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Money, Debt and Prices in the UK 1705-1996*

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ABSTRACT

This paper constructs a consistent series for the market value of UK Government debt over almost 300 years. We analyse how monetary and fiscal policy affect the path of the price level in the UK. Specifically, the paper examines the interactions between debts, deficits, the monetary base and the price level. Overall, the price level has been closely related to the evolution of the base money supply. Across different sample periods, there is little econometric evidence that fiscal policy has affected the course of the price level (or of the exchange rate under the Gold Standard). Government debt has not significantly affected the base money stock either.

Keywords: Fiscal policy, debt, monetary policy, price level determination.

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1. Introduction

The interaction between monetary and fiscal policy, and their roles in the determination and control of the price level, has been the subject of continuous debate in the academic literature. Informal rules governing the conduct of fiscal policy have also come to renewed prominence in recent years (e.g., in New Zealand and the UK). Indeed, in Europe, the Growth and Stability Pact represents a more formal set of arrangements for fiscal policy that the countries participating in the single currency should adhere to. The introduction of these rules is often justified as a complement to the reforms of monetary institutions; both types of arrangements are aimed at price stability.(1)

In the academic literature the traditional view on the determination of the price level is based on the Quantity Theory of Money. Basically this argues that the equilibrium price level equates the real purchasing power of the money stock with the demand for real money balances. The central implication is that control of the price level turns on control of the money stock. However, in an influential analysis, Sargent and Wallace (1981) highlight some potential game-theoretic interactions between monetary and fiscal authorities. Sargent and Wallace (*op. cit.*) show that under certain conditions the monetary authority might lose *de facto* control of the price level due to the need to raise seigniorage revenue. As Sargent (1987) notes, the government's present-value budget constraint (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]."

Ultimately, however, even in the Sargent-Wallace set up, the price level is still explained in familiar monetary terms.

Recently, the issue of aggregate price determination has resurfaced due to the so-called fiscal theory of the price level[(2)]. This approach also emphasises the role of the PVBC, but in a somewhat different way to Sargent and Wallace. The essence of the fiscal theory of the price level is as follows. If future primary surpluses (including seigniorage revenue) are insufficient to meet existing government liabilities, the price level and interest rates must change to ensure that, in equilibrium, the PVBC is met. Therefore, base money growth will no longer be the dominant determinant of the evolution of prices.

The debate between the monetary and the fiscal approach to price level determination turns on the intertemporal behaviour of governments. If the PVBC plays the role of a constraint, which governments observe when planning the temporal profile of taxation and expenditure, then the price level is determined in the quantity-theoretic way economists have typically thought it was.

However, if the temporal profiles of taxation and government expenditure are not so co-ordinated then, off equilibrium, the real value of existing debt may exceed, or fall short of, expected future surpluses. As emphasised by Canzoneri and Diba (1996) and Canzoneri et al. (1997, 1999), the policy implications of this view are profound; in the face of what Woodford (1994, 1996, and 1998) labels a non-Ricardian regime[(3)] the monetary authority would lose control of the price level[(4)] and/or the exchange rate.

There have been relatively few empirical analyses of either the Sargent-Wallace concerns or of the fiscal theory, and even less so for the UK. Most recent empirical work has focussed on trying to distinguish between fiscal policy regimes (i.e., Ricardian versus non-Ricardian, see the discussion below) using US data. For example, 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. They find that debt responds negatively to the primary surplus and conclude that the post-war US data are most plausibly interpreted as consistent with a Ricardian regime. Looking at the 'reverse' response, Bohn (1998a) finds that US fiscal surpluses respond positively to debt. He interprets this as 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 only surplus and debt data, and he provides simulations to this effect.

In this paper we first 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 time series of debt data allows us to incorporate in our analysis periods when major shocks to fiscal policy occurred (invariably in the form of wars). We then develop a multivariate (Vector AutoRegression) framework to analyse the effects of fiscal and monetary policy on the course of the price level. Specifically, we aim to identify how closely base money and the price level are related once we condition on fiscal variables. We interpret our results as being in favour of a quantity-theoretical explanation of the price level; this suggests that some of the concerns raised by Sargent and Wallace have not been important factors in the evolution of aggregate prices in the UK. We also find that certain correlations in the data are robust across different sample periods. Furthermore, we observe that these results are consistent with relationships found in the US data. This consistency across time and (two) countries may also help in the search for additional identifying assumptions that may be adopted in more formal analyses intended to distinguish Ricardian from non-Ricardian regimes.

The rest of the paper is laid out as follows. In section 2 we review briefly the relevant theoretical literature, and we discuss some empirical implications of the theories to be analysed. In section 3 we describe the construction of the series for the market value of government debt and take an initial look at the data. Section 4 presents our analysis of how monetary and fiscal variables influence the course of the price level over the long run of UK data. We summarise and conclude in section 5.

2. Some Theory

2.1 Theory

Theoretically one can distinguish three broad approaches to the determination of equilibrium aggregate prices.(5) The first is the quantity-theoretic approach under monetary leadership. The second is the quantity theory under fiscal leadership. And finally, the fiscal theory provides an essentially moneyless view of equilibrium price determination. The essence of these approaches can be clarified by the following familiar equations. Each period the consolidated public sector faces the following flow budget constraint:

$$\frac{B_{t+1}}{1+i_t} = B_t + P_t(g_t - \tau_t) - (M_{t+1} - M_t) \qquad (1)$$

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

$$B_t + M_t = \sum_{s=t}^{\infty}\left[P_s(\tau_s - g_s) + \frac{i_{s+1}}{1+i_{s+1}}P_s m_s\right]\left\{\prod_{j=t}^{s-1}(1+i_j)\right\}^{-1} \quad (2)$$

where we have imposed the usual transversality condition:

$$\lim_{T\to\infty}\left(B_T + M_T\right)\left\{\prod_{s=0}^{T-1}(1+i_s)\right\}^{-1} = 0\,,$$

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 the limit, the government can only issue debt if agents are prepared to hold it. The PVBC says that the present value of future net surpluses must be sufficient, in equilibrium, to discharge the government's outstanding net liabilities.

Equation (3) represents a typical money demand equation, and can be regarded as the ratio of the marginal utility of consumption to the marginal utility of money balances (or more simply as a cash-in-advance constraint).

$$M_t / P_t = f(Y_t, i_t) \qquad f_Y > 0, \quad f_i < 0 \quad (3)$$

The quantity-theoretic tradition regards this equation as crucial for the determination of prices, given output (or consumption) Y_t, the nominal interest rate i_t, and the level of the money stock M_t, which is determined (voluntarily or otherwise) by the central bank.

The quantity theory under monetary leadership envisages a situation in which the decisions on the sequence of money supplies Stackelberg lead those on the sequence of primary surpluses. In this set-up therefore the given money stock determines the period price level via equation (3) (and hence the real value of the government's outstanding liabilities $(B_t + M_t)/P_t$). Monetary policy determines the seigniorage sequence $[i_{s+1}/(1+i_{s+1})]P_s m_s, \forall s$, while the sequence of primary surpluses, $P_s(\tau_s - g_s), \forall s$ is determined essentially by residual to ensure the PVBC is met.

The quantity theory under fiscal leadership retains (3) as the equation determining the price level, however Sargent and Wallace (1981) argue that de facto control of the money supply may pass to the fiscal authorities. They envisage a situation where the fiscal authority pursues an unsustainable fiscal policy. That is, it pre-commits to a sequence of tax and expenditure plans $P_s(\tau_s - g_s)$ that require it to issue ever-increasing amounts of debt. They argue that, if the interest rate exceeds the growth rate of the economy, at some point the government will be unable to sell this debt, and the monetary authority will be required to finance the deficient budget via seigniorage revenue. The PVBC is then met, and the equilibrium price level is still determined by (3), although the base money stock is not determined by the monetary authorities anymore.

Both the above approaches to the quantity theory constitute a broad consensus that the ultimate determinant of inflation is the growth in the base money stock, (whether we face fiscal or monetary leadership). For example, much time series evidence is presented in Friedman and Schwartz (1963), while Lucas (1996) reviews cross sectional evidence. Indeed Lucas (1996) suggests that few macroeconomic theories are as consistent with the data as is the quantity theory.

The essence then of both quantity-theoretic views is that (1) holds for any initial (nominal) stock of debt and for all sequences of interest rates and price levels. If fiscal policy is set to ensure that the PVBC does hold for all these sequences, we follow Woodford in describing such a regime as Ricardian. In this case, the PVBC has no implications for the price level[(6)].

The final approach to price determination is the fiscal theory. This view is based directly on equation (1). Note that from the perspective of date t the stock of outstanding nominal government liabilities, $B_t + M_t$, is a predetermined magnitude. The fiscal approach argues that the sequence of net surpluses $P_s(\tau_s - g_s)$ and seigniorage revenue $[i_{s+1}/(1+i_{s+1})]P_s m_s$ is generally not co-ordinated as the quantity theory assumes. Such a regime can therefore be described as non-Ricardian. As a consequence the price level (or the interest rate) must shift so that the PVBC is nonetheless met in equilibrium. In this set-up equation (3) is essentially redundant as far as determination of the price level is concerned.

The intuition behind the fiscal theory is best explained by a simple example. Consider a fiscal shock in the form of a deficit that is not expected to be met in present value terms by increases in tax. At the initial price level, it would be optimal for consumption to rise, both now and in the future, since agents now have a larger consumption set available. 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 then "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 (1) holds in equilibrium. Here, the government may engineer a reduction in the real interest rate[(7)] that it faces in servicing its debt. As a consequence, it reduces the size of the future net surpluses that is required to meet the existing net liabilities.

2.2 Empirical implications

We now set out the empirical implications of the three approaches to the determination of the price level.[(8)] We should mention from the start that direct testing of the fiscal theory is not straightforward and illustrate this first with an 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, 1998a) - and one that may be non-Ricardian, in which lagged debt is merely forecasting future surpluses (Woodford, 1998).

Second, we acknowledge and emphasise the importance of a point raised by Woodford (1998b) in the context of analysing the fiscal theory empirically; a single-equation approach is unlikely to be sufficient to disentangle the impact of monetary and fiscal variables on the price level. Again, consider the previous example regarding the feedback of debt last period onto the surplus in the current period. In order to distinguish the rivalling explanations of the price level we need to characterise the effects of government debt on surpluses, *as well as* on prices. A natural characterisation of a non-Ricardian regime is that surpluses evolve independently of the (predetermined) level of debt (Canzoneri, Cumby and Diba (1997), Christiano and Fitzgerald (2000)), but also that, for given surpluses, the price level should be affected by the outstanding stock of debt. But if budget surpluses are expected to rise in the future, such a regime would lead to an observed positive relationship between current (or lagged) debt and future surpluses, and adjustment (to meet the PVBC) could be obtained without a change or 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 is ultimately determined by the base money supply. Whether these joint relationships between national debt and surpluses and between debt and the price level hold in the UK data will therefore be a key issue to examine below.

To help distinguish further the opposing explanations of the price level we also analyse how excess money balances (defined as actual money holdings relative to their equilibrium level, see section 4.2 for details of interpretation) are transmitted through the economy. The quantity theory (or Ricardian) view is that prices will ultimately rise. But a positive relationship between money and prices may also be perfectly consistent with a non-Ricardian regime[(9)]. In the non-Ricardian view, a positive correlation between money and prices would be explained by causation running from prices to money. The rise in the price level would, however, ultimately be due to a rise in government debt, where the price level adjusts to make the PVBC hold in equilibrium.

The quantity theoretic approach under monetary and fiscal leadership provides us with fairly clear empirical implications, but again it is crucial that these relationships hold simultaneously. Specifically, for the quantity theoretical explanation of the price level to be consistent with the data, three key correlations are relevant. First, the level of national debt has a positive effect on the price level, and second, national debt also has a positive effect on the monetary base. Either, or both, of these correlations would seem to legitimise the concerns raised by Sargent and Wallace.[10] Third, the monetary base and the price level should be positively related, once we condition on fiscal variables.

A maintained hypothesis of the fiscal theory is that all data (at whatever frequency) are equilibrium observations. Consequently, Cochrane (1998) has argued that we can *never* observe causality in the data since all we observe, in terms of our equations, are (1) and (3). Since we never see off-equilibrium values we have no way of identifying whether the dominant influence was monetary or fiscal policy. Others have taken a more optimistic view on the use of actual data for assessment of the fiscal theory. For example, Christiano and Fitzgerald (2000), building on discussions by Woodford (1998) and Canzoneri, Cumby and Diba (1997), emphasise the need to incorporate additional identifying assumptions into any empirical analysis. Christiano and Fitzgerald (*op. cit.*) note comments by B. Friedman (quoted in Cochrane (1998)) pointing out that the quantity theory also has no implications for the time series of money growth and inflation in the absence of additional assumptions. Indeed a large part of Fisher (1911) is devoted to spelling out just these additional assumptions. Researchers in the past have appeared willing to make a variety of such assumptions. See, for example, the discussion of the *cross section* evidence on the quantity theory presented by Lucas (1996). Similarly, Friedman and Schwartz (1963) Fisher (1911) and indeed before them Hume (1906) argue that monetary impulses affect the economy with ‘long and variable’ lags. In other words, it has long been widely acknowledged that estimating an equation like (1) without recognising the importance of lags would be a poor basis for explaining inflation. In addition, as Bohn (1998b) notes, such lags are also likely to be important, even if fiscal policy is the dominant causal influence in the determination of prices. In that case Bohn argues one ought to see prices rise in the wake of a run up in debt. In our empirical analysis we are apt to adopt that perspective and interpret the error-correction terms as capturing these lags. Our evidence, with respect to the fiscal theory is therefore at best preliminary, but not without use in the search for additional identifying assumptions.

To summarise, we are interested in analysing jointly several key feedbacks in the data to assess different views on the evolution of the price level. We use the combination of observed correlations to decide on the plausibility of the various theories examined. First, how does debt affect future surpluses? Second, how does debt affect the price level? Third, can we detect an effect from national debt on the monetary base? Fourth, how do these feedbacks change when we introduce money into the system? And finally, in that framework, does the monetary base 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 only provide an overview of the most important issues in the construction of the data. The working paper version of this paper contains a more detailed analysis of the underlying data.

Note that we need a market value series for the UK national debt. This is an implication of equation (1). Previous researchers using the long run of UK debt data have restricted themselves to par values only[(11)]. We construct a long run of market value data as follows. 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 (recorded in Pember and Boyle, 1950)[(12)]. By 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[(13)].

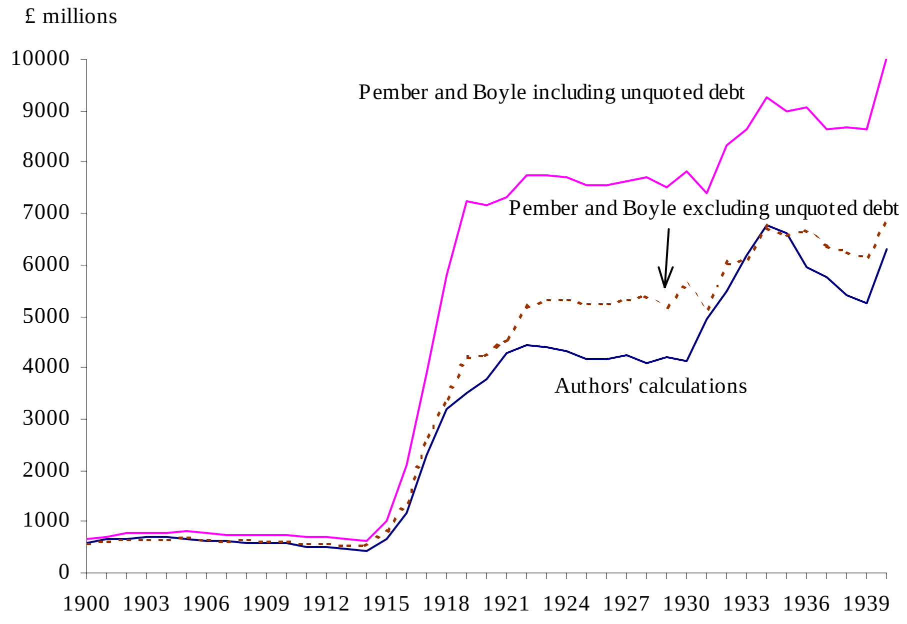
Before 1900 only *par* values of government debt are available. We calculate a proxy for the actual *market* value of the government debt B_v at the end of period $t-1$ as the ratio of the coupon interest rate on Consols c [(14)] and the Consol yield i [(15)] (both during period t), multiplied by the 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:

$$B_{v,t-1} = (c_t / i_t) B_{p,t-1}$$

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[16] 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 similar to the series excluding unquoted debt for most of the first four decades of this century. This suggests that our calculations provide a reasonably good approximation to the actual market valuation of the national debt, especially in the pre-1900 era, which is the only period for which we use this approximation.

Chart 1

Calculated market values of UK government debt and Pember and Boyle data



Both series start to diverge slightly from the early 1920s 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. The average maturity of government bonds also fell at that time, which further compromises the role of the consol rate as a proxy for the actual return on the debt in the 1930s and 1940s.

Another complication in the construction of 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 (*op cit*) and endnote 13. 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.

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

4.1 Empirical approach

Given the theoretical discussion in section 2, we are interested in explaining the evolution of the primary surplus, seigniorage/the money stock, inflation and the (long) real interest rate. We include the latter since in the fiscal theory of the price level the presence of sticky prices means that the authorities may try to reduce the real interest rate as a way to reduce the required future budget surpluses. We begin our empirical analysis by identifying the low frequency (i.e., long run) relationships in the data, for base money and government debt. 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[(17)]. 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.

In practice we analyse two versions of the VAR: one without base money (1705-1996) and one including base money (1872-1996)[(18)]. The first system focuses on the feedback between government debt, the primary surplus and inflation. Specifically with respect to the fiscal theory, this can at best be interpreted as a partial analysis on two counts. First, the fiscal theory is cast in terms of total government liabilities, i.e. base money plus nominal bonds. 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 data. Second, this distinction helps in our assessment of the concerns of Sargent and Wallace, as we are interested in examining whether money or debt is the dominant explanatory variable for inflation in the UK. Nevertheless, in section 4.2 we also compute a measure of total government liabilities, so that the empirical set-up closely mimics that of the fiscal theory, and analyse the key feedbacks discussed in section 2.2.

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[(19)]. Both systems also include a proxy for the output gap, which is instrumented using the stationary component of log real output as obtained via the Hodrick-Prescott filter[(20)]. The output gap is included in order to pick up variations in monetary and fiscal policy associated with temporary variations in output. We do not model output endogenously partly for practical reasons, but also for theoretical reasons. Most empirical work indicates that this portion of output is influenced largely by “real factors”, (see for example the discussion in Woodford (2000)). In the language of real business cycle theory it is predominantly due to exogenous changes in technology (along with cyclical variation in capacity utilisation)[(21)]. Variations in output at the business cycle frequencies due to shifts in fiscal or monetary policy are generally thought to be of second-order significance.

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 replace the inflation rate by the change in the exchange rate.

4.2

Results

VAR without money (1705-1996)

The detailed results of our empirical analysis are attached in Appendix 2, which shows the specific systems we estimated across our different sample periods. Here, we discuss the main results. The lag length of the VAR was established in the usual way for each sample and system. In all cases this was one. In the long run the restriction that the real market value of government debt (b_r)[22] is homogeneous in real GDP (y_r) cannot be rejected (see also Hendry, 2000):

$$b_r = y_r \qquad \chi^2(1) = 1.2654 \qquad p\text{-value} = 0.2606$$

The one overidentifying restriction is clearly accepted at conventional significance levels. Since data on the monetary base are not available for the whole sample period, we can only analyse the first two feedbacks discussed in section 2.2. 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 UK governments tend to pay off their existing debt, and meet the PVBC all the time. As Janssen and Nolan (1999) argue, it is also consistent with optimising tax-smoothing behaviour on the part of governments. A non-Ricardian view would be that debt is anticipating future innovations in the surplus. To help distinguish between these competing views we need additional evidence from 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 result disappears. The debt variable is highly insignificant.

Overall, we interpret these initial results as suggesting that prices and debt evolve independently. A better-founded decision on whether the fiscal policy regime affects prices, however, can be taken when monetary base data are included in the VAR system.

VAR with Money (1872-1996)

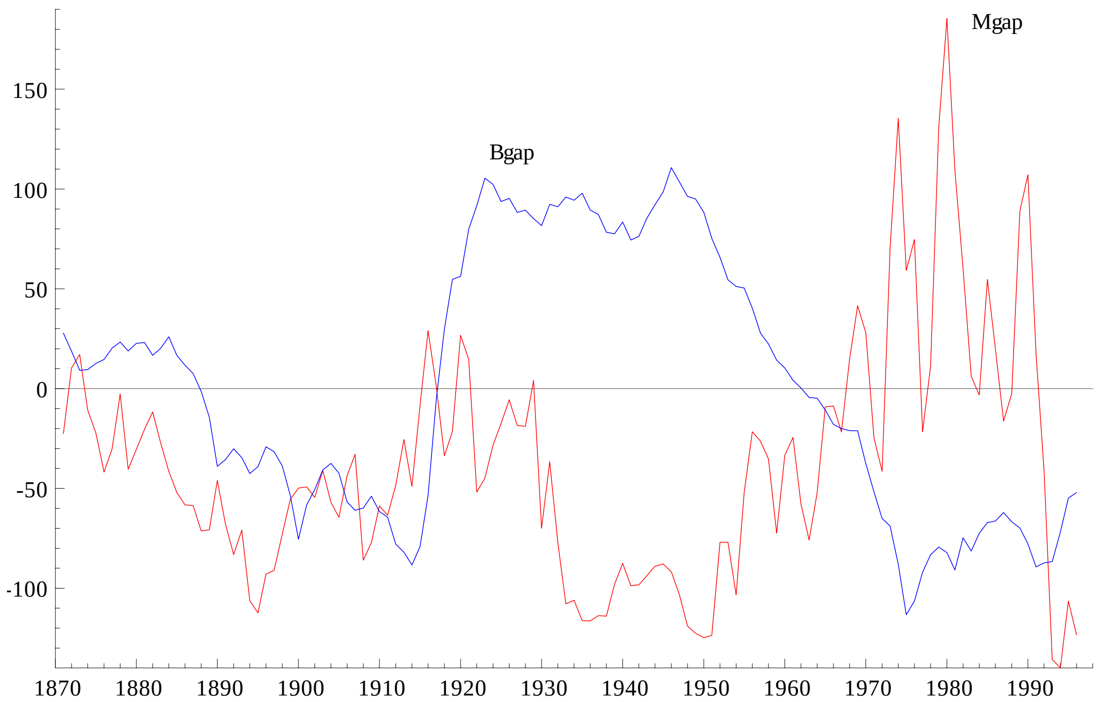
When the monetary base is incorporated into the system, the sample period runs from 1872 to 1996.[23] We re-estimate the (two) long-run relationships (in money and in debt). After imposing some overidentifying restrictions we obtain the following long-run money demand equation: $m/p = y_r - 0.27i_s$ and the same long-run equation for real debt and real GDP as before: $b_r = y_r$. These overidentifying restrictions are not rejected at the usual significance levels ($\chi^2(3) = 4.2123$ with a *p*-value of 0.2394). The estimated interest semi-elasticity of the demand for the monetary base is similar to estimates by Janssen (1998) for the UK over the period 1972-1997 with quarterly data and by Chadha, Haldane and Janssen (1998) over the period 1872-1995 using annual data. Chart 2 shows the residuals from the long-run relationships for the monetary base (Mgap) and debt (Bgap).

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 affects real monetary base growth significantly negatively. 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 monetary base growth, whereas the lagged primary surplus has a significant negative effect. This suggests that significant Sargent and Wallace type debt monetisation effects did not occur over our sample period. There is also evidence of a liquidity effect as monetary base growth appears to have negative effects on real interest rates.

Chart 2

Residuals from long-run relationships for monetary base (Mgap) and debt (Bgap)



We find a number of interesting results. First, we observe (as in the VAR without money) significant and positive feedback from national debt on to the primary surplus. The equation for the surplus to GDP ratio is 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 (see the column labelled "Surplus:GDP" in Appendix 2). Second, inflation is now largely explained by monetary factors; both excess money balances and lagged growth in the real monetary base. The effect of real interest rates on inflation is significantly negative. Both the output gap and government debt remain insignificant for inflation. All of these findings are consistent with quantity-theoretic explanations of the price level. Third, lagged inflation is (insignificantly) negatively related to money growth, suggesting that there is little or no evidence of ‘reverse’ causation from prices to money. Finally, debt does not appear to have affected prices either “directly” or via the debt monetisation channel; the coefficient on debt in the real money growth equation is -0.01, with a *p*-value of 0.41.). We interpret this as suggesting that the quantity theory under fiscal leadership does not hold over the sample period examined here and that the quantity theory under monetary leadership provides the most likely explanation of inflation in the UK.

VAR under the Gold Standard

The fiscal theory also has important implications for exchange rate policy. Canzoneri et al. (1999) exposit the unfeasibility of pegging exchange rates via monetary means when fiscal policy is non-Ricardian. From around 1821 to 1930 the Pound was pegged to the value of gold.

After re-estimation of the respective long-run relationships in the data, we examine a VAR without money (again because of data limitations), but with the change in the US Dollar/Pound exchange rate included instead of inflation. Again, we find significant feedback from debt onto the primary surplus. We also find that debt plays no role in the exchange rate equation, although we acknowledge that the change in the exchange rate is poorly explained over this period, so these results may not provide additional evidence either way.

VAR with total government liabilities

Strictly speaking, the fiscal theory examines the effects of total government liabilities on the price level. We define total liabilities as the sum of the market value of government debt and the monetary base. In the VARs analysed above the two components of government liabilities are included as separate variables, in order to allow for the possibility that debt has a more circuitous effect on inflation, via growth in the monetary base. Since we do not find any evidence in favour of either the fiscal theory or the quantity theory under fiscal leadership we re-estimate the VAR over the period 1872-1996 after adding the two types of government liabilities into one measure. The long-run relationship for total liabilities is defined as the sum of the two separate long-run relationships identified previously. Of course, in this framework we can at best test whether the fiscal theory is consistent with the data, but we cannot analyse the quantity theory at all, since we do not distinguish monetary data as a separate variable.

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=0.64) in the equation for inflation. The feedbacks found suggest that the fiscal theory does not explain the price level in the UK over the period analysed. Overall, our results over different sample periods are consistent with the traditional quantity theory under monetary leadership, where the monetary base appears to explain the price level. But when the monetary base is added to national debt, total liabilities do not affect prices at all.

5. Discussion and Conclusions

In this paper we analyse the plausibility of three explanations of the path of the price level using annual data for the UK. In addition to the traditional quantity theory of money, we examine whether a rise in the market value of national debt precedes an increase in the monetary base and in inflation, as envisaged by Sargent and Wallace (*op. cit.*). We also take a tentative first look at some evidence on the fiscal theory of the price level. To do this, we estimate several reduced-form VARs. The empirical analysis focuses on interactions between government debt, the government's primary surplus, the price level and the monetary base. A key result, over all sample periods analysed, is that surpluses and debt are significantly positively correlated, consistent with the government's PVBC holding all the time. Government debt appears insignificant in explaining inflation. When we add money to the VAR system these results are not affected, and debt is not significant in explaining monetary base growth. Indeed, our inflation equation appears better specified when money is added to the system.

The key relationships analysed in this paper provide some interesting findings. First, both the relationship between the surplus and government debt, and that between the monetary base and inflation are robust across time periods. Second, the first of these relations at least, is entirely consistent with recent results found with US data (Bohn (1998), Canzoneri et al. (1997), and Christiano and Fitzgerald (2000)). This may suggest some agreement as to the stylised facts over long periods of time and in different economies. Third, the data do not confirm at least some of the implications of the Sargent-Wallace story. In particular, a rise in debt does not appear to influence growth in the monetary base. Fourth, if one accepts that debt might affect prices only with a lag, as suggested by Bohn (1998), even if the fiscal theory is "correct", then our results indicate that more conventional explanations of inflation are more consistent with the data. However, for the reader who does not accept this "identifying restriction" our results provide little direct evidence for or against the fiscal theory.

DATA SOURCES

Yield on consols:
Homer and Sylla (1991), Harley (1976), Mitchell and Deane (1962)

National debt:
Par values: Fenn (1883), Hargreaves (1930), Mitchell and Deane (1962), Pember and Boyle (1950)
Market values:
Post-1949: CSO/ONS, *Annual Abstract of Statistics*, Table 17.15, Securities quoted on the London Stock Exchange.
1900-1949: market values constructed using prices and quantities Pember and Boyle (1950).
Pre-1900: prices obtained from Homer and Sylla (1991) and Harley (1976).

Prices:
Pre-1800: the Schumpeter-Gilboy price index in Mitchell and Deane (1962).
1800-1997: Bank of England RPI

National Income:
Pre-1830: Mitchell and Deane (1962) and Crafts (1991)
1830-1855: Deane (1968).
1855-1947: Feinstein (1972).
1947-1997: CSO/ONS, *Economic Trends*

Primary and total central government deficit:
Pre-1855: Mitchell and Deane (1962).
1855-1900: Feinstein (1972)
1900-1947: Peacock and Wiseman (1967) and Feinstein (1972)
1947-1997: CSO/ONS, *Economic Trends*

Base Money:
Capie and Webber (1985)

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Appendix 1

Econometric approach

Our econometric approach is straightforward. We model inflation as arising from three sources of excess demand (see also Metin, 1995 and Hendry, 2000), which reflect monetary, fiscal and real disequilibria. In practice, inflation may also be influenced by short-run interactions between variables, and our approach permits such interactions.

First, we estimate and identify the three equilibrium relationships. The money and government debt relationships are estimated in 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:

$$\Delta q_t = \eta + \Pi q_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta q_{t-i} + \varepsilon_t \qquad \text{(A1)}$$

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:

We impose some non-testable coefficient restrictions (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:

$$\Delta q_t = \eta + \alpha\beta' q_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta q_{t-i} + \varepsilon_t \qquad \text{(A2)}$$

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 instrumented using 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 ($\beta' q_{t-1}$), 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:

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

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

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:

$$v_t = \eta + \gamma\beta' q_{t-1} + \sum_{i=1}^{p-1} \Lambda_i v_{t-i} + u_t \qquad \text{(A4)}$$

where γ now denotes the matrix of loading coefficients of the long-run disequilibria for the stationary variables v.

Appendix 2

Results for VAR excluding money (1705-1996)

Regressors:	Dependent variable: Surplus:GDP S_t	Dependent variable: Real interest rate Lr_t	Dependent variable: Inflation DLp_t
S_{t-1}	0.82***	0.06	-0.06
Lr_{t-1}	0.18**	0.50***	0.46***
DLp_{t-1}	0.11	0.02	0.96***
$Y\text{-}gap_{t-1}$	0.01	-0.79***	0.80***
$B\text{-}gap_{t-1}$	0.01***	-0.00	0.00
Constant	-0.35	1.40**	-1.24*
S.E.	3.10	5.08	5.10

Results for VAR including money (1872-1996)

Regressors:	Dependent variable: Surplus:GDP S_t	Dependent variable: Real interest rate Lr_t	Dependent variable: Inflation DLp_t	Dependent variable: Money Growth DM_t
S_{t-1}	0.83***	-0.03	-0.04	-0.22**
Lr_{t-1}	0.19**	0.51***	-0.30***	0.25**
DLp_{t-1}	0.17*	-0.19*	0.63***	-0.21
$Y\text{-}gap_{t-1}$	-0.05	-0.37***	-0.04	0.00
$B\text{-}gap_{t-1}$	0.01**	0.01	-0.00	-0.01
DM_{t-1}	-0.06	-0.37***	0.50***	-0.17
$M\text{-}gap_{t-1}$	0.00	0.01	0.02**	-0.02**
Constant	-0.76	2.42***	2.28***	0.34
S.E.	3.81	4.09	4.41	5.04

Results for VAR including exchange rate (1821-1930)

Regressors:	Dependent variable: Surplus:GDP S_t	Dependent variable: Real interest rate Lr_t	Dependent variable: Change in Exchange Rate Dle_t
S_{t-1}	0.70***	0.24**	0.18
Lr_{t-1}	0.03	0.37***	-0.01
DLe_{t-1}	-0.02	0.05	-0.09
$Y\text{-}gap_{t-1}$	-0.03	-0.59***	-0.11
$B\text{-}gap_{t-1}$	0.02***	0.00	-0.00
Constant	0.79**	1.26**	-0.45
S.E.	2.95	4.92	7.47

Results for VAR including total liabilities (1872-1996)

	Dependent variable:	**Dependent variable:**	**Dependent variable:**
Regressors:	**Surplus:GDP** S_t	**Real interest rate** Lr_t	**Inflation** DLp_t
S_{t-1}	0.84***	0.10*	-0.20***
Lr_{t-1}	0.16*	0.44***	-0.18
DLp_{t-1}	0.16**	0.03	0.43***
$Y\text{-}gap_{t-1}$	-0.05	-0.44***	0.02
$Liab\text{-}gap_{t-1}$	0.01*	0.01	0.00
Constant	-0.45	1.44**	2.56***
S.E.	3.82	4.26	4.86

Note: * significant at the 10% level
** significant at the 5% level
*** significant at the 1% level

Endnotes

(1) A referee pointed out that some aspects of this debate were anticipated in the formulation of the UK Medium Term Financial Strategy; see for example Ball and Burns (1976) or Burns and Budd (1977). A clear analytical overview is Jackson (1990).
(2) The key contributions include Leeper (1991), Sims (1994), (1998), Woodford (1994), (1996), (1998), Canzoneri et al, (1997, 1999), Bergin (1995), Cochrane (1998)
(3) 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. See our discussion below.
(4) Sims (1998), Bergin (op cit) and Woodford (1996) use the fiscal approach to discuss the importance of the Stability Pact for inflation control in the Euro-area.
(5) We thank an anonymous referee for suggesting the following taxonomy.
(6) 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 higher surpluses being used only infrequently to retire existing debt. Indeed, in principle such policy rules could be invisible to the econometric eye. As we will show below, the government's primary surplus and the market value of its debt are strongly correlated in the UK.
(7) That is, the nominal interest rate is raised, but by an amount insufficient to avoid a fall in the real interest rate.
(8) In the empirical part of the paper all variables used are I(0), which implies that we analyse the interaction between fiscal and monetary policy and inflation.
(9) In the working paper version of this paper we consider further examples of this sort.
(10) Of course, the absence of any such effects need not indicate that those concerns are ill-founded, as institutional factors may be in place that keep in check any pressures from fiscal policy onto monetary policy. That interpretation would be consistent with policy proposals aimed at restraining aggregate fiscal policy, as in the Euro Growth and Stability Pact.
(11) See for example Barro (1987) or Ahmed and Rogers (1995).
(12) 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.
(13) Part of the national debt is unquoted, which (in the case of the UK) means that this debt is not quoted on the London Stock Exchange. This means that we have no information about the market prices of these bond issues. For the calculation of the total market value of government debt we can therefore only include these bonds at par value.
(14) 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).
(15) The consol yield indicates the market's discount rate.
(16) See endnote 14 for an explanation of unquoted debt.
(17) Details about the econometric approach can be found in Appendix 1.
(18) A consistent measure of the stock of base money is available from 1870 onwards only (source: Capie and Webber, 1985).

(19) 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 hardly affects the main results, so we only report the basic system.

(20) Similar results were obtained by linear de-trending of the output series. We also instrumented the output gap using bandpassed-filtered output, using both the Baxter-King and the Christiano-Fitzgerald filters. Our results hardly changed. In practice the correlation coefficient between these different filters was around 0.85. Relative to the HP filter the Bandpass filters remove high frequency variation and are probably more appealing. Nevertheless the HP filter is more widely understood and we report results using that filter.

(21) See for example King and Rebelo (1999) on capacity utilisation, Christiano, Eichenbaum and Evans (1999) on the size of real shocks relative to monetary shocks, and Blanchard and Perotti NBER Working Paper No. 7269, July 1999 on the relative importance of fiscal policy shocks.

(22) 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.

(23) We also estimate the previous VAR system without money over the shorter sample period, but the results are similar to those over the longer period (see working paper version).

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