MONEY, DEBT AND PRICES IN THE UK 1705-1996

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ABSTRACT

After constructing a consistent series for the market value of UK Government debt, we use nearly 300 years of UK data to examine the effects of fiscal and monetary policy on the price level in the UK. In order to distinguish between Ricardian and non-Ricardian fiscal policy regimes the analysis focuses on three feedbacks: between government debt and budget surpluses, between debt and inflation and between money and inflation.

There is no evidence that fiscal policy has affected prices, nor the exchange rate under the Gold Standard. The results from the VAR suggest that fiscal policy in the UK has operated under a Ricardian regime over the past 300 years or so. This implies that the price level has been determined by the forces of demand for and supply of money rather than those for government bonds.

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## 1.	Introduction[1]

Recently, there has been renewed interest in some fundamental aspects of the interaction between monetary and fiscal policy. This interest has resulted in a potentially far-reaching critical reassessment of the traditional, or quantity-theoretic, view of the determination of the price level[1]. This traditional view states that the equilibrium price level equates the real purchasing power of the money stock with the demand for real money balances; game-theoretic interactions between monetary and fiscal authorities notwithstanding, this is unequivocally a monetary theory of price-level determination. A more recent analysis offers an alternative explanation emphasising, instead, the role of the government's present-value budget constraint (hereafter the PVBC). The essence of this fiscal theory of the price level is that if future primary surpluses (including seigniorage revenues) are insufficient to meet existing obligations, the price level and interest rates must change so that, in equilibrium, this constraint is nonetheless met. On this view, then, the equilibrium price level could evolve completely independently of the money stock.

This debate turns on what one believes about the intertemporal behaviour of governments. Critics of the fiscal theory argue that the government's PVBC holds for any sequence of prices and interest rates. In other words, the PVBC plays the role of a constraint which any government observes when planning the intertemporal profile of taxation and expenditure. As a consequence, future surpluses will generally be

sufficient to meet existing obligations. In that case the price level can be determined in the way traditionally suggested, through control of the monetary base.

The fiscal approach, in contrast, argues that the temporal profiles of taxation and government expenditure are typically not so co-ordinated. As a consequence, out of equilibrium, the real value of existing debt may exceed, or fall short of, expected future surpluses. Hence, the price level (or interest rates) will need to change to ensure solvency. As emphasised by Canzoneri and Diba (1997) and Canzoneri et al. (1998a, 1998b), the policy implications of this view are profound; in the face of what Woodford (1994, 1996, and 1998) labels a non-Ricardian regime[2] the monetary authority would be impotent to control the price-level,[3] or peg the exchange rate.

This is not to imply that traditional analyses dismissed monetary-fiscal interactions. For example, Sargent (1987) comments that the government's PVBC

"implies that monetary and fiscal policies must be co-ordinated in the sense that, given a process for [government expenditure], processes for [taxation] and [the money stock] cannot be chosen independently if they are to satisfy [the PVBC]."

and that

"statements that 'inflation is entirely a monetary phenomenon' must be interpreted and qualified in the light of the [PVBC]."

The "qualification" envisaged by the fiscal approach to the price level is more far-ranging than Sargent had in mind, and is clearly distinct from "unpleasant monetarist arithmetic". Sargent and Wallace (1981) argue that, if the government appears to be running an unsustainable fiscal policy, the price level could "jump" today in a manner that may seem akin to the fiscal explanation of the price level. But in the Sargent and

Wallace set-up the price-level shift is a function of (an anticipated) debt monetisation, so the price level is still explained in traditional monetary terms.

It seems that the theoretical arguments for and against the fiscal theory are finely balanced, which suggests that empirical analysis may shed some more light on the issue.[4] There have been relatively few empirical tests of the fiscal theory to date. Canzoneri, Cumby and Diba (1999) analyse the response, over the post-war period, of US Debt to an innovation in the federal government's budget balance. Basically, they find that debt has responded negatively to the primary surplus and conclude that the post-war US data is more naturally interpreted as consistent with a Ricardian regime. Looking at the 'reverse' response, Bohn (1998) finds that US fiscal surpluses have responded positively to debt. He argues that this provides evidence that US fiscal policy has been sustainable, and although he does not comment directly on the fiscal theory of the price level, his results are again consistent with "traditional" views. Cochrane (1998), on the other hand, argues that it is possible to model empirically post-war US inflation independently of the money stock, using data on surpluses and debt only, and he provides simulations to this effect.

This paper contributes to the debate about fiscal policy sustainability and price level determination in three different ways. First, we construct a series for the market value of UK government debt that is broadly consistent over time, and that covers nearly three hundred years (1702-1996). Hitherto, a complete series has only been readily available from 1949 onwards. The long run of debt data allows us to incorporate in our analysis periods when major shocks to fiscal policy occurred (invariably in the form of wars). Second, we develop a framework for analysing the effects of fiscal and

monetary policy on the price level. We argue that modelling equilibrium relationships in the data, and then incorporating these in dynamic equations, allows a meaningful analysis of causal relationships between money, government budget surpluses, government debt and prices. Finally, we implement our approach in a multivariate (Vector AutoRegression) framework, in which we look both for "direct" effects, as the fiscal theory of the price level suggests, and "indirect" effects as the Sargent-Wallace, or quantity-theoretic approach, would suggest.

The rest of the paper is laid out as follows. In section 2 we review briefly some relevant theoretical literature, and we discuss some testable implications of the theory. In section 3 we describe how we construct our series for the market value of government debt and take an initial look at the data. In section 4 we present our multivariate test of whether the monetary or fiscal explanation of the price level looks to be a more plausible description of UK data. We summarise and conclude in section 5.

2.   Theory and Testable Implications

2.1   Theory

A recurring debate in the macroeconomics literature has centred around the issue of what class of nominal rule is necessary to ensure price-level determinacy. Broadly speaking, the traditional answer is that policymakers need to have some regard (at some point in the past, present or future) to the *level* of base money.[5] For instance, merely pegging the nominal interest rate (i_t), what central banks often seem to do in

practice, only suffices to pin down the ratio of money to prices. This is clear from equation (1) which represents an LM-type schedule.

$$\frac{M_t}{P_t} = f(Y_t, i_t) \tag{1}$$

The same conclusions often carry over to modern general equilibrium theories, where (1) might be replaced by a cash-in-advance constraint or the ratio of the marginal utility of consumption to the marginal utility of money balances. In contrast, the fiscal theory of the price-level shifts the focus onto the government's solvency condition. The government can be regarded as facing the following familiar flow budget constraint:

$$\frac{B_{t+1}}{1+i_t} = B_t + P_t(g_t + t_t) - (M_{t+1} - M_t) \tag{2}$$

Upper case letters denote nominal magnitudes, except i_t which is the nominal interest rate between periods t and $t+1$, and lower case denotes real values. B denotes one period bonds, P is the price-level, g is government expenditure, t is tax revenue, and m is the money stock. The time subscript $t+1$ denote stocks held at the beginning of that period. Iterating forward on this expression yields the present value budget constraint:

$$B_t + M_t = \sum_{s=t}^{\infty} \frac{P_s(t_s - g_s) + \dfrac{i_{s+1}}{1+i_{s+1}} P_s m_s}{\prod_{j=t}^{s-1}(1+i_j)} \tag{3}$$

where we have imposed the usual transversality condition:

$$\lim_{T \to \infty} \frac{B_T + M_T}{\prod_{s=0}^{T-1}(1+i_s)} = 0 \qquad (4)$$

and where

$$\prod_{j}^{j-1}(1+i_j) \equiv 1$$

Note that this transversality condition is implied by the consumer's transversality condition: in this limit, if agents do not want to hold government paper, the government cannot issue it. The fiscal theory of the price level can now be seen to follow from (3).

To begin with note that from the perspective of date t the stock of outstanding nominal government liabilities, $B_t + M_t$, is a predetermined magnitude. The orthodox view would regard (3) as holding for any initial (nominal) stock of debt, and for all sequences of interest rates and price levels. If fiscal policy is conducted to ensure that the PVBC does hold for all such sequences, we follow Woodford in describing such a regime as Ricardian. In this case, the PVBC has no implications for the price-level. Canzoneri et al. (1999) spell out in detail a class of fiscal policies (feedbacks from debt onto the surplus) that meet the Ricardian criterion. It turns out that these can be fairly lax, with surpluses responding perhaps only infrequently to retire existing debt. Indeed, in principle such policy rules could be invisible to the econometric eye. Our

results suggest, however, that these variables are strongly correlated in the data, although interpretation of this correlation has proved controversial.

In contrast, the fiscal approach argues that nothing in theory or practice requires the government's monetary-fiscal programme to follow such a path. In this case fiscal policy is described as non-Ricardian. However, since (3) has to hold *in equilibrium*, some adjustment mechanism is required. The fiscalist approach posits that the price level and interest rates provide such a mechanism.

The intuition behind the fiscal theory is straightforward. Consider a fiscal shock in the form of a deficit that is not expected to be met in present value terms by tax rises. At the initial price level it would be optimal for consumption to rise, both now and in the future. In other words, bond holders experience a positive wealth effect. In the case of perfectly flexible prices (with output at its "full employment" level), the price level will "jump" sufficiently to ensure that the PVBC holds.

In the empirically more plausible case of some sluggishness in the price level an additional channel is present to ensure that (3) holds in equilibrium. Here, the government may engineer a reduction in the real interest rate[6] that it faces in servicing its debt. As a consequence, it reduces the size of the necessary future surpluses that it is required to produce.

This brief discussion of the fiscal theory of the price level raises some empirically interesting issues. For example, can UK fiscal policy be more plausibly characterised as following a Ricardian specification, in which case surpluses respond systematically

to pay off outstanding debt, or does fiscal policy evolve according to a non-Ricardian regime? Does debt affect prices and real interest rates as suggested by the fiscal theory? How closely are money and prices correlated once this relationship is conditioned on the effects of fiscal variables?

2.2 Testable implications

Direct testing of the fiscal theory of price-level determination is not straightforward, as a number of authors have noted. Indeed Cochrane (1999) suggests that the fiscal theory yields no testable implications for the time series of debt, surpluses and prices. Recent contributions to this literature have highlighted the severity of the identification problem involved. For example, consider a regression of the government budget surplus on the previous period's stock of debt, and assume the estimated coefficient is positive. This is insufficient to distinguish between a fiscal policy that is Ricardian - where the government is viewed as systematically retiring outstanding debt (Bohn, 1998) - and one that is non-Ricardian, in which case the lagged debt is merely forecasting future surpluses.

Another example concerns a negative correlation between prices and future surpluses. This could be indicative of either a Ricardian or a non-Ricardian fiscal policy. Under a Ricardian policy, money would determine the price level, which for a given level of nominal debt would then also determine the present value of future surpluses. On the other hand, in a non-Ricardian set-up, surpluses evolve in a random way, and for a given level of nominal debt, the equilibrium price-level is determined by fiscal variables

only. However, in either regime, future surpluses and (contemporaneous) prices will be negatively related.

Yet another example concerns the relationship between money and prices. We may find empirically that money and prices are positively related, but this does not necessarily imply that policy is Ricardian. Such a result may also reflect money responding endogenously to prices, in which case a positive relationship between money and prices is perfectly consistent with a non-Ricardian regime.

This brief discussion emphasises two issues pertinent to the testing of the fiscal theory, one obvious the other perhaps less so. First, the use of a single-equation approach to testing the fiscal theory is unlikely to be sufficient to disentangle the impact of monetary and fiscal variables on the price level. Again, consider the example mentioned above regarding the feedback of debt last period onto the surplus in the following period. In order to distinguish between a Ricardian and a non-Ricardian policy, we need a joint test of the effects of government debt on surpluses *and* on the price level. A non-Ricardian regime suggests most naturally that surpluses evolve independently of the (predetermined) level of debt, but also that, for given surpluses, prices should be affected by the level of debt. But if budget surpluses are expected to rise in the future, such a regime would lead to a positive relationship between current (or lagged) debt and future surpluses, and adjustment (to meet the PVBC) could be obtained via a drop in the price level. In contrast, a Ricardian regime suggests that surpluses will always be positively related to debt (at some horizon) and that debt and prices should evolve independently. The PVBC holds independently of the path of prices which are determined principally by money. This "joint test" will then be one of

the key pieces of evidence that we examine below to distinguish the two theories of price level determination.

Another important avenue for distinguishing between the opposing explanations of the price level is to analyse how excessive money balances relative to their equilibrium (see section 4.2 for details of interpretation) are worked off The Ricardian view is that prices will ultimately rise. In addition, debt should not influence the course of prices. What would be the non-Ricardian view? If money and prices are found to be positively correlated, this would be because causation is running from prices to money. The rise in the price level would ultimately be due to a rise in debt.

The second issue may be thought of as coming under the banner 'additional identifying assumptions'. As we noted above Cochrane (1998) has argued that all observations are equilibrium observations and so we can *never* observe causality in the data. In terms of our equations, all we observe in practice are (1) and (3); we have no way of identifying whether the dominant influence was monetary or fiscal policy. This interpretation of the data would seem to be at odds with the empirical approach often adopted by macroeconomists. Friedman and Schwartz (1963) and indeed before them Hume (1906) argued that monetary impulses would affect the economy with 'long and variable' lags; it has long been widely acknowledged that estimating an equation like (1) without addressing the issue of lags would be a poor basis for explaining inflation. We would argue, as does Bohn (1998), that such lags are also likely to be important even if fiscal policy is the dominant causal influence in the determination of prices. When we come to our empirical analysis we will interpret our error-correction terms as

reflecting these lags. However, we also try to interpret our results from an "equilibrium" standpoint as recommended by Cochrane (1998).

To summarise, we are therefore interested in analysing jointly several key feedbacks in the data and assessing whether they are more consistent with one policy regime or the other. First, how does debt affect future surpluses? Second, how does debt affect the price level? Third, how do these feedbacks change when we introduce money into the system? In particular, does money affect the price level, and is there any evidence of 'reverse' causation from prices to money?

3. Data Sources and Construction

Our analysis of fiscal policy and prices in the UK uses annual data over the period 1702-1996. The appendix contains a detailed description of the data sources used for this paper, here we provide a brief overview of the most important data construction issues.

Post-1949 market values of UK government debt are taken from the ONS's Annual Abstract of Statistics. For the period between 1900 and 1949 we calculate the market value of each individual government bond issue as the product of its price and outstanding stock (these are painstakingly recorded in Pember and Boyle, 1950).[7] By then adding these market values for all outstanding bond issues we approximately obtain the total market value of national debt at the end of each year.[8]

Before 1900 only par values of government debt are available. We therefore calculate a proxy for the actual market value of the government debt B_v at the end of period $t-1$ as the ratio of the coupon interest rate on Consols $c^{(9)}$ and the Consol yield $i^{(10)}$ (both during period t), multiplied by the par value (B_p) of all outstanding government debt at the end of period $t-1$. We assume perfect foresight so that expected and actual interest rates are equal:

$$B_{v,t-1} = \frac{1+c_t}{1+i_t} B_{p,t-1}$$

This approximation of the market value of government debt is based on the assumption that most of the debt issued before 1900 had a long maturity. Chart 1 compares our proxy for the market value of government debt with the data available from Pember and Boyle (*op cit*) between 1900 and 1940 (the latter both including and excluding the value of unquoted government bond issues). Unquoted debt accounted for around 15% of the total value of government debt until the first world war. During the First World War the share of unquoted debt rose to around 30%, and to 50% during the Second World War.

Our calculated series is very similar to the series including unquoted debt over the first three decades of this century. This suggests that our calculations provide a reasonably good approximation to the actual market valuation of the national debt. Both series start to diverge more markedly from the early 1930s onwards. This is largely due to the interest rate on newly issued government bonds being above the consol rate, which makes the consol rate less appropriate as a proxy for the interest return on government

debt. Additionally, the average maturity of government bonds also fell at that time, further compromising the role of the consol rate as a proxy for the actual return on the debt.

Chart 1

**Calculated market values of UK government debt versus Pember and Boyle issues data**
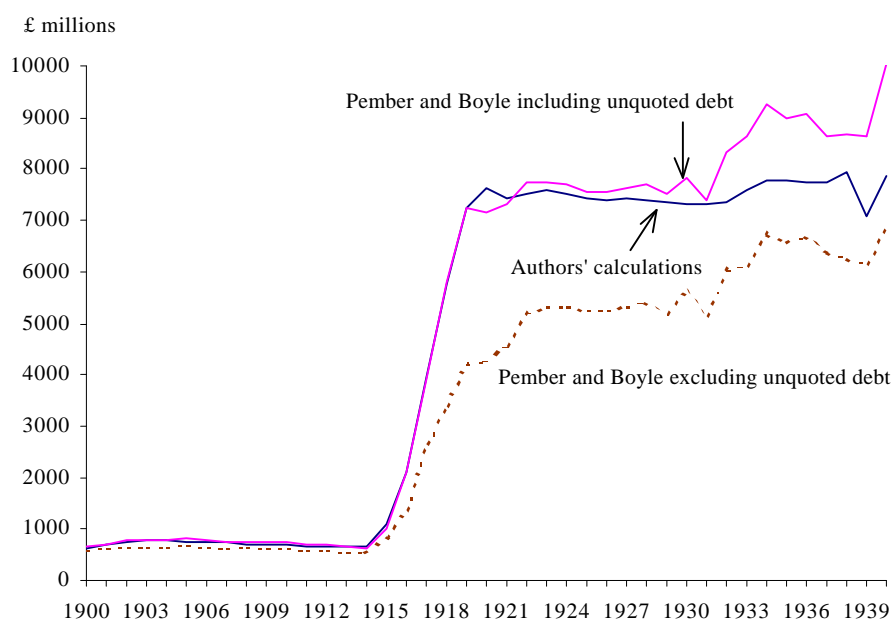
Another issue we faced constructing our time-series for government debt (both par and market values) is the dating of the observations. The data for government debt are recorded at the end of each financial year, which does not necessarily correspond to the end of a calendar year. All other data used in this paper are recorded at the end of each calendar year. We therefore follow Barro's (1987) convention in dating government debt: if the financial year ends in the first half of the year we treat that value as the stock at the end of the previous calendar year. If the financial year ends in the second half of the year we record the stock of debt as that of the end of the current calendar year. For details on the end of financial years see Barro (1987) and endnote

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7. There was no financial year in 1800, since the financial year 1798-1799 ended on October 10th and the financial year 1799-1801 ended on January 5th. The stock of debt for 1800 was therefore obtained via interpolation.

Chart 2 compares par and market values of government debt in real terms between 1702 and 1918.[11] (The Consumer Price Deflator is used to create real values because the GDP deflator data are only available from 1855 onwards.) Since consol yields were above the (consol) coupon rate most of the time before 1918, the market value of debt was generally below par over that period.
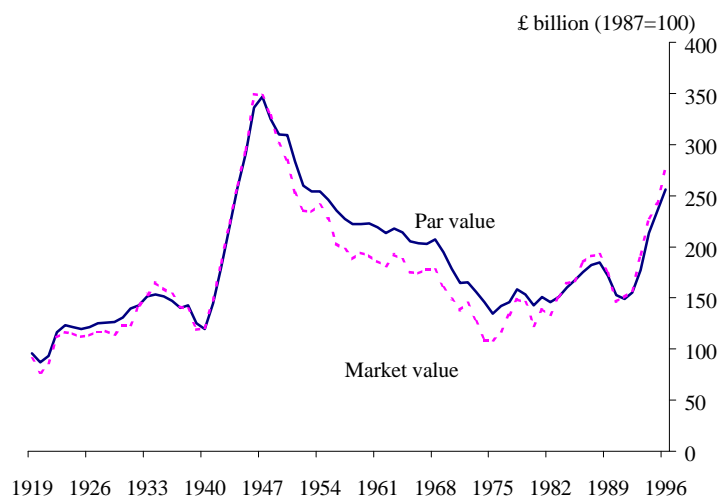
Chart 2

Real market and par values of UK government debt 1702-1918
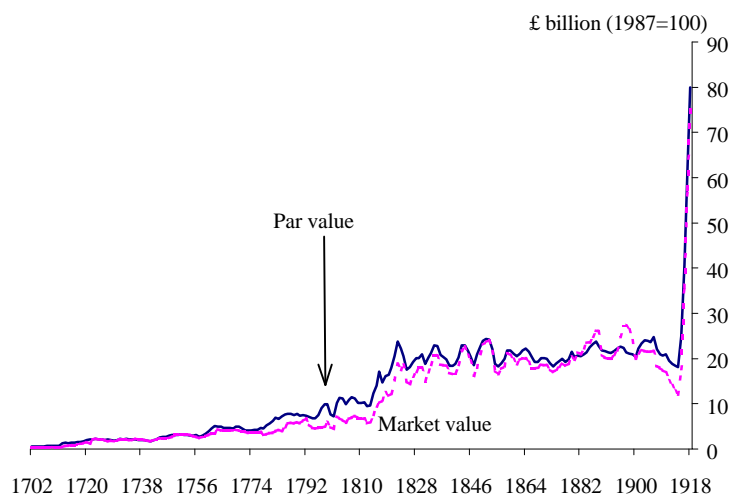
After the first World War government debt has generally traded below par as well, as Chart 3 shows. Only in the 1930s, when discount rates were less than interest rates on government debt, were market values higher than par values. We also note in passing that until the early 1980s market values were significantly lower than par values.

Chart 3

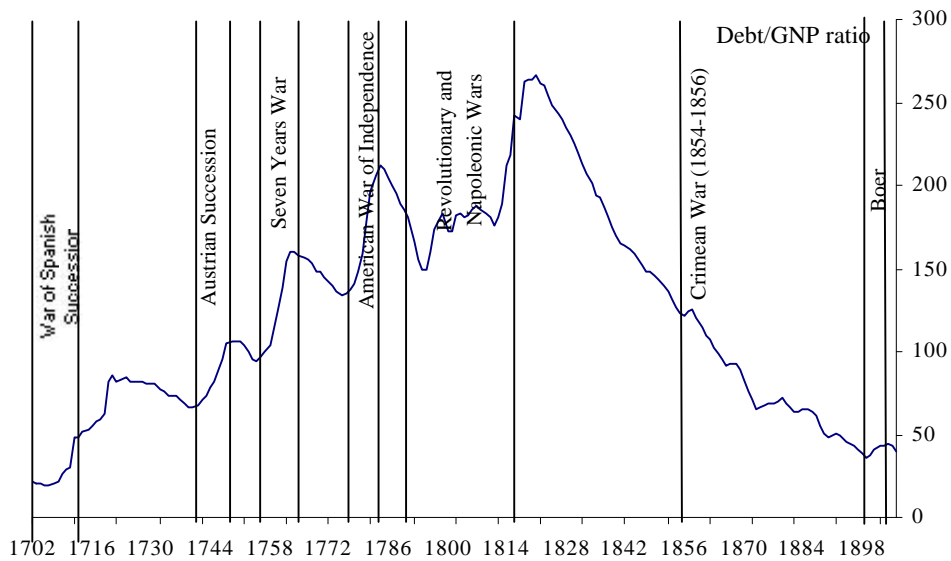**Real market and par values of UK government debt 1919-1996**

£ billion (1987=100)

A Preliminary Look at the Data: The Behaviour of Debt in the UK

As Charts 4 and 5 show, the market value of debt generally rises during wars, and falls afterwards. Similar charts could, of course, be drawn using par value data (see Charts 9 and 10 in Appendix 1). Similar time-series profiles of national debt have previously been interpreted as providing evidence in favour of tax smoothing (e.g., Barro, 1979, 1987, Bohn, 1998). It is interesting to note in passing that the theory of tax smoothing, as developed by Barro (1979), explicitly assumes that governments aim to meet their PVBC.[12]
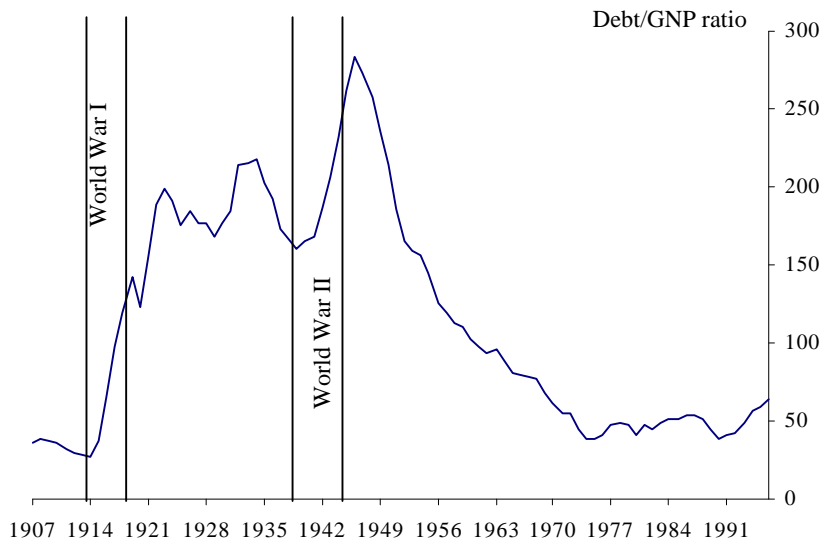
Chart 4
Ratio of nominal market value of government debt and nominal GDP and dates of major wars 1702-1906

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Chart with vertical lines marking wars: War of Spanish Succession, Austrian Succession, Seven Years War, American War of Independence, Revolutionary and Napoleonic Wars, Crimean War (1854-1856), Boer. Y-axis "Debt/GNP ratio" 0 to 300. X-axis years 1702, 1716, 1730, 1744, 1758, 1772, 1786, 1800, 1814, 1828, 1842, 1856, 1870, 1884, 1898.

Chart 5
Ratio of nominal market value of government debt and nominal GDP and dates of major wars 1907-1996

Chart with vertical lines marking World War I and World War II. Y-axis "Debt/GNP ratio" 0 to 300. X-axis years 1907, 1914, 1921, 1928, 1935, 1942, 1949, 1956, 1963, 1970, 1977, 1984, 1991.

The ratio of primary surpluses to GNP has generally fallen during wars (Charts 7 and 8 in Appendix 1), and it seems that wars have made a major contribution towards the stationarity of the series. The price level has tended to rise when the UK was at war

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(Charts 11 and 12), although the presence of what appears to be a secular trend makes it difficult to disentangle this effect merely by visual inspection of the data.

4   A framework to analyse money, debt and prices in the UK

<u>4.1   Empirical approach</u>

We begin by first identifying any long-run relationships in the data, specifically the long-run money and debt relationships. It is important to note that we assume that these relationships are invariant across Ricardian and non-Ricardian policy regimes. Indeed it is this invariance which makes direct testing of the fiscal theory a non-trivial matter. Once we have identified the long-run relationships, we nest them, as state variables (i.e., lagged one period), in a dynamic (or short-run) reduced-form Vector AutoRegressive (VAR) model, and look for the feedbacks mentioned above.[13] Note, that the terms short and long run should not be interpreted as referring to a period of time, but rather as indicating *disequilibrium* and *equilibrium* relationships, respectively.

Of course, the econometric rationale for including deviations of variables from their underlying equilibrium determinants in the dynamic VAR is that this approach allows us to specify the system in $I(0)$ space.

We analyse two basic versions of the VAR: one without base money (1705-1996) and one including base money (1872-1996).[14] The first system focuses on the feedback

between government debt, the primary surplus and inflation. This can be interpreted as a partial test of the fiscal theory on two counts. First, the fiscal theory is cast in terms of total government liabilities, i.e. base money plus nominal bonds (we perform empirical tests with total liabilities later in section 4.2), and so the first system would only test for debt as part of these liabilities. Second, we may find an important role for debt in explaining prices, but once we condition this relationship on money this effect might disappear. Our empirical approach initially distinguishes between money and bonds for two reasons. First, at a practical level, the time series for the market value of debt goes back to 1702, whereas data on the money base only start in 1870. We are reluctant to ignore the information in this longer run of government bond data. Second, we are interested to examine whether money or debt plays a dominant role in explaining inflation in the UK. Nevertheless, we also compute a measure of total government liabilities (which is more closely in line with the fiscal theory) and analyse the key feedbacks mentioned above.

The first long-run equation establishes the steady-state relationship between money, output and short interest rates; this relationship can be interpreted as a long-run money demand equation. The long-run relationship for national debt establishes a relationship between nominal debt and nominal GDP. The system without money only contains the latter long-run relationship.[15] Both systems also include a measure of the output gap, which is calculated using the Hodrick-Prescott filter. Similar results were obtained by linear de-trending of the output series. Given the long run of data used the HP filter is probably more appealing, however. Over the period of the gold standard (taken to be 1821-1930) we estimate the system without money (after re-estimating the long-run

relationship for national debt and the output gap) with the change in the exchange rate included instead of the inflation rate.

After identification of the above long-run relationships we model the following I(0) variables endogenously: the ratio of the primary surplus to nominal GDP, inflation, long real interest rates and the change in real money balances (of course, the latter is not included in the VAR excluding money).[16] The lagged residuals of the long-run relationships are also included in the respective systems. Inclusion of the change in output and in debt as endogenous variables made little difference to our results.

We note that the estimated parameters in our VARs do not represent structural relationships between the various endogenous variables. They should rather be interpreted as a reduced form representation of the underlying macroeconometric model, which may nevertheless provide a good fit to the actual data. The objective of this paper is only to identify significant feedback effects between fiscal and monetary variables and prices. The potential limited use of our model for forecasting or policy simulation purposes is therefore not essential (see Favero, 1993).

4.2 Results

VAR without money (1705-1996)

The detailed results of our empirical analysis are attached in Appendix 3. Here, we discuss the main results and interpret them from the standpoint of Ricardian and non-Ricardian policies.

In the long run real debt (b_r)[17] is homogeneous in real GDP (y_r):

$$b_r = y_r \qquad\qquad c^2(1) = 1.3863 \qquad p\text{-value} = 0.2390$$

Since money data are not available for the present sample period, we can only analyse the first two feedbacks discussed in section 4.1. First, the government's primary surplus is positively related to last period's debt overhang; the response coefficient is 0.01 (and significant at the 1% level). On a Ricardian interpretation, this suggests that there has been a sustained tendency for the government to pay off its existing debt, and meet its PVBC without requiring shifts in the general price level. On a non-Ricardian view, the positive coefficient would be interpreted as evidence that debt is anticipating future innovations in the surplus. To decide between these competing interpretations we need to find additional evidence in other regression results.

The key explanatory variables in the inflation equation are the output gap, real interest rates and lagged inflation (all of which have a positive effect on inflation). The positive coefficient in long real rates is counter-intuitive and may be accounted for by the fact that long real interest rates are a predictor of future activity. In any case, when we include money in the system this, perhaps anomalous, result disappears. The debt variable is, contrary to predictions of the fiscal theory, incorrectly signed, but insignificant in any case.

Overall, do these results suggest a Ricardian or rather a non-Ricardian interpretation? We observe that primary surpluses are highly autocorrelated. If, under a non-

Ricardian regime, debt is then anticipating future surpluses, the PVBC can only hold if prices fall. For a non-Ricardian interpretation, we would therefore expect to see prices enter the surplus equation with a negative sign. On a Ricardian interpretation, the surplus would be interpreted as paying off outstanding debt. Inflation would be independent of debt levels. Our results show that inflation is positively signed in the surplus equation, but insignificant, and that debt affects inflation insignificantly negatively. We interpret these insignificant results as suggesting that fiscal policy operated under a Ricardian regime, since prices and debt appear to evolve independently. A better founded decision on which fiscal policy regime was in operation can, however, be taken when base money data are included in the VAR system.

VAR with Money (1872-1996)

When base money is incorporated into the system, the sample period runs from 1872 to 1996. In order to investigate the effects of adding base money to the system the appendix first shows the results of the VAR without money over this sample period. The long-run relationship for debt is re-estimated and the output gap is recalculated. Overall, the results are similar to those over the longer period. The primary surplus is highly persistent and last period's debt/GDP ratio feeds back significantly on to the surplus/GDP ratio. The re-estimated output gap does not affect inflation significantly anymore, but real interest rates have a negative effect on next period's inflation rate (which is significant at the 15% level). Debt does not affect inflation significantly either.

Next, we add base money to the previous VAR model and we re-estimate the (two) long-run relationships (in money and in debt). After imposing some overidentifying restrictions on the long-run debt and money relationships we obtain the following money demand equation: $m/p = y_r - 0.26i_s$. The overidentifying restrictions on the debt and money relationships are not rejected at the usual significance levels ($c^2(3) = 4.8945$ with a *p*-value of 0.1797). The estimated interest semi elasticity of the demand for base money is similar to that estimated by Janssen (1998) for the UK over the period 1972-1997 with quarterly data and Chadha, Haldane and Janssen (1998) over the period 1872-1995 using annual data. Chart 6 shows the long-run relationships for money (Mgap) and debt (Bgap).

Chart 6

Residuals from long-run relationships for base money and debt
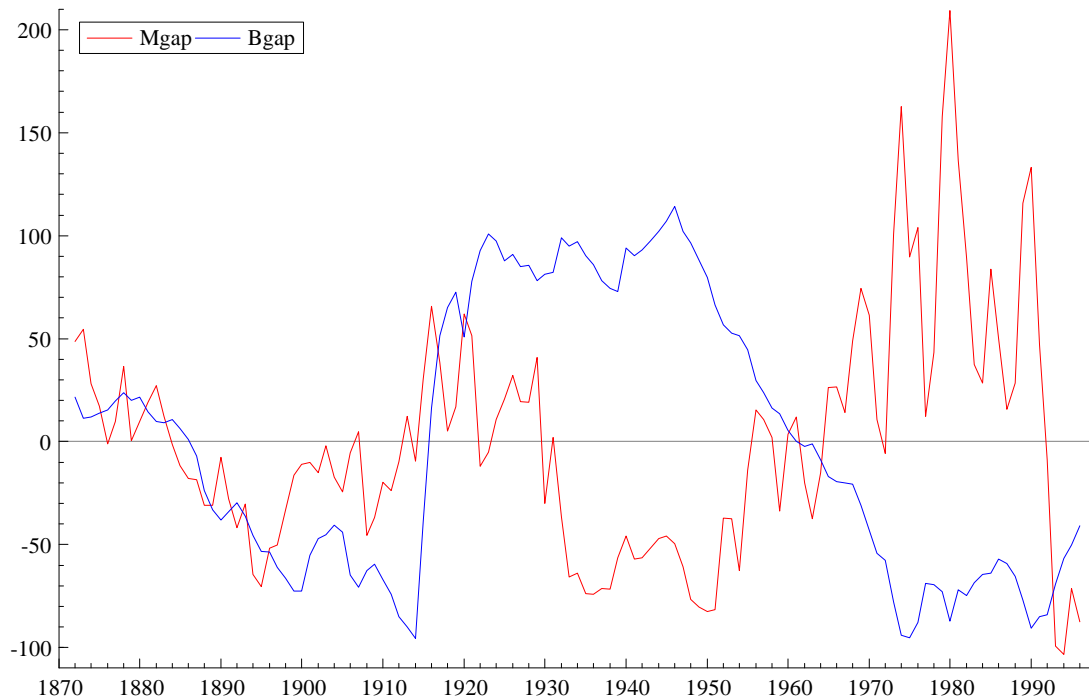
The VAR including the lagged residuals from the money and debt long-run relationships shows the following effects. The lagged residual from the long-run money demand relationship has a significant negative effect on real base money growth. This error-correction mechanism indicates that we have indeed identified a long-run money demand relationship. The lagged deviation of real government debt from real GDP has an insignificant effect on real base money growth, whereas the lagged primary surplus has a significant negative effect. There is also evidence of a liquidity effect as base money growth appears to have negative effects on real interest rates.

Of the three feedbacks we focus on in this paper, we observe (as before) significant and positive feedback from national debt on to the primary surplus. Overall, the equation for the surplus to GDP ratio is fairly robust across all models and sample periods, in particular the feedback from debt to the surplus is virtually unchanged and remains significant at the 1% level. This effect could of course be consistent with a Ricardian or a non-Ricardian policy regime.

Second, inflation is now largely explained by monetary factors, both excess balances and lagged real money growth. The effect of real interest rates on inflation is significantly negative. The output gap and debt remain insignificant. As argued previously, these results suggest that a Ricardian regime is more likely to operate.

Third, is there any evidence that fiscal variables affect money growth via prices? It appears that lagged inflation is (insignificantly) negatively related to money growth.

This suggests that the non-Ricardian explanation of 'reverse' causation from prices to money does not hold in the UK data.

Overall, we interpret the above results from the VAR with base money as suggesting that prices in the UK have not been affected in any crucial way by fiscal policy. Debt does not appear to have affected prices "directly" via the mechanism suggested by the fiscal theory. The effect of debt on money growth (which might be indicative of debt monetisation) has also been all but invisible (the coefficient on debt in the real money growth equation is -0.01, with a p-value of 0.39.).

VAR under the Gold Standard

The fiscal theory also has important implications for exchange rate policy. Canzoneri et al. (op cit) exposit the unfeasibility of pegging exchange rates via monetary means in the face of non-Ricardian fiscal policies. From around 1821 to 1930 the Pound was pegged to the value of gold. If the fiscal theory of the price level applies under a fixed exchange rate system, we would expect a rise in the national debt to lead to a devaluation of the Pound.

After re-estimation of the respective long-run relationships in the data, we examine a VAR without money, but with the change in the Dollar/Pound exchange rate included instead of inflation. Again we find significant feedback from debt onto the primary surplus. In contrast to the results for inflation, debt plays no role in the exchange rate equation (or in the inflation equation when estimated over the Gold Standard period). That said, both the surplus and the exchange rate equation appear to be poorly

explained over this period, so these results may not add much evidence to the issues analysed in this paper.

VAR with total government liabilities

Finally, we note that strictly speaking the fiscal theory provides theoretical predictions on the effects of total government liabilities on the price level. Total liabilities are defined as the sum of debt and base money. In the VARs analysed above the two components of government liabilities are included as separate variables in order to identify whether debt has a more circuitous effect on inflation, via money growth. Here, we re-estimate the VAR over the period 1872-1996 using a measure of total liabilities. The long-run relationship for total liabilities is defined as the sum of the two separate long-run relationships identified previously.

Again, the feedback from these total liabilities to the primary surplus is significant (at the 5% level) with a coefficient of 0.01, close to the estimate in the system with money as a separate variable. Total liabilities are insignificant (*p*-value=0.54) in the equation for inflation. As above, we are inclined to interpret these feedbacks as indicative of a Ricardian regime. Combined with the earlier result that inflation is explained by monetary factors, we would therefore conclude that the monetary explanation of price level determination is more likely to apply to the UK data set analysed in this paper than the fiscalist interpretation.

An 'equilibrium' interpretation of the results

As noted above, Cochrane (1998) argues that all economic data are equilibrium observations, and that causality is impossible to infer from actual data. However, even if we accept this argument, some progress can be made in understanding our results. Leaving aside our results including money, recall that the empirical relationship between lagged debt and contemporaneous surpluses appears robust. On a non-Ricardian interpretation this implies that government debt reflects an expectation of higher future surpluses. This in turn would imply that lagged debt should enter the inflation equation negatively, or equivalently that lagged inflation should enter the surplus equation negatively. Across all our samples there is little evidence for either of these effects. As in Canzoneri et al. (1999), if an innovation to the surplus resulted in a fall in surpluses further out in the future these effects need not take place. However, similar to the results for the US, our results also suggest that the degree of autocorrelation in the surplus is so strong that, if at all, such a "reversal" does not take place in the near future. Canzoneri et al. (*op. cit*.) also argue that such behaviour would be difficult to rationalise as a plausible description of government behaviour.

5.   Conclusions

Motivated by recent fiscalist theories of the price level we have developed a basic framework for analysing the effects of monetary and fiscal policy on the price level. We have applied this framework in an analysis of the UK over the past 300 years or so. One of our key results is that surpluses and debt are positively and significantly

correlated. Such a finding is neither necessary, nor sufficient, for us to conclude that fiscal policy has been Ricardian or non-Ricardian, in the terminology of Woodoford (1995). However, if this result is indicative of a non-Ricardian regime we would expect debt entering positively in an inflation equation. In fact, across all sample periods analysed we find that this is not the case. When we add money to the VAR system these results are not affected. Our inflation equation appears better specified when money is added. We view these results as being more consistent with fiscal policy being Ricardian and money playing a dominant causal role in the determination of the price level in the UK over our sample periods.

LIST OF DATA SOURCES

Crafts(1984): *British Economic Growth during the Industrial Revolution*
Deane (1969): "New estimates of gross national product for the United Kingdom 1830-1914", *Review of Income and Wealth.*
Feinstein(1972): *National income, expenditure and output of the United Kingdom, 1855-1965*
Fenn(1899): *Fenn on the Funds* Homer and Sylla(1987): *A History of Interest Rates*
Hargreaves(1930): *A history of the National Debt*
Harley(1976): "Goschen's Conversion of the National Debt and the yield on Consols", *Economic History Review.*
Mitchell and Deane (1962) : *Abstract of British Historical Statistics*
ONS/CSO: Annual Abstract of Statistics (various issues)
ONS/CSO: Economic Trends (various issues)
Peacock and Wiseman(1963): *The growth of public expenditure in the UK*
Pember and Boyle(1950): *British Government Securities in the 20th century*

Sources for particular series:

Yield on consols:
Homer and Sylla, Harley, Mitchell and Deane

National debt:
Par values: Fenn, Hargreaves, Mitchell and Deane, Pember and Boyle.
Market values. Post-1949 from Annual Abstract of Statistics, Table 17.15, Securities quoted on the London Stock Exchange. 1900-1949 market values constructed using prices and quantities from Pember and Boyle. Pre-1900 prices obtained from Homer and Sylla and Harley.

Prices:
Pre-1800 the Schumpeter-Gilboy price index in Mitchell and Deane.
1800-1997 Bank of England RPI.

National Income:
Pre-1830, Mitchell And Deane, Crafts.
1830-1855, Deane(1967).
1855-1947, Feinstein.
1947-1997, ONS Economic Trends

Primary and total central government deficit:
Pre-1855, Mitchell and Deane.
1855-1900, Feinstein.
1900-47, Peacock and Wiseman and Feinstein.
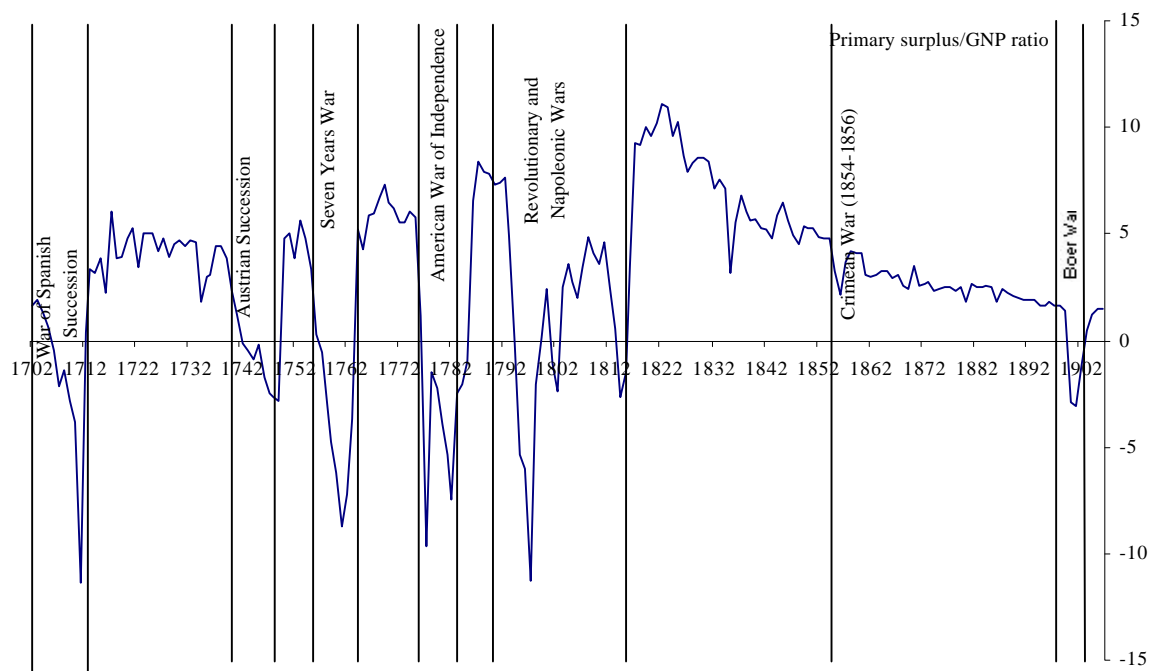1947-1997, ONS Economic Trends

Base Money:
Capie, F. and A. Webber (1985), *A Monetary History of the UK, 1870-1982*, Allen and Unwin, London.
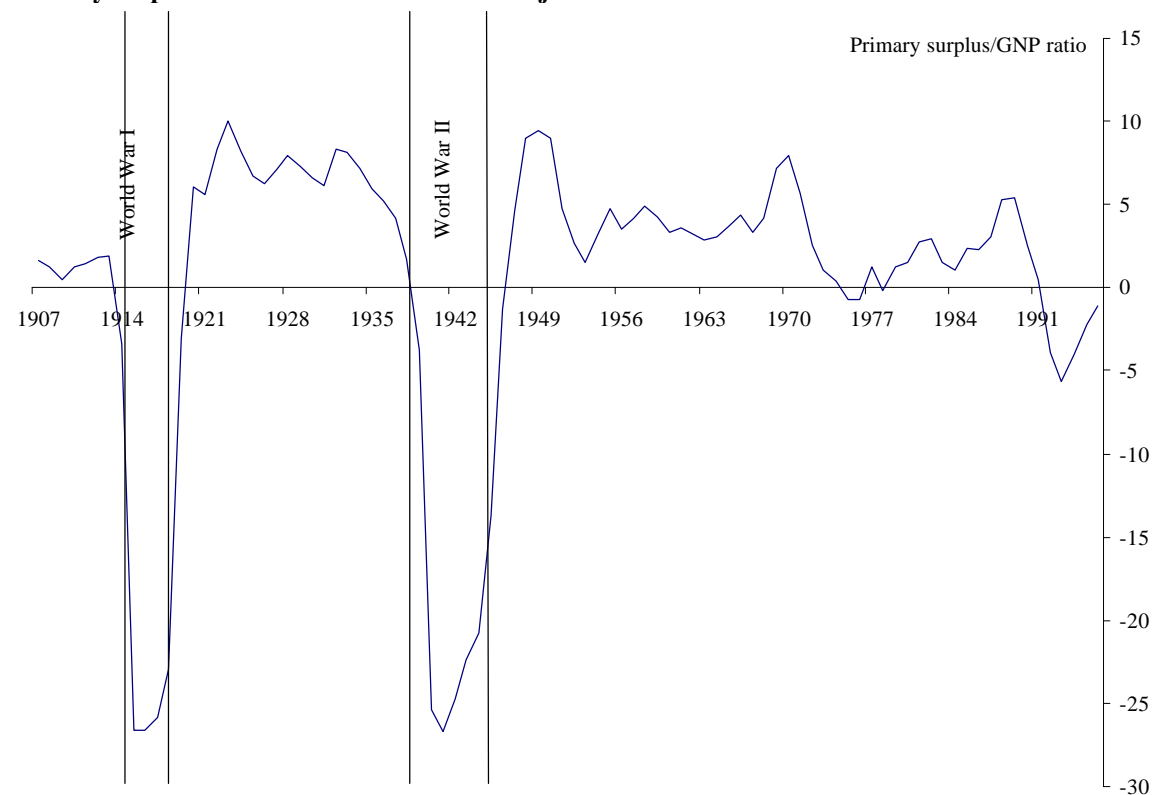
Appendix 1

Chart 7
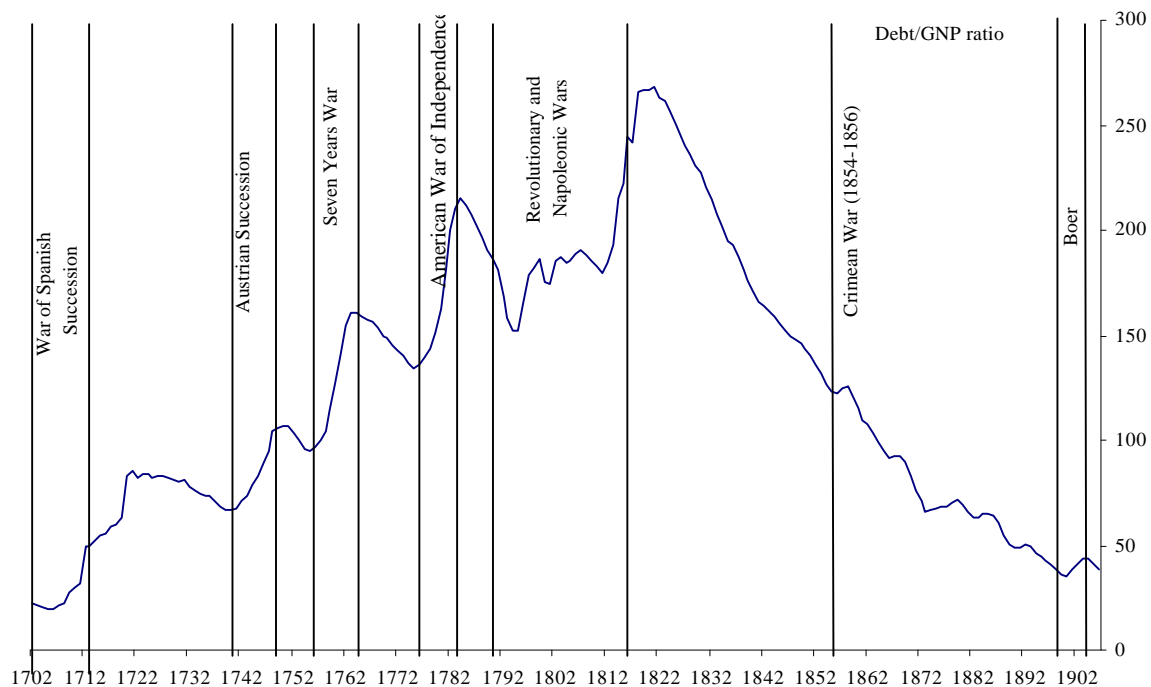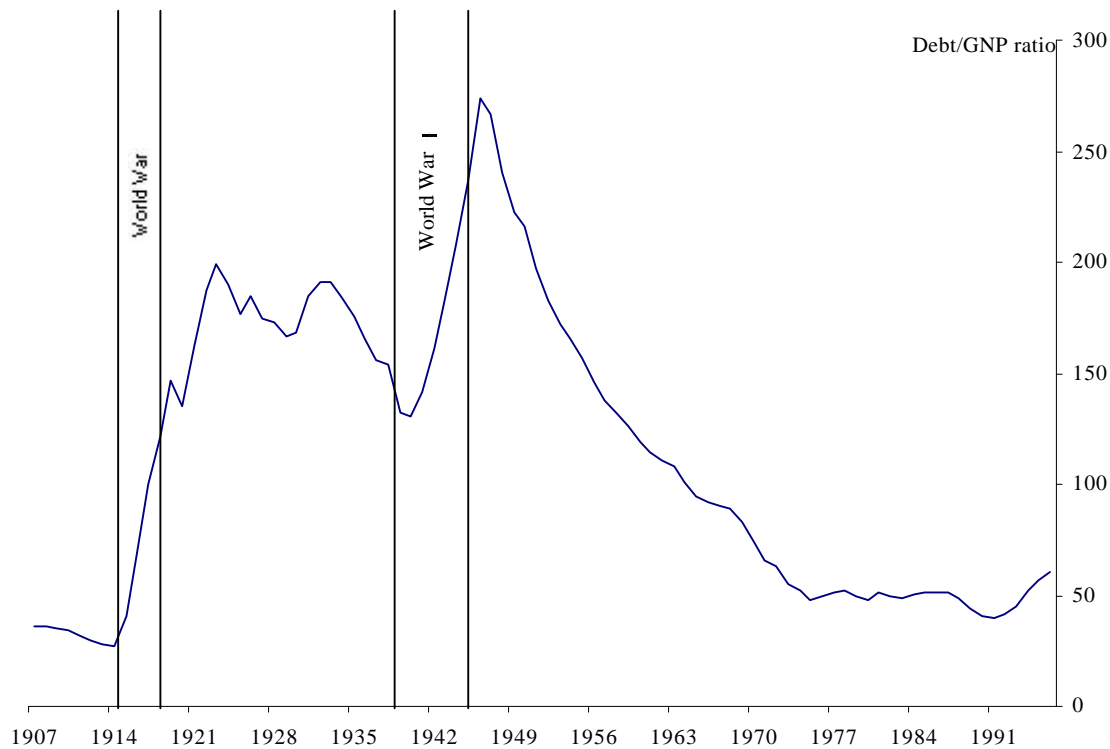**Primary surplus to GNP ratio and dates of major wars 1702-1906**

Chart 8
Primary surplus to GNP ratio and dates of major wars 1907-1996

Chart 9
Ratio of par value of debt to GNP 1702-1906

Debt/GNP ratio

War of Spanish Succession · Austrian Succession · Seven Years War · American War of Independence · Revolutionary and Napoleonic Wars · Crimean War (1854-1856) · Boer

1702 1712 1722 1732 1742 1752 1762 1772 1782 1792 1802 1812 1822 1832 1842 1852 1862 1872 1882 1892 1902

Chart 10
Ratio of par value of debt to GNP 1907-1996

Debt/GNP ratio

World War · World War I

1907 1914 1921 1928 1935 1942 1949 1956 1963 1970 1977 1984 1991

Chart 11
Log of price level and dates of major wars 1702-1906
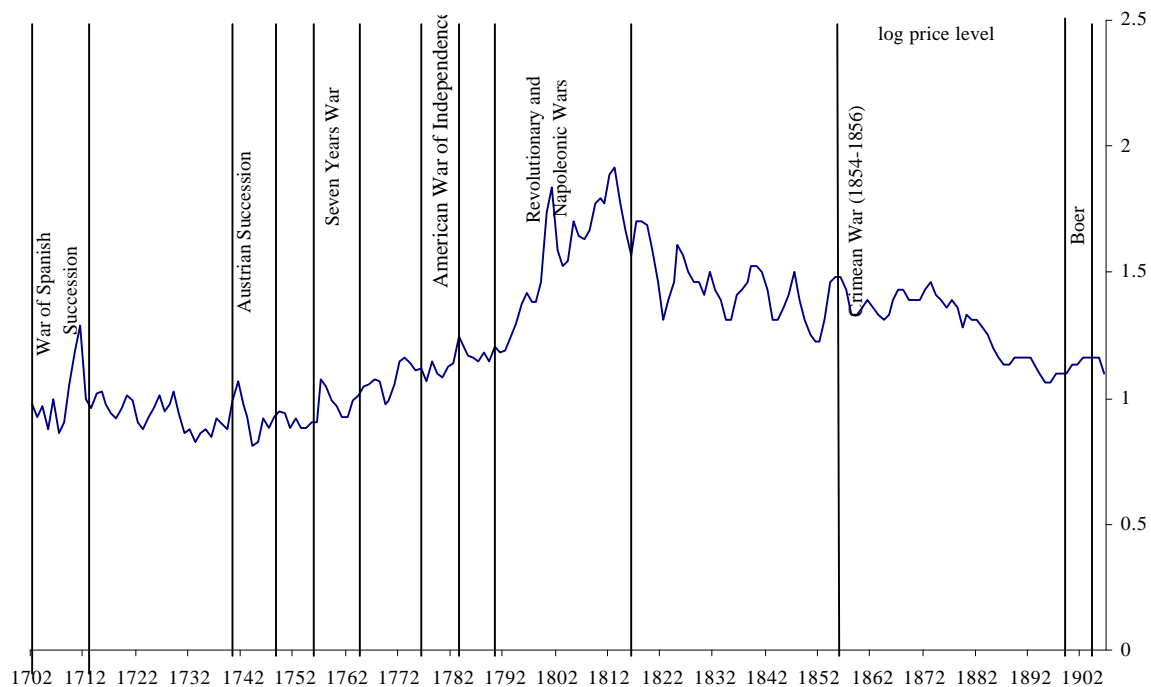
Chart 12
Log of price level and dates of major wars 1907-1996
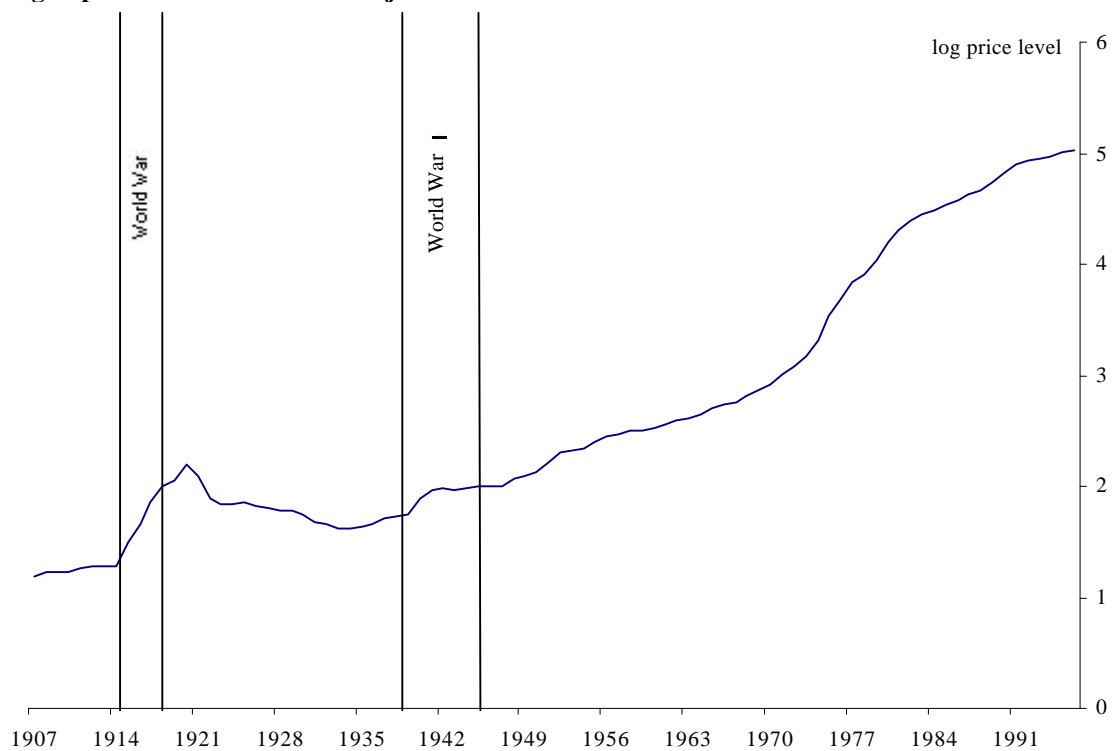
Appendix 2

Econometric approach

In the econometric approach we take into account the predetermined nature of government debt and base money in the fiscal theory of the price level by taking these variables as given in period t. This is also in line with the Friedman/Schwartz type view of monetary (and fiscal) policy that policy affects the economy with long and variable lags, which implies that an economy can be in disequilibrium for a prolonged period of time.

The main objective of our analysis is whether monetary and/or fiscal policy determines the price level. Since disequilibrium in one or more sectors of the economy can cause deviations from the steady state and lead to changes in the price level, these disequilibria can provide important information about the dynamic structure of the economy. Therefore we model inflation as arising from three (sectoral) sources of excess demand (see also Metin, 1995 and Hendry, 1998), which reflect monetary, fiscal and real disequilibria. Inflation may also be caused by dynamic effects from other variables in our VAR.

The first stage of our empirical approach then involves estimation and identification of three equilibrium relationships. The money and government debt relationships are estimated in separate unrestricted VARs. Each of these VARs can be reparameterised as a vector error correction mechanism (VECM) to distinguish the long-run relationships among the variables q_t (see section 4.1 for the variables used in the money

and debt relationships) from the short-run dynamics. The VECMs for money and government debt can formally be expressed as follows:

$$\Delta q_t = \boldsymbol{h} + \Pi q_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta q_{t-i} + \boldsymbol{e}_t \qquad \text{(A1)}$$

We use Johansen's maximum likelihood estimation procedure (Johansen, 1988 and 1991, Johansen and Juselius, 1990) to test for the rank of the matrix Π. If it is less than full rank, this test is used to determine the number of cointegrating relationships between the variables in the two respective VARs:

Restrictions derived from economic theory are then used to identify these long-run relationships. This includes imposing some non-testable coefficient restrictions, which are the minimum number required for exact identification, plus overidentifying restrictions to determine the cointegrating vectors. When some of the variables are cointegrated the matrix Π can be decomposed into two other matrices, so that (A1) becomes:

$$\Delta q_t = \boldsymbol{h} + \boldsymbol{a}\boldsymbol{b}'q_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta q_{t-i} + \boldsymbol{e}_t \qquad \text{(A2)}$$

where β' is the matrix of coefficients of the cointegrating vectors and α is the matrix of loading coefficients. The former can be interpreted as the long-run relationships in the respective systems and the latter determine the feedback of deviations from these long-

run equilibria onto the dynamics of the endogenous variables (the error-correction terms).

In contrast to the first two long-run relationships, the output gap is calculated as the deviation of actual output from its trend, as generated by the Hodrick/Prescott filter.

After identification of these three excess demand relationships the second stage encompasses both the lagged deviations from the long-run equilibria ($\boldsymbol{b}'q_{t-1}$), as well as the lagged effects from a vector of stationary endogenous variables (v_t), as described in section 4.1. In general terms, the endogenous variables v_t can then be modelled as their expectation, conditional on an information set I_{t-i}, which consists of long and short-run elements, and can formally be expressed as follows:

$$E(v_t \mid I_{t-1})\tag{A3}$$

where $I_{t-1} = [v_{t-i}, \boldsymbol{b}'q_{t-1}]$

The resulting reduced-form system (which is now defined in I(0) space and the results of which are shown in Appendix 3) can be interpreted as a VECM again:

$$v_t = \boldsymbol{h} + \boldsymbol{gb}'q_{t-1} + \sum_{i=1}^{p-1} \Lambda_i v_{t-i} + u_t \tag{A4}$$

where $\boldsymbol{g}$ now denotes the matrix of loading coefficients of the long-run disequilibria for the stationary variables v.

Appendix 3

Results

VAR excluding money (1705-1996)

Dependent variable:	Surplus:GDP S_t	Real interest rate Lr_t	Inflation DLp_t
S_{t-1}	0.83***	0.05	-0.05
Lr_{t-1}	0.17*	0.52***	0.44***
DLp_{t-1}	0.10	0.04	0.94***
Y-gap$_{t-1}$	0.01	-0.79***	0.80***
B-gap$_{t-1}$	0.01***	0.00	-0.00
Constant	-0.31	1.33*	-1.1
S.E.	3.08	5.08	5.10

VAR excluding money (1872-1996)

Dependent variable:	Surplus:GDP S_t	Real interest rate Lr_t	Inflation DLp_t
S_{t-1}	0.87***	0.12**	-0.20***
Lr_{t-1}	0.18*	0.45***	-0.18
DLp_{t-1}	0.21***	0.07	0.42***
Y-gap$_{t-1}$	-0.06	-0.45***	0.01
B-gap$_{t-1}$	0.01***	0.01	-0.01
Constant	-1.07	0.95	2.51
S.E.	3.77	4.29	4.82

VAR including money (1872-1996)

Dependent variable:	Surplus:GDP S_t	Real interest rate Lr_t	Inflation DLp_t	Money Growth DM_t
S_{t-1}	0.84***	-0.03	-0.04	-0.22***
Lr_{t-1}	0.19**	0.51***	-0.29***	0.25**
DLp_{t-1}	0.16	-0.20*	0.64***	-0.21
Y-gap$_{t-1}$	-0.04	-0.36***	-0.05	0.00
B-gap$_{t-1}$	0.01**	0.01	-0.00	-0.01
DM_{t-1}	-0.07	-0.38***	0.51***	-0.17
M-gap$_{t-1}$	0.00	0.01	0.02**	-0.02**
Constant	-0.84	2.09***	1.51**	1.17
S.E.	3.79	4.10	4.42	5.04

VAR including exchange rate (1821-1930)

Dependent variable:	Surplus:GDP S_t	Real interest rate Lr_t	Exchange Rate Dle_t
S_{t-1}	0.75***	0.25**	0.18
Lr_{t-1}	0.03	0.37***	-0.01
DLe_{t-1}	-0.02	0.05	-0.09
$Y\text{-}gap_{t-1}$	-0.02	-0.58***	-0.11
$B\text{-}gap_{t-1}$	0.02***	0.00	-0.00
Constant	0.64*	1.24**	-0.44
S.E.	2.98	4.92	7.47

VAR including total liabilities (1872-1996)

Dependent variable:	Surplus:GDP S_t	Real interest rate Lr_t	Inflation DLp_t
S_{t-1}	0.85***	0.11**	-0.19***
Lr_{t-1}	0.16*	0.46***	-0.18
DLp_{t-1}	0.15**	0.03	0.43***
$Y\text{-}gap_{t-1}$	-0.04	-0.44***	0.02
$Liab\text{-}gap_{t-1}$	0.01**	0.01	0.00
Constant	-0.82	1.08*	2.45***
S.E.	3.80	4.27	4.85

References

Barro, R. J. (1979), "On the Determination of Public Debt", *Journal of Political Economy*,

Barro, R. J. (1987), "Government Spending, Interest Rates, Prices and Budget Deficits in the United Kingdom, 1701-1918", *Journal of Monetary Economics*, 20:221-47

Bergin, Paul (1995), *Fiscal Restrictions in a Currency Union: Further Lessons on the Interaction of Monetary and Fiscal Policies*, mimeo

Bohn, H. (1998), "The Behaviour of U.S. Public Debt and Deficits", *Quarterly Journal of Economics,* 949-963

Buiter, Willem (1998), *The Young Person's Guide to Neutrality, Price Level Determinacy, Interest Rate Pegs and Fiscal Theories of the Price Level*, mimeo.

Canzoneri, Matthew B, Robert E. Cumby and Behzad T. Diba (1997), *Fiscal Discipline and Exchange Rate Regimes*, Georgetown University, mimeo.

Canzoneri, Matthew B, Robert E. Cumby and Behzad T. Diba (1999), *Is The Price Level Determined by the Needs of Fiscal Policy?*, Georgetown University, mimeo.

Canzoneri, Matthew B. and Behzad T. Diba (1996), "Fiscal Constraints on Central Bank Independence and Price Stability", *CEPR Working Paper*, no. 1463.

Chadha, Jagjit S., Andrew G. Haldane and Norbert G.J. Janssen (1998), "Shoe-Leather Costs Reconsidered", *Economic Journal*, vol. 108, March, 363-82.

Favero, Carlo A. (1993), "Error Correction and Forward Looking Models for UK Consumers' Expenditure", *Oxford Bulletin of Economics and Statistics*, vol. 55, no. 4, 453-72.

Friedman, M and A. J. Schwartz (1963), *A Monetary History of the United States, 1867-1960* Princeton University Press

Hamilton, James D., and Marjorie A. Flavin (1986), "On the Limitations of Government Borrowing: A Framework for Empirical Testing", *American Economic Review*, vol. 76, no.4, 808-819.

Harley, C.K. (1976), "Goschen's Conversion of the National Debt and the Yield on Consols", *Journal of Economic History*, pp. 101-6.

Hendry, D. (1998), *Modelling UK Inflation over the Long Run*, Nuffield College, Oxford, mimeo.

Hume, D (1906) 'Of Money (originally published in 1752)', in *Political Discourses*, the Walter Scott Publishing Company, London

Janssen, Norbert (1998), "The Demand for M0 in the United Kingdom Reconsidered: Some Specification Issues", *Bank of England Working Paper*, no. 83.

Leeper, Eric (1991), "Equilibria Under 'Active' and 'Passive' Monetary Policies", *Journal of Monetary Economics*, 27, 1991, 129-147.

McCallum, Bennet (1997), "Issues in the Design of Monetary Policy Rules", forthcoming in: John Taylor and Michael Woodford (eds.), *Handbook of Macroeconomics*.

Metin, K. (1995), "An integrated analysis of Turkish inflation", *Oxford Bulletin of Economics and Statistics*, 57, 4, 513-31.

Sargent, Thomas J. (1987), *Dynamic Macroeconomic Theory*, Harvard University Press.

Sargent, Thomas J. and Wallace (1981), "Some Unpleasant Monetarist Arithmetic", *Federal Reserve Bank of Minneapolis Quarterly Review*, Fall, 1-17.

Sims, Christopher (1994), "A Simple Model for the Study of the Price Level and the Interaction of Monetary and Fiscal Policy", *Economic Theory*, 4, 381-399.

_____, (1998), *The Precarious Fiscal Foundations of EMU*, mimeo.

Woodford, Michael (1995), "Price Level Determinacy without Control of a Monetary Aggregate", *Carnegie Rochester Conference Series on Public Policy*, 43, 1-46.

_____, (1996), *Control of the Public Debt: A Requirement for Price Stability?*, mimeo.

_____, (1998), *Public Debt and the Price Level*, mimeo

Endnotes

(1) Some of the key contributions include Leeper (1991), Sims (1994), (1998), Woodford (1994), (1996), (1998), Canzoneri et al, (1998), Bergin (19??), Cochrane (1998)

(2) Woodford defines a non-Ricardian regime as a fiscal policy that retains the PVBC only as an equilibrium condition. A Ricardian regime is characterised by policy mechanisms that ensure the PVBC holds for all sequences of prices and interest rates.

(3) Sims (1998), Bergin (199?) and Woodford (1996) have used the fiscal approach to comment on the importance, or otherwise, of the Stability Pact for inflation control in the newly created Euro-zone.

(4) Not everyone shares this view. Buiter (1998) argues that permitting the PVBC to hold only for equilibrium price-levels results in an "ill-posed" general equilibrium problem. Consequently, he argues that testing the fiscal theory is of little value. Cochrane (1998), on the other hand argues that the fiscal theory yields no testable implications for the time series of debt, surpluses and prices.

(5) See, for instance, Sargent and Wallace(), McCallum (), Canzoneri, Henderson and Rogoff ().

(6) That is, the nominal interest rate is raised but by an amount insufficient to avoid a fall in the real rate.

(7) The stock data from Pember and Boyle are recorded at the end of the financial year (31st March), whereas the price data are measured at the end of each calendar year. ONS data on market values are recorded at the end of the financial year. This implies that there is a nine month gap between the recorded stock and price data over the period 1900-1949.

(8) Part of the national debt is unquoted, which means that in the calculation of the market value these bonds can only be included at par.

(9) We take into account the effects of Goschen's conversion of the national debt in 1888, such that the coupon rate fell from 3% before 1889 to 2.5% from 1889 onwards (see Harley, 1976 for details).

(10) The consol yield indicates the market's discount rate.

(11) Note that the market values shown in the chart are obtained from Pember and Boyle (*op cit*).

(12) Woodford (1998) argues that optimal public finance need not assume Ricardian policies are in place.

(13) Details about the econometric approach can be found in Appendix 2.

(14) A consistent measure of the stock of base money is available from 1870 onwards only (source: Capie and Webber, 1985).

(15) Over most of the sample periods examined, the data suggest a third long-run relationship which can be identified as a term-structure equation. Again, this made little difference to the main results, so we only report the basic system.

(16) The choice of which variables to include is motivated by the analysis in Woodford (1996).

(17) We use the CPI deflator to obtain a time series for real government debt, since the GDP deflator is only available from 1855 onwards. This does not affect the long-run relationship between real debt and real output, however.