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GOVERNMENT SPENDING, INTEREST RATES, PRICES, AND BUDGET DEFICITS IN THE UNITED KINGDOM, 1701–1918*

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The British data from the early 1700s through WWI provide an unmatched opportunity for studying temporary changes in government purchases. Temporary increases, which appeared mainly as wartime spending, raised long-term interest rates, but significantly increased the growth rates of money and prices only during suspensions of the gold standard (1797–1821 and 1914–1918). Temporary changes in military spending accounted for the bulk of budget deficits; over the sample of more than 200 years, I found only two major non-war deficits – one associated with compensation payments to slaveowners in 1835–36 and the other with a dispute over the income tax in 1909–10. Interest rates did not react much to these 'exogenous' deficits.

1. Introduction

Fluctuations in government purchases influence the economy in numerous ways. There are effects on real interest rates, and on the quantities of output, consumption, and investment. There are direct effects on the price level, as well as indirect effects through the interplay with monetary growth. There are also effects on the current-account balance and on budget deficits, which may have additional influences on the economy.

In this paper I follow Benjamin and Kochin (1984) by using the British data from the start of the eighteenth century through World War I to study some of the economic effects of government purchases. In practice the main evidence comes from the variations in military spending that are associated with war and peace. One attraction of the sample – from a scientific viewpoint – is that it features numerous wars of varying sizes. Fortunately, there are also usable data for long periods on interest rates, price levels, a narrow monetary aggregate, and budget deficits.

Section 2 deals with interest rates. After developing a theoretical model, I study the effect of temporary military spending on long-term interest rates. Section 3 investigates the effects of military spending on the price level and the quantity of money. Section 4 explores the relation between military spending and budget deficits.

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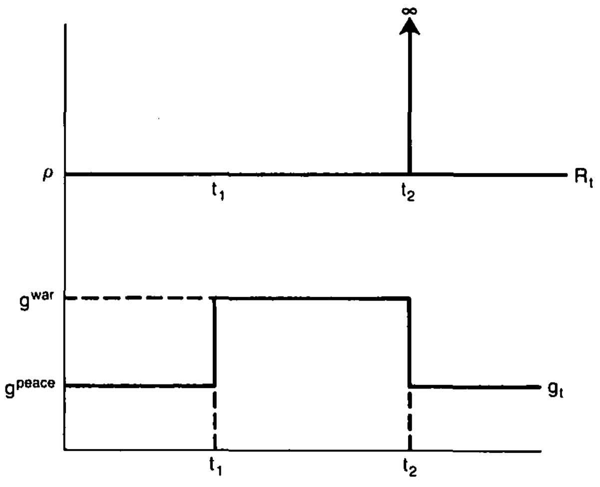

Fig. 1. Path of government spending and the real interest rate in war and peace.

2. Government purchases and interest rates

2.1. Theoretical considerations

A number of studies [Hall (1980), Barro (1986b), Judd (1985)] analyze the effect of temporary government purchases on real interest rates. I consider a closed economy[1] and assume for empirical purposes that the temporary purchases represent wartime expenditures. In fig. 1 a war starts unexpectedly at date t_1, and the ratio of government purchases to GNP, g_t, rises from g^{peace} to g^{war}. Suppose that the spending ratio remains constant during the war, then falls back to the value g^{peace} at date t_2 when the war ends. Finally, assume that the duration of the war – that is, the date t_2 – is known as of date t_1. The main idea captured here is that the onset of a war is uncertain, but wars are known not to last forever.

Consider a model where the representative individual has an infinite horizon with the constant rate of time preference on utility equal to ρ. [For an exposition of this model as applied to variations in government purchases, see Barro (1986b).] In the steady state of this economy (with no growth in real income or population), the real interest rate equals ρ. At this point each individual is satisfied with constant consumption over time. Fig. 1 assumes that the one-period (short-term) real interest rate R_t equals ρ before date t_1. If

[1] With an open economy a temporary increase in government purchases shows up partly in borrowing from abroad, instead of a higher real interest rate. See Ahmed (1986) for this type of analysis.

there are no storable (investment) goods, then consumption (or leisure) must fall to match the increase in g_t at date t_1. Then consumption remains constant at this depressed level during the war. Since consumption is constant – although at a lower level than before – during the war, the real interest rate R_t must still be equal to ρ. Therefore, the path shown for R_t in fig. 1 shows no change at date t_1 or afterwards during the war.[2]

At date t_2 the drop in g_t allows consumption to return to the higher level associated with peacetime. Since people anticipate the drop in g_t, an equilibrium requires R_t at time $t = t_2$ to exceed ρ by enough to motivate people to plan for an upward jump in consumption. Then, after date t_2, consumption is again constant and $R_t = \rho$ applies.

Looking at the situation during the war, where $t_1 < t < t_2$, short-term real interest rates are unaffected. However, long-term rates would incorporate the high short-term rate at time t_2. Hence, as Benjamin and Kochin (1984, pp. 595–596) pointed out, there would be a positive relation between g_t and real interest rates that applied to a horizon longer than $t_2 - t$. The effect on the yield to maturity would be strongest when the horizon was only slightly longer than $t_2 - t$.

The sharp distinction between short-term and long-term interest rates does not hold if there is either uncertainty about the war's duration or if there are durable (investment) goods around. In these cases temporary government purchases tend to increase short-term real interest rates, as well as longer-term rates.

Fig. 2 illustrates the results for a standard one-sector production function with reproducible (and consumable) capital. The path for R_t shown in fig. 1 is no longer an equilibrium because investors would want to liquidate their capital stocks just before date t_2. In the new equilibrium the wartime spending must crowd out some investment, as well as consumption, prior to date t_2. As the capital stock falls, the real interest rate rises to match the rising marginal product of capital. The real interest rate peaks at date t_2 – thereafter, the rate falls as the capital stock is rebuilt.[3]

One implication from the inclusion of investment is that the short-term real interest rate, R_t, depends positively on current and lagged values of g_t. The lagged values matter because they led to reductions in the capital stock and thereby to a higher current marginal product of capital. Future values of g_t also matter – however, the effect on current short-term real interest rates is

[2] If the war were anticipated, then people would expect a fall in consumption at date t_1. In that case the real interest rate would have to be well below ρ at date t_1. More generally, the higher the probability of a war, the lower the real interest rate.

[3] The level of consumption falls discretely at date t_1, then grows as long as $R_t > \rho$. Assuming that utility is isoelastic with respect to consumption (and neglecting effects on leisure), the fastest growth rate of consumption occurs at date t_2. However, the pre-war level of consumption is reattained only asymptotically as R_t approaches ρ.

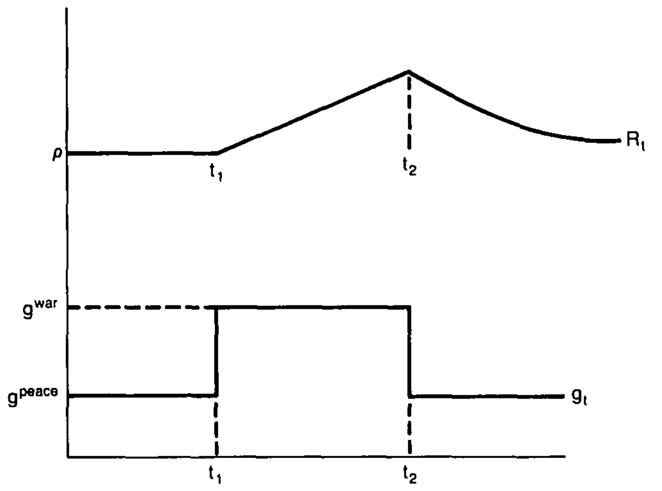

Fig. 2. Path of government spending and the real interest rate in war and peace, allowing for investment goods.

negative, whereas that on current long rates is uncertain (because future short rates rise).

This study uses wartime as an observable example of temporary government expenditure. However, there are other aspects of wars that can affect real interest rates. One is the possibility of defeat, which affects the default premium on government bonds, and may also influence the security of property rights in private bonds and capital stocks. If the threat to all assets is the same, then a greater probability of defeat raises real interest rates and reduces capital intensity. Another consideration is that wartime controls in the form of rationing and production directives can substitute for movements in interest rates as devices for crowding-out private spending. Then the observed response in interest rates will be weaker than otherwise. For the British case examined here, this aspect of a command economy would be important mainly during World War I [see Pollard (1969, ch. II)].

2.2. The data for the United Kingdom

Thus far, there is little evidence from the U.S. time series that verifies a positive effect of temporary government purchases on real interest rates – see Barro (1981; 1987, ch. 12), Plosser (1982,1987), and Evans (1987). But, as stressed by Benjamin and Kochin (1984), the long-term British data are promising for isolating this effect if it exists. Especially during the eighteenth century and through 1815, the United Kingdom was involved in numerous wars, which provide for substantial temporary variations in government

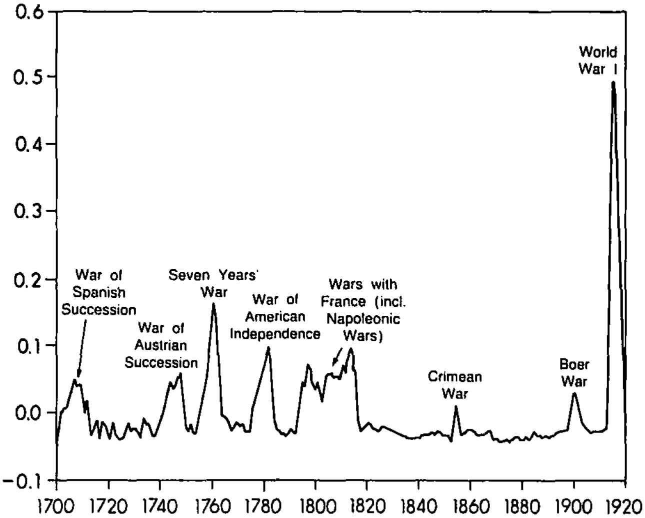

Fig. 3. The ratio of real military spending to trend real GNP, 1701–1920; the figure shows the spending ratio, g_t, less the mean value of g_t, 0.067.

purchases. Further, until World War I, the economy was free of most other governmental interventions, such as extensive price and interest-rate controls, which often accompany wars.

Fig. 3 shows the ratio of real military spending to trend GNP for the United Kingdom from 1701 to 1920. Real military spending is nominal spending divided by an index of wholesale prices.[4] Trend real GNP comes from a trend line through the data on real GNP, using one growth rate (0.55% per year) from 1700 to 1770 and another (2.18% per year) from 1771 to 1938.[5]

A quick examination of fig. 3 reveals the peaks associated with the eight major wars from 1701 to 1920 (treating the wars with France from 1793 to

[4]The data on military expenditure are from Mitchell and Dean (1962, pp. 390–391, 396–399). The figures combine the items for army, navy and ordnance, and for expenditures on special expeditions and votes of credit. The dating of expenditures refers to disbursements rather than orders [see Benjamin and Kochin (1984, p. 602, fn. 6)]. For 1729–51 the fiscal-year data ended September 29 were treated as calendar year numbers. The same procedure was used for 1752–99, where the fiscal year ended on October 10. For 1801–54 the fiscal year figures ended January 5th were treated as applying to the previous calendar year. For 1855–1919, the fiscal-year data ended March 31st were also viewed as covering the prior calendar year. The data on wholesale prices are from Mitchell and Deane (1962, pp. 469–470, 474, 476). The series is a linking together of the following wholesale price indexes: 1871–1920, Board of Trade total index of wholesale prices; 1850–70, Sauerbeck–Statist overall index; 1790–1849, Gayer, Rostow and Schwartz index of domestic and imported commodities; 1700–89, Schumpeter–Gilboy index of consumer goods.

[5]The data on real GNP are from Feinstein (1972, pp. T4,T10,T14,T18) for 1856–1918. For 1830–55, the data are from Deane (1968, pp. 104,106). Before 1830 there are estimates at 10-year intervals in Deane and Cole (1967, pp. 78,282).

1815 as one event). These wartime periods provide the main evidence about the effects of temporarily high government purchases. In particular, there are no comparable variations in non-military spending over the sample period (except for the transfer payments in 1835, which are discussed in section 4).[6]

The other suggestion from fig. 3 is the absence of permanent changes in the ratio of military spending to GNP, at least up to 1920. This property means that the raw movements in the spending ratio, g_t, correspond to values of the ratio that are temporarily high or low. Hence, the sample will not be useful in identifying the economic effects of permanent changes in government purchases. In the next section I model the stochastic process for g_t in order to isolate the temporary part of this variable – that is, the departure of g_t from some concept of a 'normal' value. It is this temporary part that has the effects on real interest rates shown in figs. 1 and 2. However, as suggested by inspection of fig. 3, the normal spending ratio changes little over time. Therefore, for explaining the changes in interest rates or other variables, the variable g_t turns out to do about as well as my constructed measure of temporary spending.

Table 1 shows the values of the military spending ratio for the eight main wars during the sample period. (This tabulation neglects a large number of small conflicts – in India, China, Afghanistan, Africa, Burma, etc. – that peaceloving Britain pursued, but which have insubstantial effects on the military spending ratio.) Note from the table that the value of the spending ratio (relative to its mean of 6.7%) ranges from a high of 49% during World War I (1916) to 16% in the Seven Years' War (1761), 10% for the American Revolution (1782), 9% during the Napoleonic Wars (1814), 6% for the War of the Austrian Succession (1748), 5% for the War of the Spanish Succession (1707), 3% for the Boer War (1901), and 1% during the Crimean War (1855). Some comparable values for the U.S. are 20% for World War I (1918), 34% for World War II (1944), and 2% for the Korean War (1952) [see Barro (1986b, table 3)].

For the long-term interest rate I use the yield on consols (or on the comparable perpetual annuities for 1729–52), which is available continuously since 1729.[7] These government bonds are perpetuities, except that they were redeemable at par after a stated number of years. The theory implies that temporary government spending would have a positive effect on these interest

[6]Except for 1835 non-military expenditures of the central government remained between 2% and 3% of trend GNP from 1801 to 1900. See Mitchell and Deane (1962, pp. 396–398) for the data. These expenditures reached 4% of trend GNP in the early 1900s, but then fell back to 2% during World War I.

[7]The data are from Homer (1977, pp. 156, 161–162, 195–197, 416). The yields apply to 3% annuities or consols until 1888 and to $2\frac{1}{2}$% consols thereafter. The possibility that the 3% consols would be redeemed at par implies that the yields on these instruments were misleadingly high after 1888.

Table 1

Behavior of temporary military spending during major wars.[a]

(1) Period	(2) War	(3) Average value of g_t[b] (relative to mean of g_t, %)	(4) Peak value of g_t[b] (relative to mean of g_t, %)	(5) ΔP^c (percentage points)	(6) ΔP^c (%)
1702–1713	War of Spanish Succession	2.3	5.1 (1707)	2.7[d]	1
1740–1748	War of Austrian Succession (and other wars)	3.3	5.7 (1748)	0.6	1
1756–1763	Seven Years' War (French & Indian War)	9.6	16.1 (1761)	1.2	2
1775–1783	American Independence	4.9	9.8 (1782)	1.9	3
1793–1815	Wars with France (including Napoleonic Wars)	5.2	9.4 (1814)	1.6	74
1854–1856	Crimean War	0.7	0.7 (1855)	0.2	6
1899–1902	Boer War	2.5	2.7 (1901)	0.4	4
1914–1918	World War I	37.7	49.3 (1916)	1.2	109

[a] g_t is real military spending as a ratio to trend real GNP (see text) less the mean value of the spending ratio (6.7%) over the period from 1701 to 1918. ΔR is the change in the consol rate in percentage points, and ΔP is the percentage change in the wholesale price index. These changes apply from the year before each war to the final full year of the war.

[b] Periods are 1703–12, 1741–48, 1757–62, 1776–82, 1794–1815, 1855, 1900–01, 1914–18.

[c] Periods are 1701–12, 1739–47, 1755–62, 1775–82, 1792–1814, 1853–55, 1898–1901, 1913–17.

[d] Uses the rough estimate for R_t of 6.0% for 1702 and the value $R_t = 8.7\%$ for 1712 – see Homer (1977, p. 156).

rates. Empirically, the broad nature of this relation is evident from fig. 4. Note that, over the period from 1729 to 1918,[8] the interest rate (solid line) appears to rise along with the spending ratio (dotted line).

Table 1 reports the changes in the long-term interest rate during each of the major wars. These changes are all positive and in excess of 1 percentage point in five of the eight cases. Since the standard deviation of the annual first difference of the interest rate from 1730 to 1918 is 0.26 percentage points, these five cases involve increases in interest rates that are 5 to 7 times this standard deviation. (The sample mean of the interest rate from 1729 to 1918 is 3.54%.)

[8] The sample ends in 1918 because non-military government spending begins to become important after World War I, and because different accounting conventions apply thereafter to the breakdown between military and non-military spending. However, it would be possible to extend the sample beyond 1918.

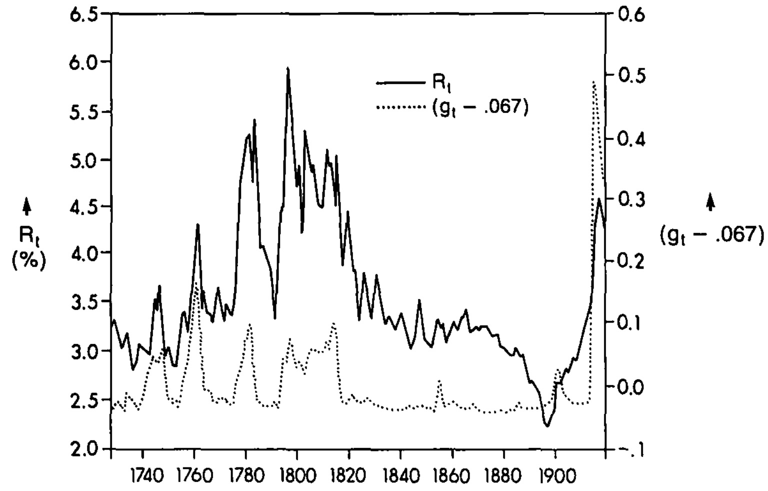

Fig. 4. Military spending and the interest rate, 1729–1918.

A usable series on short-term interest rates is unavailable for the full sample. Most short-term interest rates, including the Bank of England's bank rate, were subject to a usury ceiling of 5% from 1714 until 1833. This ceiling was an effective constraint until at least 1817. [See Homer (1977, pp. 163–165, 205–208).] If the sample started in 1817 or later, then much of the action in the government spending variable would be lost (see fig. 1). Thus I do not report results with short-term interest rates in this paper.

The interest rate data measure nominal rates rather than the expected real rates that matter theoretically. The actual inflation rate averaged 0.4% per year from 1701 to 1918 and 0.1% per year from 1701 to 1913. It may be that the long-term expected rate of inflation was also stable and close to zero, in which case the nominal interest rates are also expected real rates. Up to now, I have been unsuccessful in generating reliable quantitative measures of long-term inflationary expectations. One problem, as discussed in section 2, is that these expectations depend primarily on long-term assessments about the chances for remaining on (or in some intervals returning to) the gold standard. Possible changes in the price of gold, which did not occur to a significant extent over the sample period, might also come into play. In any event, I cannot rule out the possibility that some of the observed variations in interest rates represent changes in long-term inflationay expectations, rather than movements in expected real interest rates.

Another problem is that the wartime movements in interest rates might represent changes in the default premium on British bonds. However, this view suggests greater movements in interest rates during the wars where defeat was likely and would threaten repayment of debt. The Napoleonic Wars and World War I stand out here, but – especially for World War I – these experiences do not exhibit increases in interest rates that are obviously above those warranted by the course of expenditures. Some more information could be obtained by comparing the changes in British interest rates during British wars with the concurrent changes in interest rates in non-combatant countries. However, for the period of especial interest before 1815, the data for this comparison do not seem to exist [see Homer (1977, ch. XII)].

2.3. Temporary military spending

This section models the stochastic process for the military spending ratio, g_t, and uses the results to construct a measure of temporary spending. The first difference of g_t is satisfactorily modeled with second-order autoregressive and moving-average terms – that is, g_t is an ARIMA (2,1,2) process. This process captures the temporary, but serially correlated, aspects of wartime, and also allows for the possibility of permanent shifts in the spending ratio. The fitted equation from 1704 to 1918 is

$$\begin{aligned} g_t - g_{t-1} &= \underset{(0.25)}{1.26}(g_{t-1} - g_{t-2}) - \underset{(0.12)}{0.41}(g_{t-2} - g_{t-3}) \\ &\quad + e_t - \underset{(0.26)}{0.72}e_{t-1} - \underset{(0.18)}{0.27}e_{t-2}, \\ \hat{\sigma} &= 0.026, \qquad R^2 = 0.30. \end{aligned} \tag{1}$$

(The Q-statistic with 10 lags is 3.1, 5% critical value of 12.6.) If a constant is added to eq. (1), its estimated coefficient is 0.002, *s.e.* = 0.008 – hence, there is no evidence of drift in the ratio of spending to GNP.

Since the coefficients of the two moving-average terms in eq. (1) sum nearly to -1,[9] the results are similar in level form for g_t:

$$\begin{aligned} g_t &= \underset{(0.011)}{0.070} + \underset{(0.11)}{1.27}g_{t-1} - \underset{(0.11)}{0.43}g_{t-2} + e_t + \underset{(0.13)}{0.25}e_{t-1}, \\ \hat{\sigma} &= 0.026, \qquad R^2 = 0.88. \end{aligned} \tag{2}$$

Thus, as suggested by inspection of fig. 1, g_t may be stationary in levels. For subsequent purposes I use the first-difference specification in eq. (1), although the results would be similar with eq. (2).

Using eq. (1) and the estimated values of the residuals, e_t, it is possible to form 'forecasts' of g_{t+i} for any date t and forecast horizon i. Thereby one can

[9]The sum is -0.99, but with an estimated standard error of 0.39.

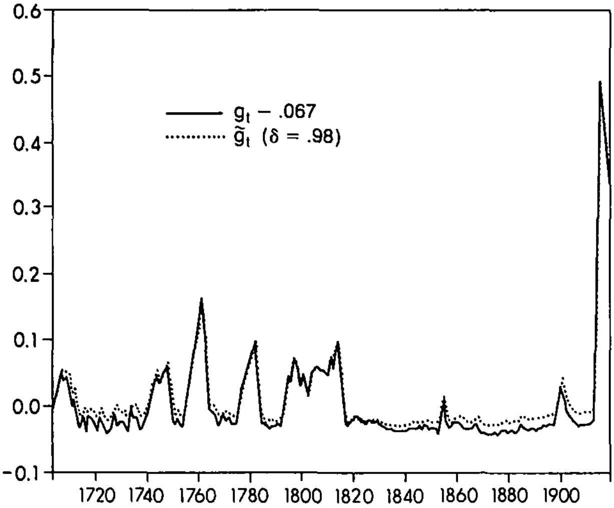

Fig. 5. Alternative measures of temporary military spending, 1705–1918.

measure the 'permanent' ratio of spending to GNP (analogous to permanent income) as

$$\hat{g}_t = (1-\delta)\cdot\left(g_t + \delta g^e_{t+1} + \delta^2 g^e_{t+2} + \cdots\right), \tag{3}$$

where the superscript e denotes a forecast, and δ is a constant discount factor such that $1-\delta$ is approximately equal to the difference between the real interest rate and the growth rate of real GNP. (The constancy of δ is only an approximation.) For the British case the long-term real interest rate (from 1729 to 1913) averaged 3.5%, while the growth rate of real GNP (from 1730 to 1913) averaged 1.8%. Therefore, δ should be about 0.98. Hansen and Sargent (1981, p. 260) provide a formula that can be modified to calculate $\hat{g}_t$ for a given value of δ and for the set of ARMA coefficients estimated in eq. (1).

The temporary part of the spending ratio is $\tilde{g}_t = g_t - \hat{g}_t$. This variable is plotted for the value $\delta = 0.98$ as the dotted line in fig. 5. The resulting series has a similar pattern to that for the raw series g_t (net of a constant mean), which is shown as the solid line in fig. 5. Further, the subsequent findings on interest rates and other variables do not differ greatly whether one uses $\tilde{g}_t$ or g_t as an explanatory variable. This result is not surprising, since the expectation from examination of fig. 3 was that permanent movements in the spending ratio would be unimportant relative to the temporary fluctuations. For this reason I have not carried out further refinements of the measurement of $\tilde{g}_t$ [such as estimating eq. (1) jointly with other equations].

2.4. Formal results on interest rates

I model the determination of the interest rate in the form

$$r_t = a_0 + a_1 \tilde{g}_t + u_t, \tag{4}$$

where the coefficient a_1 is positive. If the error term u_t were stationary with an unconditional mean of zero, then a_0 would be the long-run mean of the interest rate. In fact, for Britain from 1729 to 1918 – where the continuous data series is available – the long-term interest rate exhibits nearly random-walk behavior, although there is some indication of stationarity. (The consol rate would have to be close to a random walk or else there would remain either very high or very low expected returns from holding these long-term bonds over short periods.) I model the error term in eq. (4) by the first-order autoregressive process,

$$u_t = \lambda u_{t-1} + \varepsilon_t, \tag{5}$$

where ε_t is white noise, and the positive coefficient λ is close to but below unity.

Eqs. (4) and (5) imply that, aside from the influence of temporary military spending, the other determinants of the interest rate, u_t, are close to random walks. In the random-walk case where $\lambda = 1$, eq. (4) could be estimated satisfactorily in first-difference form (with a zero constant). But if $\lambda < 1$, then it is appropriate to deal with levels of variables.

Conditional on the constructed series for $\tilde{g}_t$ (based on $\delta = 0.98$), the maximum-likelihood estimates of eqs. (4) and (5) are:

1730–1913

$$\underset{(0.20)}{R_t = 3.54} \; + \underset{(1.3)}{6.1} \cdot \tilde{g}_t, \qquad \underset{(0.029)}{\hat{\lambda} = 0.909},$$

$$\hat{\sigma} = 0.243, \quad R^2 = 0.89, \quad R^2 \text{ (for } R_t - R_{t-1}) = 0.14, \quad DW = 2.2, \tag{6}$$

1730–1918

$$\underset{(0.27)}{R_t = 3.54} \; + \underset{(0.7)}{2.6} \cdot \tilde{g}_t, \qquad \underset{(0.027)}{\hat{\lambda} = 0.931},$$

$$\hat{\sigma} = 0.248, \quad R^2 = 0.89, \quad R^2 \text{ (for } R_t - R_{t-1}) = 0.11, \quad DW = 2.1. \tag{7}$$

These results, and also those below, differ only slightly if g_t replaces $\tilde{g}_t$ as the explanatory variable.

Over the sample from 1730 to 1913 the estimated coefficient on $\tilde{g}_t$ is 6.1, $s.e. = 1.3$ ('t-value' relative to 0 of 4.9). The result implies that an increase by 1 percentage point in the temporary-spending ratio raises the long-term interest rate by 6.1 basis points.

The estimated value, $\hat{\lambda} = 0.909$, $s.e. = 0.029$, implies a 't-value' relative to the null hypothesis $\lambda = 1$ of 3.1. Considering the one-sided alternative, $\lambda < 1$, this statistic differs significantly from zero at less than the 1% level using the t-distribution. It is significant at about the 2.5% level according to the distribution that is generated by Monte Carlo methods for an analogous non-stationary model in Fuller (1976, table 8.5.2, $\hat{\tau}_\mu$ sect.). Thus there is some evidence that supports the stationarity of the long-term interest rate over the period from 1730 to 1913.

Adding the World War I experience, 1914–18, to the sample in eq. (7) lowers the estimated coefficient on $\tilde{g}_t$ to 2.6, $s.e. = 0.7$.[10] Although the interest rate rises from 3.4% in 1913 to 4.6% in 1917 – that is, by 1.2 percentage points – the estimated eq. (6) would have predicted an increase by 2.6 points. It may be that the command economy aspects of World War I, which were mentioned previously, explain the failure of the interest rate to rise as much as predicted. For this reason, the sample that excludes World War I in eq. (6) may be better than the full sample in eq. (7) for estimating the response of interest rates to temporary spending in a free-market setting.

Because of the cumulative effect on capital stocks, the theory implies that the current interest rate, R_t, also reacts positively to lagged values of $\tilde{g}_t$. If five lags are included, the results for the sample, 1730–1913, are

$$\begin{aligned} R_t = \underset{(0.20)}{3.54} &+ \underset{(1.5)}{7.9}\tilde{g}_t - \underset{(1.9)}{2.9}\tilde{g}_{t-1} + \underset{(1.9)}{3.1}\tilde{g}_{t-2} + \underset{(1.9)}{3.9}\tilde{g}_{t-2} \\ &- \underset{(1.9)}{5.1}\tilde{g}_{t-4} + \underset{(1.5)}{3.3}\tilde{g}_{t-5}, \qquad \hat{\lambda} = \underset{(0.030)}{0.917}, \\ &\hat{\sigma} = 0.234, \quad R^2 = 0.90, \quad R^2 \text{ (for } R_t - R_{t-1}) = 0.22, \quad DW = 2.2. \end{aligned} \tag{8}$$

Eq. (8) shows an influence of five lagged values, although the negative effects of $\tilde{g}_{t-1}$ and $\tilde{g}_{t-4}$ are hard to explain. Additional lags are unimportant.

3. Prices and money

Benjamin and Kochin (1984, pp. 598–600) argue that temporary military spending has a positive effect on the general price level in the United

[10] Using a likelihood-ratio test, one can reject at the 5% level the hypothesis that the data from 1730 to 1913 are generated from the same model as the data from 1914 to 1918.

Kingdom. In fact, they argue that the dual influence of war accounts for the celebrated positive association between the interest rate and the price level, which is known as the Gibson Paradox. However, Barsky and Summers (1985, sect. I) observe that the Benjamin/Kochin explanation is inadequate because the Gibson Paradox applies also during non-war periods.

The connection between military spending and the price level is straightforward under a paper standard where governments use the printing press to finance wartime expenditures. Although a common view is that governments shift readily off of commodity standards and toward paper standards during wartime or other emergencies, this view does not apply to the United Kingdom during the eighteenth and nineteenth centuries. The U.K. was on some form of commodity standard from 1700 to 1931, except for two instances of suspension of specie payments by the Bank of England. The first was from 1797 to 1821 and was precipitated by the wars with France [see Clapham (1945, vol. II, ch. 1)]. The second involved a variety of restrictions on specie payments that began in the middle of 1914 during World War I [see Sayers (1976, ch. 5)]. In this case the gold standard was not resumed until 1925. Although financial crises arose at other times – especially during some wars of the eighteenth century – the suspension of specie payments did not occur [see Clapham (1945, vol. I, ch. 7)]. Basically, except for the years 1797–1821 and 1914–1925, the U.K. was on a gold standard from 1700 to 1931. [Until 1821 the system was formally bimetallic with gold overvalued at the mint – see Del Mar (1877).]

Under a gold standard the possibilities for a link between the spending ratio, g_t, and the price level, P_t, are limited. Since P_t is an index of wholesale prices, the linkage requires an effect of g_t on the price of a basket of produced, mainly tradable goods relative to the price of gold. If increased military purchases imply an increase in the demands for these goods relative to gold, then the price level would rise.

Given the value of P_t, a link between g_t and the quantity of money, M_t, amounts to a link between g_t and the real demand for money. The overall effects here are ambiguous. The real demand for money falls because the interest rate, R_t, rises. However, wartime may have a direct positive effect on the demand for money. In addition, if g_t affects real income, then the demand for money would change on this count. Empirically, I find no relation between g_t and M_t for periods where the gold standard was maintained (see below).

During periods when the gold standard is suspended, the prediction is that a higher value of g_t leads to faster rates of growth of money and prices. This prediction is based on the government's incentive to use the inflation tax under a paper standard.

3.1. Results for money

I measure the narrow money supply, M_t, by the quantity of bank notes – issued solely by the Bank of England from 1729 to 1764 and from 1775 to 1833,

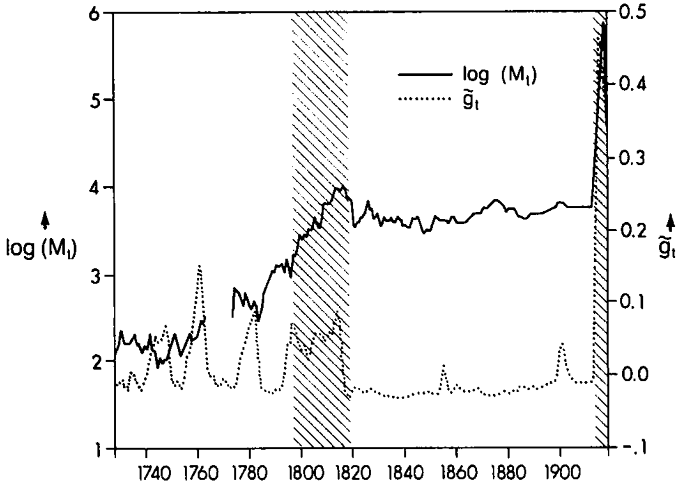

Fig. 6. The money supply and temporary military spending, 1729–1764 and 1775–1918; periods of suspension shown by shaded areas.

and including also the issues by country, Scottish and Irish banks from 1834 to 1918.[11]

The empirical relation of this concept of money to military spending is illustrated by the following least-squares regressions:

Suspension periods: 1797–1821, 1914–1918

$$\log(M_t/M_{t-1}) = \underset{(0.020)}{-0.001} + \underset{(0.13)}{1.12}\tilde{g}_t,$$

$$\hat{\sigma} = 0.092, \quad R^2 = 0.73, \quad DW = 1.9, \tag{9}$$

Gold-standard periods: 1731–1764, 1777–1796, 1822–1913

$$\log(M_t/M_{t-1}) = \underset{(0.006)}{0.004} + \underset{(0.18)}{0.02} \cdot \tilde{g}_t,$$

$$\hat{\sigma} = 0.076, \quad R^2 = 0.00, \quad DW = 2.2. \tag{10}$$

[11] The data are from Mitchell and Deane (1962, pp. 441–443, 450–51). Values for 1729 to 1764 refer to August 31st of each year. Those from 1775 to 1833 are averages of figures from the end of February and the end of August. Values from 1834 onward are annual averages of monthly or weekly figures. The available data prior to 1729 are rough estimates. The figures that I found from 1765 to 1774 are not comparable to those for the other years.

There is a strong positive relation between $\tilde{g}_t$ and monetary growth during the periods of suspension (1797–1821, 1914–1918), but no significant relation during the gold-standard years.[12] This finding also appears in fig. 6, which plots the values of $\log(M_t)$ and $\tilde{g}_t$.

The conclusion is that military spending during wars led to money creation only if it first led to suspension of the gold standard. Furthermore, this pressure to suspend was successful only in two cases – the Napoleonic period and World War I – although the sample includes six other major wars (see table 1). It is interesting to conjecture why suspension occurred when it did – in 1797 and effectively in 1914 – and not at other times. For World War I, the magnitude of military spending is probably a sufficient explanation (see table 1). However, through 1797, the ratio of military spending to GNP – which averaged 10.8% from 1794 to 1797 – was less than that of the Seven Years' War (average of 16.3% from 1757 to 1762), and similar to that of some other wars (9.0% from 1703 to 1712, 10.0% from 1741 to 1748, and 11.6% from 1776 to 1782). The main distinction of the wars with France after 1793 was the duration – 22 years with only brief interruptions – although it is unclear that this length would have been foreseen in 1797. However, it may be that the French Revolution and Napoleon made the conflicts after 1793 more threatening than the earlier wars. One other indicator that these conflicts were taken more seriously than the prior wars was the introduction of taxes on income and property in 1799. On the other hand, Clapham's (1945, vol. 1, ch. VII) discussion of the earlier periods indicates that the Bank of England's reserve of specie was nearly exhausted in several cases – in 1710, 1745, 1763, and 1783. Therefore it may be mainly a matter of luck that suspension occurred in 1797 and not at these other times.

3.2. Results for the price level

Estimated equations for inflation rates (based on indexes of wholesale prices) that parallel the equations for monetary growth are as follows:[13]

Suspension periods: 1797–1821, 1914–1918

$$\log(P_t/P_{t-1}) = \underset{(0.021)}{-0.031} + \underset{(0.14)}{0.62}\tilde{g}_t,$$

$$\hat{\sigma} = 0.099, \quad R^2 = 0.37, \quad DW = 1.5, \tag{11}$$

[12] A likelihood-ratio test rejects at less than the 1% level the hypothesis that the coefficients of the equations for monetary growth are the same for the two sub-samples.

[13] The variable $\tilde{g}_t$ involves the current value of real spending, $g_t = G_t/P_t$, where G_t is nominal spending. Therefore, measurement error in P_t (which is likely to be serious here) tends to generate a downward bias in a regression of $\log(P_t/P_{t-1})$ on $\tilde{g}_t$. The results shown in eqs. (11) and (12) are instrumental estimates using as an instrument for $\tilde{g}_t$ the value that would be calculated if G_t/P_t were replaced by G_t/P_{t-1}.

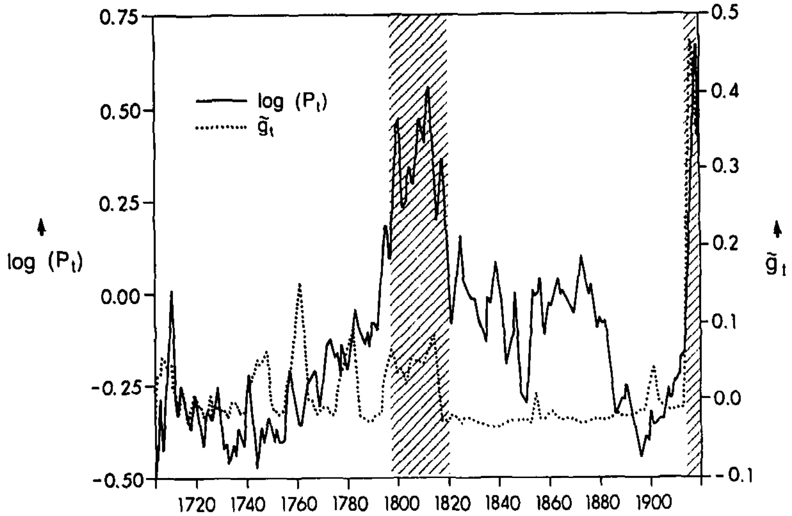

Fig. 7. The price level and temporary military spending, 1705–1918; periods of suspension shown by shaded area.

Gold-standard periods: 1705–1796, 1822–1913

$$\log(P_t/P_{t-1}) = \underset{(0.005)}{0.003} + \underset{(0.15)}{0.31}\tilde{g}_t,$$

$$\hat{\sigma} = 0.062, \quad R^2 = -0.01 \text{ (see n. 13 above)},$$

$$DW = 1.9. \tag{12}$$

The results show that the effect of $\tilde{g}_t$ on $\log(P_t/P_{t-1})$ is significantly positive for the suspension period and just significantly positive for the gold-standard period. However, the effect is substantially larger for the period of suspension in eq. (11).[14] In fact, fluctuations in military spending explain virtually none of the variations in inflation over the gold-standard period. Fig. 7 shows graphically the relation of $\log(P_t)$ to $\tilde{g}_t$.

For making long-range forecasts of inflation an important issue is whether the level of prices is stationary – that is, whether there is a systematic tendency for the price level to return to a normal value (see fig. 7). Under the gold standard it is conceivable that the price level would be stationary. However, a regression with $\log(P_t)$ as the dependent variable does not reject at

[14] A likelihood-ratio test rejects at less than the 1% level the hypothesis that the same model for the inflation rate applies over both sub-samples.

the 5% level the hypothesis that the coefficient of $\log(P_{t-1})$ is unity.[15] This finding applies to the gold-standard sample, 1705–1796, 1822–1913, and also to the suspension sample, 1797–1821, 1914–1918. Of course, even a finding that the price level was stationary under the gold standard would not be so useful if there were a non-zero probability (presumably related to $\tilde{g}_t$) of shifting to the suspension regime where the price level was non-stationary.

It would be useful for the previous study of nominal interest rates to use the results from eqs. (11) and (12) to calculate long-term expected inflation. One difficulty in this procedure is the measurement of the transition probabilities between the regimes. Although the sample is long, it features only two suspensions (a third if 1931 were added) and one resumption (a second if 1925 were included). Hence the sample is still small in this regard.

4. Budget deficits

4.1. Military spending and budget deficits

In some previous papers I discussed the tax-smoothing theory of government deficits [Barro (1979, 1986a), see also Pigou (1928, ch. VI), Kydland and Prescott (1980), and Lucas and Stokey (1983)]. Some of the principal conclusions were the following. First, temporary government spending, as in wartime, would be financed primarily by budget deficits. Thereby tax rates rise uniformly during and after the war, instead of being unusually high during the war. Second, a permanent increase in the ratio of government spending to GNP leads to a parallel increase in tax rates, with no increase in the budget deficit. Third, the government runs deficits during recessions and surpluses in booms to prevent tax rates from being unusually high or low at these times. Fourth, expected inflation has a one-to-one effect on the growth rate of the nominal debt. Thereby the planned behavior of the real debt is invariant with expected inflation. On the other hand, unexpected inflation does not affect the budget deficit, and therefore impacts in the opposite direction on the stock of real debt outstanding.

Empirical results for the United States for the period 1916 to 1983 provided reasonably good estimates for the effects on budget deficits from business fluctuations and expected inflation [see Barro (1986a)]. However, there was less

[15] For example, over 1705–1796, 1822–1913, the result of the instrumental estimation is

$$\log(P_t) = \underset{(0.008)}{-0.009} + \underset{(0.15)}{0.21}\tilde{g}_t + \underset{(0.032)}{0.943}\log(P_{t-1}), \qquad \hat{\sigma} = 0.063, \quad DW = 1.9.$$

The test that the coefficient of $\log(P_{t-1})$ is unity uses Fuller's (1976, p. 373) distribution, which was discussed before, and applies to the one-sided alternative that the coefficient is less than one. The same outcome with respect to stationarity obtains if the additional lagged variable, $\log(P_{t-2})$, is added to the regression.

information about the impact of temporary government spending, which was dominated by the observations for World Wars I and II.

It is clear from the previous discussion that the long-term British data are well suited for studying the relation of budget deficits to temporary military spending. On the other hand, the sample does not permit reliable estimates of cyclical effects. That is because annual data on GNP are available only since 1830, and the quality of these data before the middle 1850s is especially uncertain. Further, for reasons mentioned earlier, I have not yet been able to use the data to assess the effects from changes in anticipated inflation. Therefore, I focus the present study on the relation between budget deficits and temporary military spending.

I calculate the nominal deficit for each year from the difference between the government's total expenditures (including interest payments) and total revenues.[16] I then compute a time series for the stock of public debt outstanding (at 'book value') by adding the cumulative deficit to a benchmark stock of debt from the end of 1700.[17] This procedure is necessary because the reported figures on the stock of public debt treat all numbers as par values even when new debt is issued or retired at a discount from par. This problem is especially serious during the Napoleonic Wars and to some extent during the American Revolution, where large quantities of debt were issued at a discount to yield about 5% but were carried on the books as though issued at par (3%).[18] Hence the change in the public debt as recorded far exceeded the true deficit at these times. Then the error was effectively undone later in the nineteenth century when the old debt was eventually redeemed. Thus, by World War I (and before the 1770s), the series that I calculate turns out to be close to the reported numbers on the stock of public debt outstanding. (However, my series is not a market-value construct, since it does not consider the changes in market value that occurred subsequent to the issue date of a security.)

Fig. 8 shows the ratio of the real public debt (the nominal amount from the start of the year relative to the wholesale price index for the year) to trend real GNP from 1701 to 1918. The ratio rose from about 25% in 1701 to 70% in 1718 (after the War of the Spanish Succession) and declined during peacetime to less than 50% by the early 1740s. Then the ratio reached 90% after the War of the Austrian Succession (1750) and 140% after the Seven Years' War (1764). Following a decline during peacetime to 100% in 1775, the ratio rose to over 130% after the American Revolution (1785). After another peacetime decline to less than 90% in 1795, the ratio rose to nearly 160% at the conclusion of the

[16]The data are from Mitchell and Deane (1962, pp. 386–398). The dating of the fiscal years corresponds to that for military spending, as discussed in footnote 4 above. Given this correspondence, there is no problem in matching the budget deficits with the expenditure numbers.

[17]This figure – £14.2 million – comes from Mitchell and Deane (1962, p. 401).

[18]See Fenn (1883, pp. 6–9) for the details.

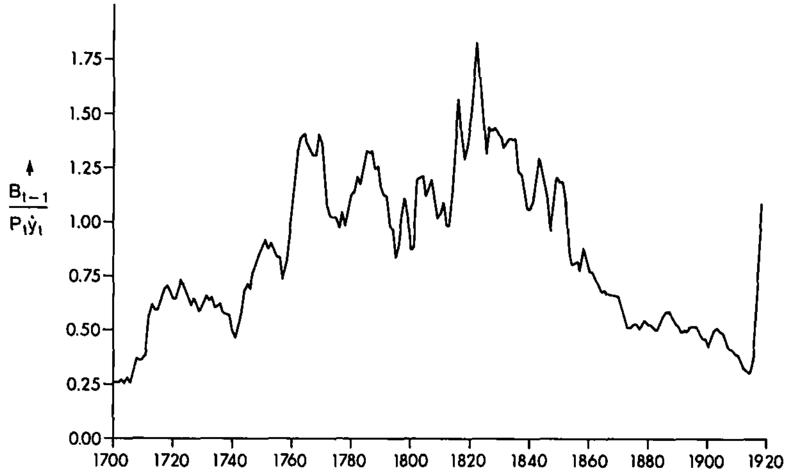

Fig. 8. Ratio of real public debt to trend real GNP, 1701–1918.

Napoleonic Wars in 1816, and (with the sharp decline in the price level) to the all-time peak of 185% in 1822.[19] There followed a long peacetime decline – with only minor interruptions from some small wars – to a low point of 30% in 1914. Then with World War I the ratio reached 110% in 1918.

Fig. 9 shows more clearly the dominant influence of temporary military spending on budget deficits. This figure graphs the ratio of the nominal deficit to trend GNP (trend real GNP multiplied by the wholesale price index), along with the temporary-spending ratio, $\tilde{g}_t$. The figure shows that the relationship is positive and also accounts for the bulk of fluctuations in the deficit.

The specification of the equation for deficits is

$$(B_t - B_{t-1})/P_t\hat{y}_t = b_0(B_{t-1}/P_t\hat{y}_t) + b_1\tilde{g}_t + v_t, \tag{13}$$

where B_t is the nominal debt at the end of year t (calculated as above), $B_t - B_{t-1}$ is the budget deficit for year t, P_t is the wholesale price index, $\hat{y}_t$ is trend real GNP, $\tilde{g}_t$ is the temporary-spending ratio as discussed before, and the error term v_t is generated from

$$v_t = \phi v_{t-1} + \eta_t, \tag{14}$$

where η_t is white noise and $|\phi| < 1$. Note that the dependent variable in eq.

[19]Using the reported figures on the stock of public debt, this peak ratio is 275% rather than 185%. The difference is the extent to which the debt figures – recorded at par – overstated the deficit during the wartime years. See the discussion above.

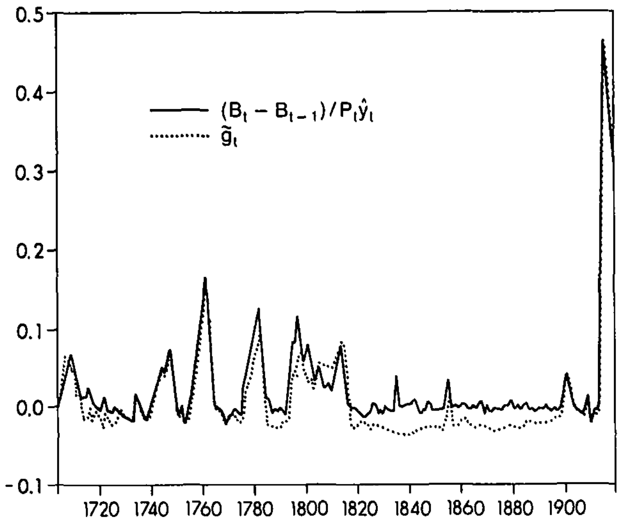

Fig. 9. Budget deficits and temporary military spending, 1705–1918.

(13) is a deficit–GNP ratio. The coefficient b_0 is the growth rate of the nominal debt that occurs when $\tilde{g}_t$ and v_t equal zero. In previous analysis [Barro (1979)] this rate corresponded to the trend growth rate of real GNP plus the rate of expected inflation. That is, when $\tilde{g}_t = v_t = 0$, the current deficit is set so as to maintain constancy over time for the planned ratio of the debt to GNP. In the present setting I treat the parameter b_0 as a constant. However, non-constancy of expected inflation is one element that could generate serial correlation of the error term v_t in eq. (13). The omission of cyclical effects, which would themselves be autocorrelated, could also generate this serial correlation. The autogressive form of the error process in eq. (14) is intended to account for these effects.

The estimates of eqs. (13) and (14) for 1706–1913 are

$$\frac{(B_t - B_{t-1})}{P_t\hat{y}_t} = \underset{(0.003)}{0.013} \cdot \left[\frac{B_{t-1}}{P_t\hat{y}_t}\right] + \underset{(0.04)}{0.96}\tilde{g}_t, \qquad \hat{\phi} = \underset{(0.04)}{0.76},$$ [20]

$$\hat{\sigma} = 0.0087, \quad R^2 = 0.93, \quad DW = 2.0. \tag{15}$$

The first coefficient – 0.013, *s.e.* = 0.003 – should equal the trend growth rate of real GNP[21] plus the average rate of expected inflation. In fact, the average

[20] The value $\hat{\phi}$ is significantly less than one according to Fuller's (1976, p. 373) distribution.

[21] I have not allowed for different coefficients in different sub-periods, although the average growth rate of real GNP from 1701 to 1770 (0.5% per year) was well below that from 1770 to 1913 (2.1% per year).

growth rate of real GNP from 1701 to 1913 was 1.6% per year, while the average rate of change of the wholesale price index was 0.1% per year. Thus the estimated value of the coefficient on the lagged debt, 0.013, does approximate the trend growth rate of real GNP plus the average rate of inflation.

The estimated coefficient on $\tilde{g}_t$ – 0.96, $s.e. = 0.04$ – indicates the fraction of temporary government spending (as measured) that is financed by deficits. Note that the estimated coefficient differs significantly from zero, but insignificantly from unity. The result indicates that temporary military expenditure was financed by the issue of debt, rather than taxes.[22]

The serial correlation coefficient – $\hat{\phi} = 0.76$, $s.e. = 0.04$ – presumably picks up factors such as cyclical fluctuations and persisting variations in expected inflation. Thus far, I have no detailed results on these elements.

With World War I included, the results for the period 1706–1918 are

$$\left[\frac{B_t - B_{t-1}}{P_t \hat{y}_t}\right] = \underset{(0.004)}{0.008} \cdot \left[\frac{B_{t-1}}{P_t \hat{y}_t}\right] + \underset{(0.02)}{1.03}\tilde{g}_t, \qquad \hat{\phi} = \underset{(0.04)}{0.81},$$

$$\hat{\sigma} = 0.0101, \quad R^2 = 0.98, \quad DW = 2.1. \tag{16}$$

These results are similar to those in eq. (15).

As an example of the effect of wartime, from 1757 to 1762 the average value of the temporary-spending ratio $\tilde{g}_t$ was 9.6%. Multiplying by the coefficient 0.96 from eq. (15), the prediction is that the debt–GNP ratio would rise on average by 9.2 percentage points per year during this war. In fact, the ratio rose over the period from 0.74 to 1.39 or by 10.8 percentage points per year.

During peacetime the variable $\tilde{g}_t$ is negative, rather than zero. Hence, instead of predicting a constant ratio of the debt to GNP, eq. (15) says that this ratio will fall during peacetime. This behavior underlies the tendency for the debt–GNP ratio to decline during years that do not involve major wars, as is apparent from fig. 8. For example, from 1822 to 1913, the average value of

[22] For much of the sample the dominant forms of the central government's tax revenues were customs duties and excise taxes. [See Mitchell and Deane (1962, pp. 387–388, 392–394) for the data.] The tax on land was also significant, amounting to about 20% of total revenue in 1800, but less than 10% by 1840. Income (and property) taxes, begun in 1799, accounted for as much as 15% of overall revenue during the Napoleonic Wars. After lapsing in 1817, income taxes were reintroduced in 1843 at about 10% of total revenue. This percentage reached 15% around 1900 and 30% in 1915. An excess-profits tax for World War I accounted for about 30% of overall receipts. Thus, in order to generate more tax revenues, the government partly raised the rates of existing taxes, and partly introduced new types of levies. Also, especially during World War I, there was a tendency for non-military components of governmental outlays to fall during wartime.

the variable $\tilde{g}_t$ was -2.1%. Therefore the prediction is that the debt–GNP ratio would fall on average by 2.0 percentage points per year (0.021×0.96). In fact, the ratio fell over this period from 1.85 to 0.30 or by 1.7 percentage points per year.

4.2. *Budget deficits versus government spending as determinants of interest rates*

The present study related interest rates to temporary government purchases, with the method of finance for those expenditures regarded as secondary. However, other theories argue that interest rates respond positively to budget deficits rather than to government spending as such. It would be desirable to use the long-term British data to discriminate between these viewpoints. However, since temporary spending and budget deficits move closely together, as is clear from fig. 9, it is difficult to disentangle the effects of spending from the effects of deficits. Moreover, since the variable $\tilde{g}_t$ is just an estimate of temporary spending, it is even possible that budget deficits are a better measure than $\tilde{g}_t$ of temporary spending. In addition, to the extent that budget deficits represent endogenous responses to recessions or expected inflation, a positive association between deficits and interest rates need not reveal the effect of deficits, *per se*.

Theories that stress the effects of budget deficits on interest rates, such as Blanchard (1985), also predict an impact from the lagged stock of public debt. This prediction distinguishes the deficit viewpoint from a model that focuses on the effects of current temporary spending. However, as discussed before, the spending theories allow also for effects of lagged expenditures, which would be correlated with past deficits and hence with the accumulated stock of debt. Therefore it remains difficult to discriminate between the two theories.

Over the period from 1730 to 1913 the regression for the long-term interest rate on the deficit–GNP ratio and the lagged debt–GNP ratio is

$$R_t = \underset{(0.27)}{3.01} + \underset{(1.1)}{5.9} \cdot \frac{(B_t - B_{t-1})}{P_t \hat{y}_t} + \underset{(0.22)}{0.48} \left[\frac{B_{t-1}}{P_t \hat{y}_t} \right], \qquad \hat{\lambda} = \underset{(0.033)}{0.905},$$

$$\hat{\sigma} = 0.238, \quad R^2 = 0.90, \quad R^2 \text{ (for } R_t - R_{t-1}) = 0.17, \quad DW = 2.2. \tag{17}$$

Hence, with government expenditure variables excluded, the current budget deficit and the lagged stock of debt each have significantly positive effects on the interest rate. Also, the fit of eq. (17) is similar to that based on current and lagged temporary purchases in eq. (8).

With the spending variables included the regression becomes

$$R_t = \underset{(0.28)}{3.16} + \underset{(4.0)}{4.3}\tilde{g}_t - \underset{(3.3)}{3.9}\tilde{g}_{t-1} + \underset{(3.5)}{5.4}\tilde{g}_{t-2} + \underset{(3.4)}{2.2}\tilde{g}_{t-3} - \underset{(2.9)}{5.0}\tilde{g}_{t-4} + \underset{(2.1)}{3.9}\tilde{g}_{t-5}$$

$$+ \underset{(2.2)}{4.3}\left[\frac{B_t - B_{t-1}}{P_t \hat{y}_t}\right] + \underset{(0.23)}{0.34}\left[\frac{B_{t-1}}{P_t \hat{y}_t}\right], \qquad \hat{\lambda} = \underset{(0.033)}{0.906},$$

$$\hat{\sigma} = 0.232, \quad R^2 = 0.91, \quad R^2 \text{ (for } R_t - R_{t-1}) = 0.24, \quad DW = 2.2. \tag{18}$$

Not surprisingly, the significance attached to each of the spending variables is less than that when the deficit variables are excluded [eq. (8)], and the significance of the deficit variables is less than that when the spending variables are excluded [eq. (17)]. For the set of six spending variables the joint hypothesis that all coefficients are zero leads to the value for $-2 \cdot \log$(likelihood ratio) of 15.8, which is below the 2% critical value for the chi-squared distribution with 6 degrees of freedom. For the two deficit variables the corresponding statistic is 4.5, which is nearly equal to the 10% critical value with 2 degrees of freedom. In this sense the results indicate some preference for the expenditure variables as influences on interest rates. However the principal finding is an inability to disentangle the effects of spending from the effects of budget deficits.

4.3. Two episodes of non-war budget deficits

Since temporary spending and budget deficits move together during wartime, it is natural to search for other experiences that break the collinearity in these variables. In particular, the best experiments would be budget deficits run for no reason – that is, deficits that are not endogenous responses to wartime, recession, expected inflation, etc. For the present sample, which contains over two hundred years of British history, I have been able to isolate two such episodes.

Following the decision in 1833 to free the West Indian slaves, there were large compensatory payments by the British government to slaveowners. The amounts were $\mathscr{L}$16.7 million in 1835 and $\mathscr{L}$4.1 million in 1836.[23] These figures, when divided by the wholesale price index, represented 4.3% and 0.9%, respectively, of trend real GNP. Thus the transfer payments in 1835 were similar in scale to a medium-sized war (see table 1). Since the transfers were

[23] See Mitchell and Dean (1962, p. 399, fn. e). Some discussion of the events appears in Burn (1937, ch. II) and Fogel and Engerman (1974).

temporary, they should be included nearly one-to-one in the concept of the temporary-spending ratio, $\tilde{g}_t$, which so far included only military expenditures. With this adjustment the measured value of $\tilde{g}_t$ rises in 1835 from -0.033 to 0.010 and in 1836 from -0.035 to -0.026. Using this revision to the $\tilde{g}_t$ variable, the estimated deficit–GNP ratio from eq. (15) for 1835 becomes 0.034, as compared with the actual value of 0.039. The previous estimate, based on the unrevised concept of $\tilde{g}_t$, was -0.007. For 1836, the revised estimate for the deficit–GNP ratio is -0.006, as compared to the actual value of 0.003.[24] The main point is that the compensatory payments to slaveowners were financed primarily by debt. Thus the budget deficit reacts to temporary peacetime spending in a manner similar to temporary wartime spending.

On the other hand, with respect to interest-rate determination, the freeing of the slaves and the payments to slaveowners would be different from temporary military purchases. The freeing of the slaves, *per se*, converts some non-human assets – that is, ownership rights in slaves – into human capital.[25] With 'imperfect' capital markets, this change could raise the desire to save in non-human form, and thereby reduce market interest rates. However, the financing of the compensation payments by public debt offsets this effect.

The Ricardian view of budget deficits says that the extra public debt is matched by a higher present value of future taxes, and thereby has no effect on desired national saving or on interest rates. This view assumes that imperfections in capital markets are unimportant in this context – therefore the view also implies that the freeing of the slaves, *per se*, has no appreciable impact on market interest rates. Overall, the Ricardian view predicts no important effect on interest rates from the freeing of the slaves and the associated budget deficit.

The actual path of long-term interest rates was 3.76% in 1831, 3.58% in 1832 (when there was discussion of the pending legislation for freeing the slaves), 3.42% in 1833 (when the emancipation legislation and the compensation package were enacted), 3.32% in 1834, 3.29% in 1835 (when the main compensatory payments were made and the budget deficit was large), 3.35% in 1836, and 3.30% in 1837. Thus, despite the large budget deficit in 1835, there was no apparent impact on long-term interest rates. Short-term interest rates[26]– which are far more volatile from year to year – do show increases after 1833. The path here was 3.69% in 1831, 3.15% in 1832, 2.73% in 1833, 3.38% in 1834, 3.71% in 1835, 4.25% in 1836, and 4.44% in 1837.

[24] The previous estimate for 1836, which was 0.022, reflected the large positive residual for 1835 [see equation. (15)]. If the effect of this residual were eliminated, then the previous estimate would have been -0.016.

[25] I am grateful to Levis Kochin for this point.

[26] The data are Gurney's rates for first-class three-month bills from Mitchell and Deane (1962, p. 460).

The second episode of non-war budget deficits concerns the debate over income taxes and other levies in 1909 (actually the fiscal year ended March 1910).[27] The dispute over what kinds of taxes to enact and at what levels produced a legislative deadlock during fiscal 1909–10, which created a one-year lapse in the government's authority to collect certain revenues, especially from the income tax. Therefore, although there was no temporary bulge in expenditures, the sudden drop in receipts, mainly from the income tax, produced a budget deficit of 1.5% of trend GNP in 1909 [as compared to an estimated value of -0.4% from eq. (15)]. This deficit was financed with short-term debt, which was paid off as promised when the uncollected taxes ('arrears') were paid during the following year. The receipt of these backlogged taxes, when added to the regular revenues, generated a budget surplus of 2.0% of trend GNP for 1910 (actually the fiscal year ended March 1911).

The scientific attraction of this episode is that it involves movements in budget deficits that are not confounded by correlated shifts in government expenditures for the military or other purposes. Therefore, the behavior of interest rates in 1909–10 provides information about the effects of a budget deficit *per se* – although a deficit that was pretty much assured to be temporary and balanced by a surplus the next year. The path of long-term interest rates was 2.90% in 1908, 2.98% in 1909 (when there was a budget deficit), 3.08% in 1910 (when there was a budget surplus), and 3.15% in 1911. These data do not indicate that the budget deficit or surplus had a major effect on long-term rates. For short-term rates,[28] the pattern was 2.29% in 1908, 2.28% in 1909, 3.16% in 1910, and 2.90% in 1911. Hence the short-term interest rate was higher in the year of budget surplus, 1910, than in the year of deficit, 1909.

Overall, one cannot detect a clear relationship between budget deficits and interest rates for these two 'natural experiments'. In any event, while these episodes are valuable because of the rarity of exogenous deficits, it remains true that the sample of such experiments is small.

5. Conclusions

The British data from the early 1700s through World War I provide an unmatched opportunity for studying the effects of temporary changes in government purchases. In this paper I examined the effects of these changes on interest rates, the quantity of money, the price level, and budget deficits. But the data should be useful for many other purposes.

The main findings are as follows. Temporary increases in government purchases – showing up in the sample as increases in military outlays during

[27] For a discussion, see Mallett (1913, pp. 298–315).

[28] The data are for three-month bank bills from Mitchell and Deane (1962, p. 460).

wartime – had positive effects on long-term interest rates. The effect on the growth rate of money (bank notes) was positive only during the two periods of suspension of the gold standard (1797–1821 and 1914–1918). As long as convertibility of bank notes into specie was maintained, there was no systematic relation of government spending to monetary growth. Similarily, the main interplay between temporary government spending and inflation occurred during the periods of suspension.

Temporary changes in military spending accounted for the bulk of budget deficits from the early 1700s through 1918. This association explains the main increases in the ratio of the public debt to GNP, as well as the decreases that typically occurred during peacetime. Because of the close association between temporary military spending and budget deficits, it is not possible to say with confidence whether interest rates react to temporary spending *per se* or to the associated deficits.

Over the sample of more than two hundred years, I found two examples of major budget deficits that were unrelated to wartime (or the business cycle). One episode featured compensation payments to slaveowners in 1835–36, and the other involved a political dispute over the income tax in 1909–10. Because of the 'exogeneity' of these deficits, it is interesting that interest rates showed no special movements at these times.

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