Government Spending, Interest Rates, Prices and Budget Deficits in the United Kingdom, 1730-1918

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Budget Deficits in the United Kingdom, 1730-1918*

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Effects of Temporary Spending on Interest Rates and the Price Level

A number of existing analyses (Hall, 1980; Barro, 1981b, 1984a, Chapter 13; Judd, 1983) discuss the effect of temporary government purchases on real interest rates. The simplest case is for government consumption expenditure that does not substitute directly for private spending. If an increase in government purchases is temporary, households' permanent income falls by less than one-to-one. Accordingly, consumer demand tends to decline by less than the increase in purchases, and aggregate demand for goods rises. There is a corresponding excess of investment demand over desired national saving, which means that the real interest rate must increase. When the Ricardian view of the public debt is valid--so that households view taxes and deficits as equivalent--this result obtains independently of whether the temporary spending is financed by taxes or debt. The same conclusion holds also in the case of monetary finance as long as changes in monetary growth do not have major effects on real interest rates.

The tendency for temporary government purchases to raise real interest rates still follows if government consumption substitutes for private consumption, as long as this substitution is less than one for one. Similarly, one can allow for a contemporaneous effect of public services on private production functions, and hence on the supply of goods. Finally, the increase in real interest rates applies as well to the case of public investment, which may substitute imperfectly for private investment.

The basic idea is that a higher real interest rate is the appropriate price signal when the government's demand for goods is temporarily high.[1]

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[1]With an open economy the effect shows up partly in borrowing from abroad and partly in a higher real interest rate. See Ahmed (1984) for an analysis of government spending and the balance of payments.

This signal motivates people to demand less goods today (for consumption and investment) and supply more goods today (by working harder and by using existing capital more intensively). Thus, the tendency to substitute intertemporally buffers the shock from the government's unusual demand for goods.

Benjamin and Kochin (1984, 595-96) point out that temporary government purchases, such as in wartime, affect the term structure of real interest rates. For example, suppose that a war starts today and everyone knows that this war will last for one year.[2] The response of the private market is to substitute intertemporally between the period of high government demand, which is the current year, and the normal period after the end of the war. Therefore, there is an increase in real interest rates with maturity greater than one year. But today's short-term real interest rates (of maturity less than one year) apply to an interval over which the government's demands are uniformly high. Since there is no motivation to substitute over time within the one-year period, there is no apparent upward pressure on short-term rates.

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

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[2] I use wartime as an observable example of temporary government expenditure. There are other aspects of wars that can affect real interest rates, such as the prospect of victory or defeat. To the extent that defeat threatens property rights, these are downward effects on desired investment and desired saving, which have an ambiguous net effect on real interest rates. Also, direct wartime controls can substitute for movements in interest rates as a device for crowding-out private spending. Then the observed responses in interest rates will be weaker than otherwise. For the British case examined in the present study, this aspect of a command economy would be important mainly during World War I (see Pollard, 1969, Chapter II).

as longer-term rates. However, Benjamin and Kochin are still correct in that the response of short-term rates tends to be relatively weak. Thus, from an empirical standpoint, it is probably best to focus on the reaction of longer-term interest rates.

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 (1981a; 1984a, Chapter 13) and Plosser (1982). But, as stressed by Benjamin and Kochin (1984), the long-term British data are especially promising for isolating this effect if it exists. From 1729 to 1918 the U.K. was involved in numerous wars, which provide for substantial temporary variations in government purchases.[3] Further, the economy was free of most other governmental interventions, such as extensive price and interest-rate controls, which often accompany wars.

The solid line in Figure 1 shows a measure of temporary government spending as a ratio to GNP. Specifically, the variable is $\tilde{g}_t \equiv (g_t - \hat{g}_t)$, where g_t is real military spending as a ratio to trend real GNP (nominal spending divided by the wholesale price index, and then divided by trend real GNP) and $\hat{g}_t$ is an estimate of the "normal" ratio of real spending to real GNP. The variable $\hat{g}_t$, discussed in detail below, is a distributed lag of past values of the spending ratio. Trend real GNP comes from a trend line through the data on real GNP, using one growth rate (.55% per year) from 1700 to 1770, and another (2.18% per year) from 1771 to 1938.[4]

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[3] I began in 1729 in order to use a consistent series of long-term interest rates. The data since 1753 refer to consols (first issued in 1751), while those from 1729-52 are for nearly comparable perpetual annuities. See Homer (1977, pp. 161, 175, 416).

[4] The data on military expenditure are from Mitchell and Deane (1962, pp. 390-91, 396-99). The figures combine the items for army, navy and ordnance, and for expenditures on special expeditions and votes of credit. The dating

Table 1 shows the values of the temporary spending variable for the seven main wars during the sample period (treating the wars with France from 1793 to 1815 as one event). 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 measure of temporary military spending. Note from the table that the temporary-spending ratio ranges from a high of 50% during World War I (1916) to 16% in the Seven-Year's War (1761), 9% for the American Revolution (1782), 7% during the Napoleonic Wars (1814), 6% for the War of the Austrian Succession (1748), 5% for the Boer War (1901), and 2% during the Crimean War (1855).[5] 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, 1984b, Table 3).

For the interest rate I use the yield on consols (or on the comparable perpetual annuities for 1729-52), which is available over the entire period under study. These government bonds are perpetuities, except that they were

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[4] of expenditures refers to disbursements rather than orders (see Benjamin and Kochin, 1984, p. 602, n.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 5 were treated as applying to the previous calendar year. For 1855-1919, the fiscal-year data ended March 31 were also viewed as covering the prior calendar year. 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).

[5] Non-military expenditures of the central government show much less short-term fluctuation and remain between 2 and 3% of trend GNP from 1801 to 1900 (except for 1835 as discussed at the end of the paper). See Mitchell and Deane (1962, pp. 396-98) for the data. This spending reaches 4% of trend GNP in the early 1900s, but then falls back to 2% during World War I.

redeemable at par after a stated number of years.[6] The theory implies that temporary government spending would have a positive effect on these long-term interest rates. Empirically, the broad nature of this relation is evident from Figure 1. In particular, the interest rate (dotted line) appears to rise along with the temporary-spending ratio (solid line). Table 1 reports the changes in these interest rates during each of the major wars. Note that these are all positive and in excess of 1 percentage point in four of the cases. Since the standard deviation of the annual first difference of the interest rate from 1730 to 1918 is .26 percentage points, these four cases involve increases in interest rates that are 5-7 times this standard deviation. (The sample mean of the interest rate is 3.54%.)

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. 163-65, 205-08.) If the sample started in 1817 or later, then much of the action in the government spending variable would be lost (see Figure 1). In any event, the theory suggests only weak effects of temporary government spending on short-term rates.

Finally, the interest rate data measure nominal rates rather than the expected real rates that matter theoretically. I discuss below some preliminary attempts to use measures of expected inflation in order to sort out the movements in real rates from the movements in nominal rates. (This section is missing in the present version.)

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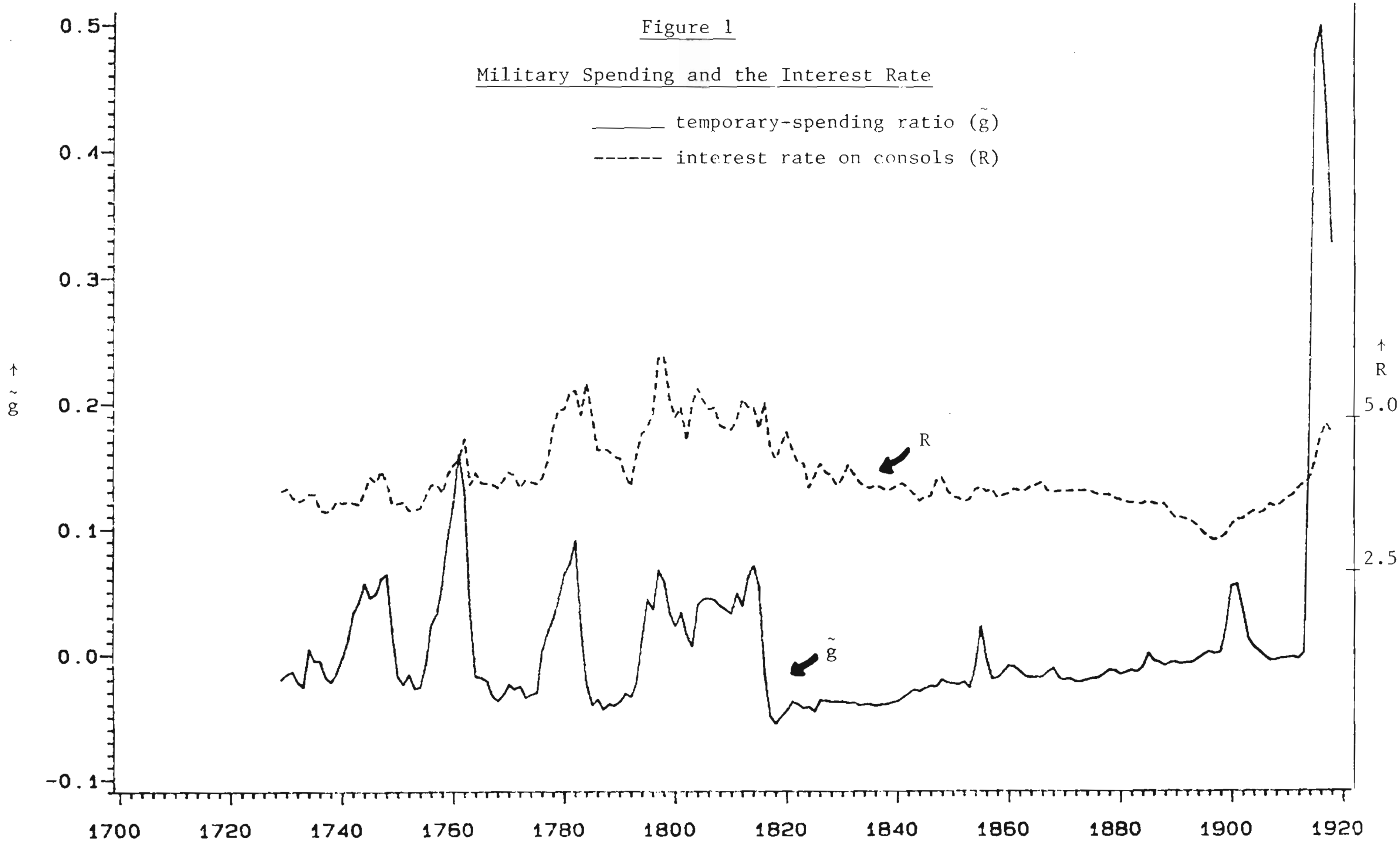
[6] The data are from Homer (1977, pp. 161-62, 195-97, 416). The yields apply to 3% consols until 1888, and to 2-1/2% consols threafter. The possibility that the 3% consols would be redeemed at par implies that the yields on these instruments were misleadingly high after 1888.

Figure 1

Military Spending and the Interest Rate



Temporary government spending tends also to affect the price level, although Britain was on some form of commodity standard throughout the sample period. Basically a gold standard applied, although the system was formally bimetallic (with gold overvalued at the mint) until 1821 (see Del Mar, 1877). However, specie payments for Bank of England notes were suspended between 1797 and 1821 (see Clapham, 1945, Chapter 1). A variety of restrictions on specie payments also applied after the middle of 1914 during World War I (see Sayers, 1976, Ch. 5).

The effect of temporary government spending on the price level can be viewed in terms of forces that affect either the supply of base money or the (real) demand for base money. The main element that raises the money supply is the increase in circulating notes (from the Bank of England), which are associated with the government's financing of wartime spending. This mechanism is offset by the tendency for the precious metals to move abroad in reaction to high domestic prices. However, as pointed out by Barsky (1984), high real interest rates also motivate a decrease in gold and silver held for non-monetary purposes.

The real demand for base money falls because of high interest rates. Also the demand for paper notes declines with fears of suspension or of permanent changes in the price of gold or silver. On the other hand, wartime may have direct positive effects on the demand for media of exchange. The overall response of the price level is ambiguous, although a positive effect tends to arise at times when there is actual or threatened suspension of the gold standard.

Empirically, I measure the price level by linking together several indices of wholesale prices.[7] Benjamin and Kochin (1984, pp. 598-600) show that the net effect of temporary wartime spending on this concept of the price level is positive. The broad nature of this relation shows up in Figure 2, which graphs the log of the price level (dotted line) along with the temporary spending variable $\tilde{g}$ (solid line). Table 1 shows that prices increase during each of the major wars. However, the main effects are during the Napoleonic Wars and World War I, which are also the only two periods of suspension of the gold standard. Since an increase in temporary spending raises long-term interest rates, Benjamin and Kochin 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. Barsky (1984) argues that the Benjamin/Kochin explanation is quantitatively unsatisfactory.

Interest Rates and Prices

I model the determination of the interest rate in the form,

$$(1) \quad R_t = a_0 + a_1\tilde{g}_t + u_t,$$

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, the long-term

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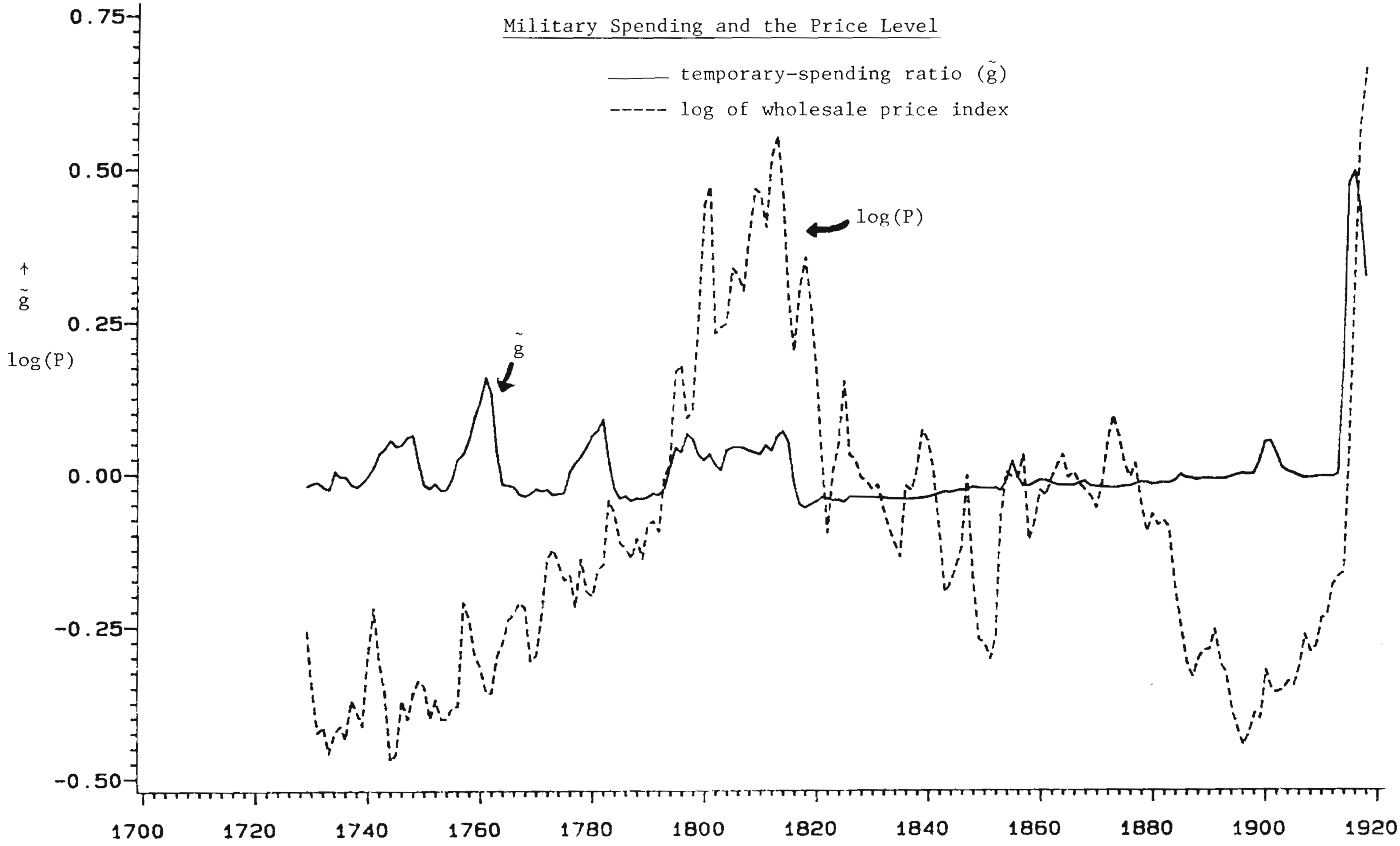
[7]The data are from Mitchell and Deane (1962, pp. 469-70, 474, 476). The series is a linking together of the following wholesale price indexes: 1871-1918, Board of Trade total index of wholesale prices; 1850-70, Sauerbeck-Statist overall index; 1790-1849, Gayer, Rostow and Schwartz index of domestic and imported commodities; 1700-89, Schumpeter-Gilboy index of consumer goods.

Figure 2

Military Spending and the Price Level



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 equation (1) by the first-order autoregressive process,

$$(2)\quad u_t = \rho u_{t-1} + e_t,$$

where e_t is white noise, and the positive coefficient ρ is close to but below unity.

Equations (1) and (2) say 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 $\rho = 1$, equation (1) could be estimated satisfactorily in first-difference form (with a zero constant). But if $\rho < 1$, then it is appropriate to deal with levels of variables. Note that if the temporary-spending ratio $\tilde{g}_t$ is positive, as in wartime, then equation (1) indicates an increase in the interest rate. Then, when the variable $\tilde{g}_t$ declines at the end of war, the specification implies that the interest rate falls without any slow adjustment. It turns out that the data are reasonably in accord with this specification.

An analogous formulation for the price level is

$$(3)\quad \log(P_t) = b_0 + b_1\tilde{g}_t + v_t,$$

where v_t is the error term and $b_1 > 0$. As with the interest rate, the (log of the) price level seems to be close to a random walk, but barely stationary. In this case the error term appears to be a second-order process,

$$(4) \quad v_t = \lambda_1 v_{t-1} + \lambda_2 v_{t-2} + \eta_t,$$

where η_t is white noise. If the log of the price level is stationary, then $\lambda_1 + \lambda_2 < 1$ applies.

Again aside from the influence of temporary military spending, equations (3) and (4) say that the other determinants of the price level, v_t, are close to random walks. Also as before, if temporary spending $\tilde{g}_t$ is positive during a war, then equation (3) indicates that the price level rises. But, when the war ends and $\tilde{g}_t$ declines, the formulation implies that the price level falls without any lag. The data turn out to be inconsistent with this specificaton, since a lagged adjustment of the price level seems to occur. This process would be consistent, for example, with a gradual decline in the stock of money after the end of a war. (The available monetary data are fragmentary.) A preferable specification for the price level, which captures this behavior and therefore performs better than equations (3) and (4), is

$$(5) \quad \log(P_t) = c_0 + c_1\tilde{g}_t + c_2\bullet\log(P_{t-1}) + c_3\bullet\log(P_{t-2}) + \epsilon_t,$$

where ϵ_t is white noise. In the present paper I report results only in the form of equation (5), although those for equations (3) and (4) are also available.

Empirical Results

Up to this point I have not been successful in modeling directly the time-series process for the ratio of military spending to GNP. This process involves the temporary positive effect of wartime (which persists corresponding to the stochastic lengths of wars), along with longer term shifts in the spending ratio. The latter appear to be mild--notably the peacetime ratio of military spending to GNP may be stationary over the entire period 1700-1918.

For present purposes I assume that the permanent component[8] of the spending ratio, denoted by $\hat{g}_t$, satisfies the adaptation relation,

$$(6)\quad \hat{g}_t - \hat{g}_{t-1} = \beta(g_t - \hat{g}_{t-1}).$$

A small value of β indicates that the variance of permanent shifts to the spending ratio is small relative to that of the temporary (i.e., wartime) disturbances (see Muth, 1960). At this stage I have chosen the estimate of the coefficient β that yields the best fits in the equations below for the interest rate, price level, and (in the next section) the budget deficit. The value β = .03 per year turns out to deliver an approximation to the best fit in each case--I have not considered explicitly the overall likelihood of the joint system.

Conditional on the value β = .03 per year, the maximum likelihood estimate of the interest-rate equation (1) for annual data over 1730-1918 is

$$(7)\quad R_t = \underset{(.29)}{3.56} + \underset{(.57)}{2.10}\bullet\tilde{g}_t, \qquad \hat{\rho} = \underset{(.026)}{.935},$$

$$\hat{\sigma} = .25,\ R^2 = .89,\ R^2(\text{for } R_t - R_{t-1}) = .10, \qquad DW = 2.1$$

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[8]The relevant concept of "permanent" is the expected present value of future real spending, expressed as a ratio to current real GNP.

The estimated coefficient on $\tilde{g}_t$, 2.10, s.e. = .57, differs significantly from zero (with a t-value of 3.7). The result implies that an increase by 1 percentage point in the temporary-spending ratio raises the long-term interest rate by 2.1 basis points.

The estimated value $\hat{\rho}$ = .935, s.e. = .026, implies a "t-value" relative to the null hypothesis $\rho = 1$ of 2.5. Considering the one-sided alternative, $\rho < 1$, this statistic differs significantly from zero at the 1% level using the t-distribution. However, it is significant only at the 5% level (for a one-sided test) according to the distribution that is generated by Monte Carlo methods for an analogous non-stationary model in Fuller (1976, Table 8.5.2, the section for $\hat{\tau}_{\mu}$). Thus, there is some evidence that supports the stationarity of the long-term interest rate over the period 1730-1918.

Over a sample that excludes World War I, 1730-1913, the estimated coefficient of $\tilde{g}_t$ is substantially larger. In this case the results are

$$(8) \quad R_t = \underset{(.28)}{3.54} + \underset{(1.07)}{5.02} \bullet \tilde{g}_t, \qquad \hat{\rho} = \underset{(.026)}{.937}$$

$$\hat{\sigma} = .24, \; R^2 = .89, \; R^2(\text{for } R_t - R_{t-1}) = .14, \qquad DW = 2.2$$

According to equation (8) a one-percentage-point increase in $\tilde{g}_t$ raises the long-term interest rate by over 5 basis points. The relatively weak response of the interest rate during World War I (see Table 1) substantially lowers the estimate in equation (7). It may be that the command economy aspects of World War I explain this finding (see n. 2 above). The estimate of $\hat{\rho}$ in equation (8) is similar to that in equation (7).

For the price level there is another problem to consider in the estimation. The value g_t is nominal military spending divided by the contemporaneous wholesale price index and then divided by trend real GNP. But, since deflation by the wholesale price index is an imperfect way to calculate "real" military spending, this procedure generates a spurious negative association between $\log(P_t)$ and $\tilde{g}_t$. Hence, the usual estimate of the c_1 coefficient in equation (5) would be biased downward. Therefore, I calculate instrumental estimates, where the instrument for $\tilde{g}_t$ is the value that would be calculated for the temporary spending ratio if current real spending were replaced by current nominal spending divided by the lagged price index, P_{t-1}. (The results are virtually identical if I substitute the estimated value of P_t from the fitted equation for the lagged value P_{t-1}.)

The instrumental estimates of equation (5) for the period 1730-1918 are as follows:

$$(9) \quad \log(P_t) = \underset{(.005)}{-.004} + \underset{(.07)}{.39}\cdot\tilde{g}_t + \underset{(.07)}{1.12}\cdot\log(P_{t-1}) - \underset{(.07)}{.17}\cdot\log(P_{t-2}),$$

$$\hat{\sigma} = .065, \ R^2 = .93, \ R^2(\text{for } \log(P_t/P_{t-1})) = .19, \quad DW = 1.9.$$

The estimated coefficient on $\tilde{g}_t$ in equation (9), .39, s.e. = .07, differs significantly from zero (t-value = 5.7).[9] The result implies that an

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[9]Benjamin and Kochin (1984, p. 603, n. 10) report that the estimated coefficient of current temporary spending, $\tilde{g}_t$, is insignificant when lagged spending is also included. That result does not obtain in the case of instrumental estimates, where the instrument for $\tilde{g}_t$ excludes the current price level P_t. In fact, the lagged values $\tilde{g}_{t-1}$ and $\tilde{g}_{t-2}$ are insignificant

increase by one percentage point in the ratio of temporary spending to GNP raises that year's price level by about 4-tenths of a percent. (Recall that, under the same circumstances, the long-term interest rate rose by about 2 basis points in the 1730-1918 sample or 5 basis points in the sample that excludes World War I.)

The sum of the estimated coefficients on the lagged dependent variables in equation (9) is .954 with an estimated standard error of .021. Therefore, the standard t-value, relative to the null hypothesis of non-stationarity where the sum equals one, is 2.2. Considering the one-sided alternative where the sum is less than one, this t-statistic differs significantly from zero at the 2% level. Using Fuller's (1976, Table 8.5.2) distribution, the value is significant only at about the 10% level. Therefore, there is weak indication of stationarity for the price level over 1730-1918.

For the sample that excludes World War I, 1730-1913, the estimates are

$$(10)\quad \log(P_t) = \underset{(.005)}{-.004} + \underset{(.13)}{.23}\tilde{g}_t + \underset{(.07\ )}{1.12}\bullet\log P_{t-1} - \underset{(.07\ )}{.16}\bullet\log P_{t-2},$$

$$\hat{\sigma} = .065,\ R^2 = .92,\ R^2\ (\text{for}\ \log\ (P_t/P_{t-1})) = .04,\quad DW = 1.9$$

These results do not differ significantly from those shown in equation (9), in the sense that the hypothesis of unchanged structure would be accepted for the sub-samples, 1730-1913 and 1914-18. However, the addition of World War I dramatically increases the sample variation in the temporary spending variable $\tilde{g}_t$, which results in a more significant coefficient for this

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[9]if added to equation (9), while the estimated coefficient of $\tilde{g}_t$ remains highly significant.

variable. Also the R^2 for the inflation rate is much higher when World War I is included.

Inflationary Expectations and Interest Rates

(Section to be added)

Budget Deficits

In some previous papers I discussed the tax-smoothing theory of government deficits (Barro, 1979, 1984b--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 deficits. Thereby, tax rates rise uniformly during and after the war, rather than being extraordinarily high during the war. Second, the government runs deficits during recessions (surpluses in booms) in order to prevent tax rates from being unusually high (low) at these times. Third, 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, since unexpected inflation does not affect the deficit, there is a change in the opposite direction for the stock of real debt outstanding.

Empirical results for the U.S. for the period 1916-84 provided reasonably good estimates for the effects on deficits from business fluctuations and expected inflation (see Barro, 1984b). However, there was less 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 British data from 1729 to 1918 are well suited for studying the relation of 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, I am not yet in a position to use the data to assess the effects from changes in anticipated inflation. Therefore, I focus the present study on the relation between 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.[10] 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.[11] 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%).[12] Hence the change in the public debt as recorded far exceeded the true deficit at these times. Then the errror was effectively undone later in the 19th 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.

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[10] The data are from Mitchell and Deane (1962, pp. 386-98). The dating of the fiscal years corresponds to that for military spending, as discussed in n. 4 above. Given this correspondence, there is no problem in matching the deficits with the expenditure numbers.

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

[12] See Fenn (1883, pp. 6-9) for the details.

Figure 3 shows how important the British public debt is in relation to the economy. The ratio of real debt (the nominal amount from the start of the year relative to the wholesale price index for the year) to trend real GNP rose from about 25% in 1701 to 70% in 1718 (after the War of the Spanish Succession) and then declined 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 to 100% in 1775, the ratio rose to over 130% after the American Revolution (1785). After a decline to less than 90% in 1795, the ratio rose to nearly 160% at the conclusion of the Napoleonic Wars in 1816, and (with the sharp decline in the price level) to the all-time peak of 185% in 1822.[13] There followed a long decline with only minor interruptions to a low point of 30% in 1914. Then with World War I the ratio reached 110% in 1918.

Figure 4 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 $\tilde{g}$. 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

$$(11) \quad (B_t - B_{t-1})/P_t\hat{y}_t = d_0(B_{t-1}/P_t\hat{y}_t) + d_1\tilde{g}_t + w_t,$$

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[13] 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.

<u>Figure 3</u>

<u>Ratio of Public Debt to Trend GNP</u>

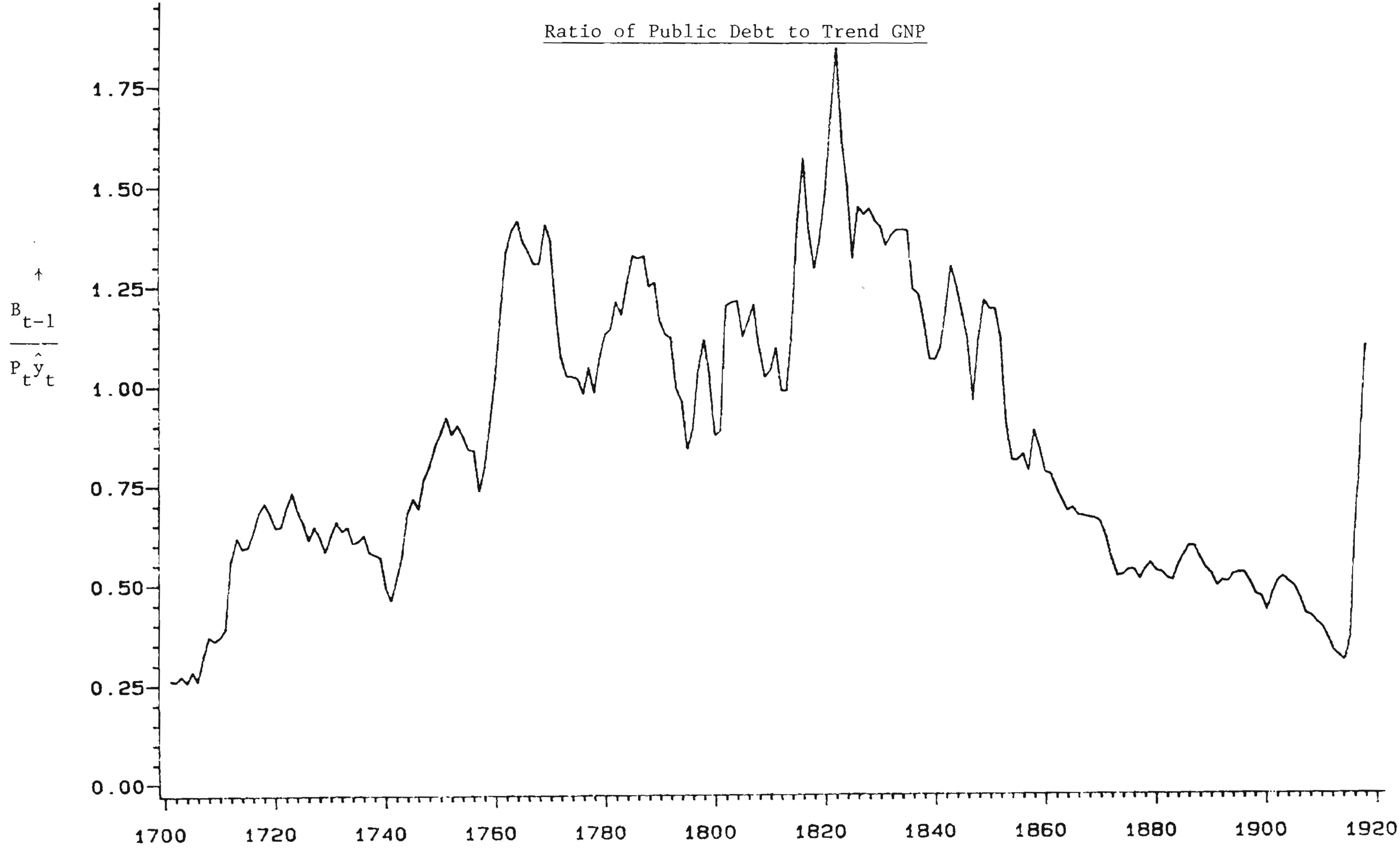
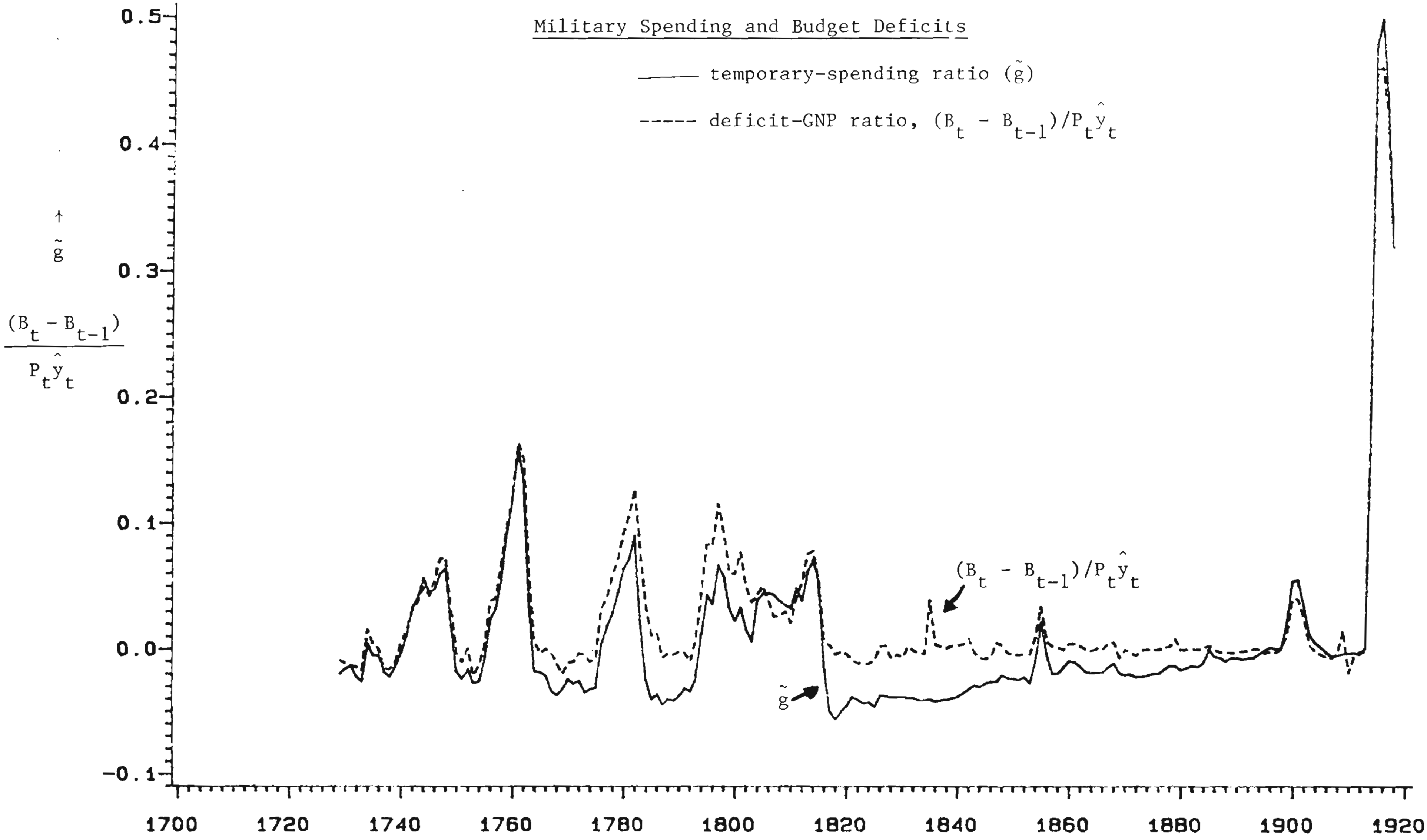


Figure 4

Military Spending and Budget Deficits



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 w_t is generated from

$$(12) \quad w_t = \phi w_{t-1} + \theta_t,$$

where θ_t is white noise. Note that the dependent variable is a deficit-GNP ratio. The coefficient d_0 is the growth rate of the nominal debt that occurs when $\tilde{g}_t$ and w_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 $\tilde{g}_t = w_t = 0$, the current deficit is set so as to maintain constancy over time for the planned ratio of the nominal debt to nominal GNP. In the present setting I treat the parameter d_0 as a constant. However, non-constancy of expected inflation could be one element that generates serial correlation of the error term w_t in equation (11). The omission of cyclical effects, which would themselves be autocorrelated, could also generate this serial correlation.

Using the same time series for the temporary-spending ratio $\tilde{g}_t$ as before (with the adaptive coefficient β = .03 per year), the estimates of equation (11) for 1730-1918 are[14]

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[14]For 1730-1913 the results are similar:

$$\underset{(.003)}{.016}\cdot(B_{t-1}/P_t\hat{y}_t) + \underset{(.04)}{.87}\tilde{g}_t, \quad \hat{\phi} = \underset{(.05)}{.80},$$

$$\hat{\sigma} = .0081, \; R^2 = .94, \quad DW = 2.1.$$

$$(13)\quad (B_t - B_{t-1})/P_t\hat{y}_t = \underset{(.003)}{.017}\cdot(B_{t-1}/P_t\hat{y}_t) + \underset{(.02)}{.93}\tilde{g}_t, \qquad \hat{\phi} = \underset{(.05)}{.79},$$[15]

$$\hat{\sigma} = .0084, \quad R^2 = .985, \quad DW = 2.1.$$

The first coefficient--.017, s.e. = .003--should equal the trend growth rate of real GNP[16] plus the average rate of expected inflation. In fact, the average growth rate of real GNP from 1730 to 1913 (or from 1730 to 1918) was 1.8% per year, while the average rate of change of the wholesale price index was 0.1% per year (0.5% per year for 1730 to 1918). Thus, the estimated value of the coefficient on the lagged debt, .017, does approximate the trend growth rate of real GNP plus the average rate of inflation.

The estimated coefficient on $\tilde{g}_t$, .93, s.e. = .02, indicates the fraction of temporary government spending (as measured) that is financed by deficits. Note that the estimated coefficient differs significantly from zero, and is also just significantly below unity. The result indicates that something over 90% of temporary military expenditure is financed by the issue of debt (including amounts monetized by the Bank of England), while the remainder is financed by higher taxes.[17]

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[15] The value $\hat{\phi}$ is significantly less than one according to Fuller's (1976, Table 8.5.2) distribution.

[16] I have not allowed for different coefficients in different sub-periods, although the average growth rate of real GNP from 1730 to 1770 (0.7% per year) is well below that from 1770 to 1918 (2.1% per year).

[17] 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. 387-88, 392-94 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, levied after 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

As an example of the effect of wartime, from 1757 to 1762 the average value of the temporary-spending ratio $\tilde{g}$ was 9.8% (see Table 1). Multiplying by the coefficient .93 in equation (13), the prediction is that the debt-GNP ratio would rise on average by 9.1 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.

Similarly, from 1794 to 1815, the average value of $\tilde{g}$ was 4.0%. Hence, the prediction is that the debt-GNP ratio would rise on average by 3.7 percentage points per year (.040 x .93). The actual figures show an increase from 0.96 to 1.57 for an average increase of 2.8 percentage points per year. (The sharp--and presumably partly unexpected--rise in the price level accounts for some of the discrepancy.)

During peacetime the variable $\tilde{g}_t$ is negative, rather than zero. Hence, rather than predicting a constant ratio of the debt to GNP, equation (13) says that this ratio will fall during peactime. This behavior underlies the tendency for the debt-GNP ratio to decline during years that do not involve major wars, as is apparent from Figure 3. For example, from 1822 to 1913, the average value of the variable $\tilde{g}$ was -1.6%. Therefore, the prediction is that the debt-GNP ratio would fall on average by 1.5 percentage points per year (-.016 x .93). In fact, the ratio fell over this period from 1.85 to 0.30, or by 1.7 percentage points per year. (The level of the nominal debt

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[17] 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.

changed relatively little--from £ 564 million at the beginning of 1822 to £ 643 million at the end of 1913.)

The serial correlation coefficient in equation (13), $\hat{\phi}$ = .79, s.e. = .05, presumably picks up factors such as cyclical fluctuations and persisting variations in expected inflation. Thus far, I have no detailed results on these elements.

Two Episodes of Non-War Budget Deficits

Unlike for the case of wartime, it is typically difficult to isolate temporary fluctuations of peacetime government expenditures. Therefore, in explaining deficits (and interest rates), I have not attempted to include a measure of temporary spending aside from the military component. However, there are two interesting episodes of peacetime deficit finance that are worth exploring.

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 £ 16.7 million in 1835 and £ 4.1 million in 1836.[18] These figures, when divided by the wholesale price index, represented 4.3% and 0.9%, respectively, of trend real GNP. Since these payments were temporary, they should be included nearly one-to-one in the concept of the temporary-spending ratio, $\tilde{g}$, which so far included only military expenditures. With this adjustment the measured value of $\tilde{g}$ rises in 1835 from -.040 to .001, and in 1836 from -.042 to -.034. Using this revision to the $\tilde{g}$ variable, the estimated deficit-GNP ratio for 1835 becomes .032, as compared with the actual value of .039. The previous estimate, based on the

[18] See Mitchell and Deane (1962, p. 399, note e). Some discussion of the events appears in Burn (1937, Chapter II) and Fogel and Engerman (1974).

unrevised concept of $\tilde{g}$, was -.006. For 1836, the revised estimate for the deficit-GNP ratio is -.004, as compared to the actual value of .003.[19] The main point, which stands out for 1835, is that the 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. Notably, in the Ricardian view where budget deficits, per se, do not affect interest rates, the payments to slaveowners in 1835-36 would not be predicted to affect interest rates at all. In contrast, the crowding-out view of deficits predicts a positive effect on interest rates for 1835-36 (and perhaps earlier when the program was discussed and enacted). The actual path of interest rates is 3.76% in 1831, 3.58% in 1832 (when there was discussion of the pending legislation), 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 interest rates. The result is interesting because it is normally difficult or impossible to separate the response of interest rates to budget deficits from the response to the associated government expenditures (which were temporary military spending in most cases). In this "natural experiment," the temporary spending in the form of transfer payments to slaveowners should have no direct effect on interest rates. Therefore, the

[19] The previous estimate for 1836, which was .024, reflected the large positive residual for 1835 (see equation (13)). If the effect of this residual were eliminated, then the previous estimate would have been -.012.

observed movements in interest rates reflect only the impact of budget deficits, which turns out to be nil.

The second episode concerns the debate over income taxes and other levies in 1909 (actually the fiscal year ended March 1910).[20] The dispute over what kind of taxes to enact and at what level 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 substantial deficit of 1.5% of trend GNP in 1909 (as compared to an estimated value of -0.2% from equation (13)). 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 large budget surplus of 2.0% of trend GNP for 1910 (actually the fiscal year ended March 1911).

As with the first episode, this one generates movements in budget deficits that are not compounded by correlated shifts in government purchases, such as for the military. Therefore, the behavior of interest rates in 1909-10 provides information about the effects of budget deficits, per se--although in this case a deficit that was pretty much assured to be balanced by a surplus the next year. The path of 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 interest rates.

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[20] For a discussion, see Mallett (1913, pp. 298-315).

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Table 1
Behavior of Temporary Military Spending

during Major Wars

Period	War	Average Value of $\tilde{g}_t$ (%)*	Peak Value of $\tilde{g}$	ΔR** (percentage points)	ΔP** (%)
1740-48	War of Austrian Succession (and other wars)	4	6 (1748)	0.6	1
1756-63	Seven Years' War (French & Indian War)	10	16 (1761)	1.2	2
1775-83	American Independence	5	9 (1782)	1.9	3
1793-1815	Wars with France (including Napoleonic Wars)	4	7 (1814)	1.6	74
1854-56	Crimean War	2	2 (1855)	0.2	6
1899-1902	Boer War	5	5 (1901)	0.4	4
1914-18	World War 1	38	50 (1916)	1.2	109

* Periods are 1741-48, 1757-62, 1776-82, 1794-1815, 1855, 1900-01, 1914-18.

** Periods are 1739-47, 1755-62, 1775-82, 1792-1814, 1853-55, 1898-1901, 1913-17.

Note: $\tilde{g}$ is the temporary part of real military spending as a ratio to trend real GNP (see text). 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.