cyclical Adjustment of Budgetary Aggregates*, IMF Fiscal Affairs Department

Ghosh, A. R., Kim, J. I., Mendoza, E. G., Ostry, J. D., & Qureshi, M. S. (2013), *"Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies"*, Economic Journal, 123(566)

Hills, S and Thomas, R. (2010), *"The UK recession in context — what do three centuries of data tell us?"*, Bank of England Quarterly Bulletin, 2010 Q4

Mauro, P., Romeu, R., Binder, A., & Zaman, A. (2015), *"A modern history of fiscal prudence and profligacy",* Journal of Monetary Economics, 7655-70

Mendoza, E. G., & Ostry, J. D. (2008), *"International evidence on fiscal solvency: Is fiscal policy 'responsible'?"*, Journal of Monetary Economics, 55.1081-1093

OBR (2015), *Fiscal Sustainability Report*

Reinhart, C. M., & Rogoff, K. S. (2009), *"This time is different: eight centuries of financial folly"*, Princeton, Princeton University Press

Data appendix

[To be added]