The differing effects of pre- and post-1981 federal budget deficits on tax-adjusted real interest rates

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Allen, Stuart D. and Mark Wohar (1996) "The Differing Effects of Pre- and Post- 1981 Federal Budget Deficits on Tax-Adjusted Real Interest Rates," *Applied Economics*, 28(1), 45-53.

Abstract:

This paper employs an estimating equation relating tax-adjusted real interest rates to deficits and other economic variables to examine the differing effects of pre- and post-1981 federal budget deficits on *ex ante and ex post* real tax-adjusted short-term interest rates over the period 1961:1-1992:2. The results for the 1961:1-1992:2 period, taking into account a shift in the linkage between the ratio of alternative measures of the deficit to potential GDP occurring in 1981:1, indicate that the ratio of both the NIPA deficit and the cyclically adjusted deficit to potential GDP have a significant effect on *ex ante* and *ex post* real tax-adjusted interest rates for the post-1981 period, but no significant effect before 1981.

Article:

I. INTRODUCTION

Economists are divided on the theoretical treatment and empirical evidence concerning the impact of federal deficits on interest rates. The non-Ricardian view holds that large deficits and increasing federal debt burden will increase nominal and real interest rates causing crowding out of private sector borrowing and the trade sector, Bailey (1972) and Barro (1974) challenged this point of view and developed the theoretical foundations for the Ricardian equivalence proposition, where rational economic agents view debt as a substitute for tax financing of government expenditures. Under this view, any increase in public sector debt represents an increase in future tax collections from the private sector which induces an increase in current private sector savings so that national savings (the sum of private and public savings) is unchanged. Ricardian equivalence predicts that there will be no relationship between deficits and consumption and changes in the deficit will have no impact on real interest rates (Seater, 1993).

This paper was motivated by the shift in the absolute size of the budget deficit in the early 1980s, the rising burden of the federal debt expressed as a percent of potential GDP, the prospect for this debt measure to continue its rise in the 1990s, and the lack of evidence on the effect of budget deficits on real interest rates during the 1980s. We posit that several policy changes which occurred during the first Reagan administration, including the Economic Recovery and Tax Act of 1981 and increases in government spending, resulted in a structural change in the fiscal process and the linkage between deficits and interest rates. We argue that if one does not take account of this structural shift, empirical tests of the effects of deficits on real interest rates may produce misleading results. The primary objective of this paper is to empirically test for the effect of a fiscal shift on real interest rates. We posit that the increased deficit burden which began in 1981 may have resulted in a structural change in the linkage between budget deficits and real interest rates.[1] When accounting for this structural shift, we find that federal budget deficits (relative to potential GDP) do exert a significant positive effect on real short-term interest rates during the period following 1981:1, but exert no significant effect on real interest rates for the period prior to 1981.

As an initial illustration of the structural change that occurred in 1981, we begin with some observed statistical facts. In 1981 there was an upward shift in the federal deficit, measured by the National Income and Products Account (NIPA) deficit expressed as a percent of potential GDP, and the real interest rate, measured as the tax-

adjusted 3-month Treasury bill rate minus the actual rate of inflation computed using the GDP deflator. This set the 1980s apart from the previous two decades. The N1PA deficit as a percent of potential GDP averaged 0.3, 1.8 and 3.6% in the periods 1961:1-1969:4, 1970:1-1980:4, and 1981:1-1992:2 respectively. The short-term tax-adjusted ex *post* real interest rate averaged 0.4, —1.7 and 2.7% in the same three periods.[2] The real interest rate whether measured on an *ex post* or *ex ante* basis, shifted from negative to positive in 1981:1 and remained above 2% for most of the next five years, The NIPA deficit which had fluctuated between 0.3 and 2.6% of potential GDP between 1976:4 to 1980:4 rose in 1981 and shifted to a range between 2.1 and 5.3% of potential GDP from 1982:1-1992:2. Furthermore, the ratio of the par value of private held gross federal government debt to potential nominal GDP, which had fluctuated between 20.4 and 22.8% from 1975:4-1980:4, increased from 21.0 in 1981:3 to 44.8% in 1992:2.[3] The shift in the federal budget deficit relative to potential GDP and in the *ex post (ex ante)* tax-adjusted real interest rate may suggest that the linkage between budget deficits and real interest rates was much stronger after 1981.

Most empirical work, cited below, has focused on the effect of deficits rather than debt on real interest rates, and has found weak evidence that budget deficits affect short-term interest rates. This paper examines the effect of federal purchases of goods and services, the federal budget deficit and the par value of the privately-held gross debt on short-term *ex ante* and *ex post* tax-adjusted real interest rates, taking into account any change in the linkage between federal deficit spending and real interest rates that occurred in the early 1980s. When this structural shift is accounted for, we find that deficits in the post-1981 period had a significant positive effect on real ex *post* and real *ex ante* tax-adjusted interest rates, For the period prior to 1981, deficits relative to potential GDP are found to have no significant effect on real *ex post* or real ex *ante* tax-adjusted interest rates. In this paper we test for the 1981 shift in fiscal policy and note the importance of this policy shift in examining the effect of federal budget deficits on real interest rates. Taking into account the shift in the federal budget deficit in 1981:1, we find that both current *ex ante* and ex *post* tax-adjusted real interest rates are significant and positively related to the ratio of the NIPA and the cyclically adjusted deficit relative to potential GDP post 1981.

Section II provides a brief literature review. Section III presents the theoretical foundations of the subsequent empirical analysis, while Section IV examines the econometric technique employed to generate inflationary expectations required to calculate an *ex ante* tax-adjusted real rate, Section V presents the empirical results for the sample period 1961A-1992:2. Section VI concludes the paper.

II. PREVIOUS LITERATURE

A large body of literature published during the past decade has examined the behaviour of real interest rates. One set of papers by Mishkin (1981, 1984), Huizinga and Mishkin (1984, 1986) and Bonser—Neal (1990) employ the ex *post* real rate as a proxy for the real *ex ante* rate.[4] In examining *ex post* real interest rates these studies did not consider any effect from deficits and debt nor any shift in fiscal policy.

A second group of papers tests for the effect of deficits on nominal and real interest rates. For example, Evans (1985) employs an IS—LM framework and finds that large deficits were not associated with high nominal or real *ex post* rates during the Civil War, World War 1 or the post-1979 periods.[5] Evans (1987a), using monthly data, finds no evidence that nominal or real interest rates are related to past, current or future deficits between 1908:6 and 1984:3 and Evans (1987b), using quarterly data, finds no significant positive (and sometimes a negative and significant) relation-ship between unanticipated budget deficits and nominal rates in data from six of the G7 countries for 1976-95. In addition, no strong evidence of a positive association between deficits and *ex post* real rates are reported by Dewald (1983), Makin (1983) and Motley (1983), while Kolluri and Giannaros (1987) report a negative and significant relationship in an IS—LM framework between a real *ex ante* rate generated by the Livingston inflation survey and the NIPA deficit for the 1966-83 period.[6] Positive evidence between deficits and real interest rates are reported by Hutchison and Pyle (1984) for pooled data for seven major countries from 1973 to 1982 and for the USA by Zahid (1988) and Cebula (1990a, 1990b).

A third group of papers has investigated the effect of government debt on interest rates. Plosser (1982,1987) tests for the effect of monetized debt, privately held federal debt and government purchases and finds no relationship between the excess return on government bills and bonds for period t to $t + 1$ and actual values of these three variables in his 1982 article and unanticipated values of these three variables in his 1987 article.[7] De Leeuw and Holloway (1985) using annual data find evidence from a reduce-form equation that suggests that the ratio of cyclically adjusted debt to GNP rather than changes in this ratio are positively related to nominal rates.[8] Allen (1990, 1991, 1992) using quarterly data reports a positive association between real ex *post* rates and various measures of the federal debt as a ratio to potential GDP.

THEORETICAL FRAMEWORK

In an effort to ground our findings in a common model and to provide for comparisons with other studies, we employ an estimating equation derived from the traditional IS—LM model where *ex ante* and ex *post* real tax-adjusted short-term interest rates are regressed on the current values of the federal budget deficit, federal government expenditures, high-powered money (monetary base), exports, and one-period lagged values of government debt and high-powered money (all relative to potential GDP).[9] In addition, we include a time trend and intercept and slope shift terms in order that we can examine the differing effects of pre- and post-1981 federal budget deficit on *ex ante* and *ex post* real tax-adjusted interest rates. A theoretical framework, which employs the IS—LM model, augmented by a government budget constraint and wealth effects, and expressed in discrete time, will provide the basis for generating a rational inflationary expectations forecast.[10] Equation 1 is the expression for the real tax-adjusted *ex ante* rate of interest, r; and is derived from a structural model (in an appendix available upon request). All of the right-hand-side variables of Equation 1 are in real terms and are divided by potential real GDP:[11]

$$r_t^e = k_0 + k_1(H_t/P_t) + k_2(H_{t-1}/P_{t-1}) + k_3(B_{t-1})/P_{t-1}) + k_4 G_t + k_5 EX_t + k_6 D_t \qquad (1)$$

An increase in high-powered money will cause the real interest rate to fall in the short run due to the liquidity effect ($k_1 < 0$). An increase in the budget deficit from a tax cut, an increase in transfer payments or an increase in interest expense will cause the tax-adjusted real interest rate to rise ($k_6 > 0$). Any exogenous increase in the export demand, in national income or previous periods wealth (which increases the demand for real money balances) will cause the real interest rate to rise ($k_5, k_3 > 0$).[12] Equation 1 embodies the effect on tax-adjusted ex *ante* real interest rates of both the stock of federal debt in period t - 1 as well as the Row of federal debt, as measured by the deficit variable at time t,D_t.[13] This equation is next modified to account for the stochastic properties of the regressors and is then estimated by instrumental variables as discussed in Section V. At this point we make a digression to explain how we computed the *ex ante* tax-adjusted real interest rate employed in this study.

IV. THE *EX ANTE* REAL INTEREST RATE

The *ex ante* tax-adjusted real rate of interest is defined as

$$r_{t,j}^e = [i_{t,j}(1 - \tau)] - \pi_{t,t+j}^e \qquad (2)$$

where $r_{t,j}^e$ is the expectation formed at time t of the real tax-adjusted return with j months to maturity, $i_{t,j}$ is the nominal return on an asset with j months to maturity, τ is the marginal tax rate, and $\pi_{t,t+j}^e$ is a forecast of the annualized rate of inflation formed in period r that is expected to prevail over the next j months.[14] Although previous studies have employed both the GDP deflator and the seasonally-adjusted consumer price index-urban (CPI) to construct the *ex ante* interest rate, $r_{t,j}^e$, we will focus on the results for the GDP price deflator. We choose the GDP price deflator because it is a broader price index and exhibits less variability than the CPI.[15] Furthermore, the CPI contains the prices of imported goods and thus has been more sensitive to supply shocks (say to the price of inputs) than has the GDP price deflator.[16] Our measure of $i_{t,j}$ is the annualized, continuously compounded, average yield of 13-week Treasury bills for the end-of-quarter month which is centred on the 15th of the month.[17] Employment of the GDP deflator measures the price index over the quarter in question for

period *t* so the initial value of the GDP deflator can be considered to be *centred* on the middle of the second month of the quarter and 30 days prior to the conservation of if . $i^*_{t,j}$.[18]

A number of alternative approaches have been suggested to obtain an estimate of the *ex ante* real interest rate from observable variables. One approach is to employ survey data as a measure of inflationary expectations. A second approach (e.g. Mishkin, 1981, 1984 and Huizinga and Mishkin (1984, 1986)] employs the *ex post* real rate as a proxy for the *ex ante* rate of interest on the basis that information can be inferred about the relationship between the *ex ante* real rate and the variables in the model by an *ex post* real rate regression.[19] A third approach is to assume rational formation of inflationary expectations in which the expected inflation rate can be expressed as a linear projection onto an observable information set. We employ this third approach and forecast the inflation rate in period $t + 1$ based on the information set available in period *t.* The regressors are a constant, a one-to four-period lag of the inflation rate, a one- and two-period lag of the NIPA deficit, the growth of M_1, and the growth of real GDP, and a one-period lag of a supply shock variable (the ratio of import prices to the GDP deflator), the GDP gap, and the percent-age change in the trade-weighted dollar exchange rate.[20]

One necessary condition for rationality requires that the inflationary expectation series be an unbiased predictor of actual inflation. This requires that the residuals, e_t, from a regression of actual inflation regressed on expected inflation are not serially correlated and that $\alpha_0 = 0$ and $\alpha_1 = 1$ as a joint hypothesis test in Equation 3

$$\pi_t = \alpha_0 + \alpha_1 \pi_t^e + e_t \qquad (3)$$

where π_t is the annualized quarterly rate of inflation of the GDP price deflator, and π_t^e is the respective generated rate of inflationary expectations. The null hypothesis that $\alpha_0 = 0$ and $\alpha_1 = 1$ was never rejected for a joint hypothesis test at the 5% level of significance. We also could not reject white noise residuals when e_t was regressed against a constant and a one-to four-period lag of e_t.

A second necessary condition for rationality requires that the forecast errors of

$$E(\pi_t - \pi_t^e | \phi_{t-1}) = 0 \qquad (4)$$

be uncorrelated with the variables in the information set, ϕ, at time t — 1. For the GDP price deflator, the forecast errors were regressed against a constant and all of the right-hand-side variables, lagged one period, for the period 1961:1-1992:2. No single regressor was significant at the 5% level for a two-tailed test. Thus, the π_t^e series passes tests of unbiasedness and rationality. We use the forecast of inflation to construct an ex *ante* tax-adjusted real interest rate using the GDP deflator.

V. EMPIRICAL RESULTS

Prior to conducting our regression analysis it is necessary to determine whether the series used in the regressions are integrated variables. If any of the series possess unit roots then the spurious regression problems will result (Newbold and Davies, 1978). In this regard, we use the method for testing for unit roots with structural breaks proposed by Perron (1989) in conjunction with the traditional augmented Dickey—Fuller (1979, 1981) (ADF) tests for unit roots. The results of these ADF tests indicate that the real monetary base, real federal government expenditures and real exports are found to be integrated of order one, *I*(1), and thus must be first differenced to make these series stationary. The deficit measured on a national income and products account basis *(NIPADEF)* and the cyclically adjusted deficit *(CYCLDEF)* are found to be stationary about a time trend. However, the real debt variable must be first differenced to induce trend stationarity.[21]

Perron (1989), Christiano (1992), and Zivot and Andrews (1992) however, warn against drawing conclusions from Dickey—Fuller tests alone since unit root behaviour mimics the behaviour of a series that contains a structural break. Based on our supposition that there is a fiscal structural change in the linkage between real interest rates and deficits which began in 1981:1, as well as the evidence concerning the level shift in real interest rates presented earlier, we test for a structural break in 1981:1 for all of the series. We apply Perron's test allowing for a structural break. Perron's methodology requires detrending the original series, allowing for a structural break through an intercept (level) shift, and then testing for unit root behaviour. All variables were subjected to this test. The only variables whose behaviour exhibited stationarity around a trend with a level shift

were the real *ex post* and real *ex ante* interest rates. Based on this evidence, and combined with the fact that the deficit relative to GDP has increased since 1981, we augment Equation 1 with a time trend, a level shift dummy variable (D811) that equals one in 1981:1 and after, and an interactive deficit variable (D811D) equal to D811 multiplied by the deficit variable (D).[22]

Following Evans (1987a) and others, Equation 1 is estimated with all right-hand-side variables measured relative to potential real GDP when the variable is in real terms, and relative to potential nominal GDP for the deficit, the debt, and the monetary base variables which are measured in nominal terms.[23]

Results for the *ex ante* and the *ex post* rates are presented in Table 1. We employ the actual and forecasted rate of inflation (using the GDP deflator) to construct the tax-adjusted *ex post* and *ex ante* real interest rates respectively. All regressions were estimates by two-stage least squares using an adjustment to account for an AR(1) process in the error structure. With the inclusion of endogenous right-hand side variables, the use of instrumental variables is required. The endogenous variables are high-powered money and the deficit, while exports, federal purchases, lagged high-powered money and the lagged debt are exogenous, The instrumental variables employed are a constant, one- and two-period lagged values of high-powered money, debt and the deficit, as well as the one-period lag of the dependent variable, current values of real exports and real federal government purchases, a time trend and the D811D interactive deficit variable to allow for a shift in the effect of deficits on real interest rates after 1981. For comparison purposes, all regressions will contain a time trend and will be adjusted for first-order serial correlation, regard-less of the statistical significance of the autoregressive parameter or time trend.

Table 1. *Dependent variable = level of interest rate; right-hand-side variables are first differenced except for the deficit variable*

	Real tax-adjusted interest rates											
	Constant	$D(H/P)_t$	$D(H/P)_{t-1}$	$D(B/P)_{t-1}$	$D(G)_t$	$D(EX)_t$	D_t	T	$D811D_t$	DW	R^2/SE	ρ
1961:1–1992:2: 2SLS												
Ex post rates												
(1a) *NIPADEF*	2.11	−27.45	−11.26	0.18	−0.35	0.21	−0.31	−0.03	2.15	2.01	0.40	0.28
	(1.48)	(−1.89)	(−2.34)	(0.51)	(−0.34)	(0.27)	(−0.79)	(−2.15)	(5.12)		1.92	(2.73)
(1b) *CYCLDEF*	−1.58	−7.78	−7.93	0.22	0.10	−0.53	−1.10	−0.01	2.20	2.07	0.44	0.43
	(−0.86)	(−0.49)	(1.31)	(0.71)	(0.69)	(−0.75)	(−1.78)	(0.68)	(2.92)		1.86	(4.43)
Ex ante rates												
(2a) *NIPADEF*	1.93	−11.62	−6.99	−0.04	−0.41	0.25	−0.33	−0.03	1.73	2.05	0.64	0.33
	(2.00)	(−1.49)	(−2.23)	(−0.16)	(−0.60)	(0.50)	(−1.19)	(−2.48)	(7.33)		1.24	(2.48)
(2b) *CYCLDEF*	−0.51	8.90	1.76	−0.07	0.55	−0.15	−1.52	0.01	1.44	2.06	0.60	0.66
	(−0.24)	(1.02)	(0.39)	(−0.36)	(0.53)	(0.29)	(−1.65)	(0.48)	(2.26)		1.31	(8.47)

Notes: All variables are in real terms and have been divided by potential real GDP. The GDP deflator measure is used in the computation of the real tax-adjusted rate. *T*-statistics are in parentheses and R^2 is adjusted. *D*811 = 0 before 1981:1 and 1 thereafter. *D*811*D* = *D*811 multiplied by the deficit variable, D_t.
NIPADEF = national income and products account deficit.
CYCLDEF = cyclically adjusted budget deficit.

Table 1 reports the empirical results. The regression results of Table 1 were obtained employing the level of the real interest rate regressed on a time trend, first differences of all right-hand-side variables, except the deficit variable, and an interactive deficit variable to account for a regime shift after 1981. This is an appropriate procedure based on the previous results of the unit root tests in which all variables were found to be first-differenced stationary with the exception of real interest rates (which was stationary around a trend with a level shift), and the NIPA deficit and cyclically adjusted deficit which were trend stationary. The estimated equations in Table I allow for the linkage between deficits and real interest rates to differ between pre- and post-1981, Allowing for a regime shift in 1981:1 for the deficit variable, we find that the time trend is significant in both the *ex post* and *ex ante* real interest rate equations, accounting for the trend in real interest rates as well as the deterministic trend that exists in the *N1PA* and the cyclically adjusted deficit variables. Furthermore, the coefficient associated with the interactive deficit variable (NITA deficit) is significant in Equation la of Table 1

for ex *post* real rates and for *ex ante* real rates in Equation 2a of Table 1, while the deficit variable has no effect on either real *ex post* or real *ex ante* interest rates.

The effect of the NIPA deficit *(D)* on both real *ex post* and *ex ante* real interest rates (reflecting the effect on real interest rates pre-1981) is insignificant, while the D811D interactive variable (reflecting the effect of deficits of real interest rates Post-1981) has a positive and significant coefficient.[24] The NIPA deficit relative to potential GDP has a positive and significant effect on both real *ex post* and *ex ante* interest rates after 1981:1, which is confirmed by the positive and significant coefficient for D811D, but has no significant effect on real rates pre-1981:1.[25] The results when the cyclically adjusted deficit is substituted for the NIPA deficit are reported in Equations lb for *ex post* rates and 2b for *ex ante* rates, The time trend is insignificant when the cyclically adjusted deficit is substituted for the NIPA deficit. The cyclically adjusted deficit coefficient interactive variable is also positive and significant supporting the results for the NIPA deficit.[26] In addition, the government expenditure coefficient is insignificant on a consistent basis for both the real *ex post* and real *ex ante* interest rate.[27] Results obtained for Table 1 in which the breakpoint is 1979:4 were also conducted. The results are quite similar, with the interactive deficit variable remaining significant. However, the standard error of the coefficient as well as the standard error of the regression are slightly larger than when 1981:1 is used as the breakpoint.

Finally, a few final comments are worth noting. The debt—GDP variable lagged one period is never significant in any version of the estimated equations. An increase in the deficit—GDP variable represents a tax cut as government expenditures and debt are held constant.[28] If we consider Equations la and 2a as preferred equations, the coefficient associated with the NIPA deficit suggests that, for the post-1981 period, a 1 percentage point decline in the ratio of the NIPA deficit to potential GDP (financed by an increase in taxes) will result, *ceteris paribus,* in a 2.15 percentage point decline in *ex post* tax-adjusted real interest rate and a 1.73 percentage point decline in *ex ante* tax-adjusted real interest rates.[29] Given the 1993 deficit reduction package of the Clinton administration and the large decline in interest rates during 1993, these estimates, although somewhat large, do not seem completely economically unreasonable.

It has been argued that the tax system is not neutral to changes in income tax rates (i.e. an increase in the marginal tax rate raises the nominal interest rate insufficiently for the real rate of interest to fall). To test this we also included the marginal tax rate as an explanatory variable in our regressions. The coefficient on the marginal tax rate when added to the regressions in Table 1 was negative and significant in the *ex post* real interest rate regressions but was insignificant for *ex ante* real interest rates. The statistical significance of the deficit variable and the expenditure variable were unchanged.

VI. CONCLUSION

This paper investigates the effect of federal government deficits and government debt on *ex ante* and *ex post* real tax-adjusted short-term interest rates by estimating a reduced-form equation that is derived from an IS—LM model that provides a basis for a rational forecast of the expected rate of inflation. When a shift in the linkage between deficits to potential GDP in 1981:1 is taken into account in examining the period 1961:1-1992:2 we find that both current *ex ante* and the *ex post* tax adjusted real interest rates are positively related to the ratio of the NIPA deficit to potential GDP (and cyclically adjusted deficits to potential GDP) and that government debt lagged one period has no significant effect on real interest rates. These results suggest that the ratio of NIPA deficit to potential GDP, which has seen an almost uninterrupted rise since 1981, and the level shift in real tax-adjusted *ex post* and *ex ante* interest rates that occurred after 1981, has strengthened the positive linkage between deficits and real interest rates which we confirm for the period 1981:1-1992:2. For the period prior to 1981, deficits relative to potential GDP are found to have no significant effect on ex *post* or *ex ante* real interest rates. For the period 1981-92, the results suggest that a 1 percentage point decline in the ratio of the NIPA deficit to potential GDP (financed by an increase in taxes) will result, *ceteris paribus,* in a 2.15 percentage point decline in *ex post* tax-adjusted real interest rates and a 1.73 percentage point decline in *ex ante* tax-adjusted real interest rates.

Notes:

[1] Support for such a structural change in fiscal policy is provided by the findings of Tanner and Liu (1994) who examine the intertemporal government budget constraint and find a shift in the fiscal process in 1981:4.

[2] The average *ex ante* rates for the three periods (0.2, — 1.3 and 2.5) are very similar to the *ex post* rates.

[3] The total gross government debt which had fallen from 53.1 in 1961:1 to a trough of 31.3% in 1974:4 fluctuated between 31 and 34% until its second trough of 31.3 in 1981:3, and then rose to 68% by 1992:2.

[4] These papers use various measures of the inflation rate to generate different inflationary expectation series in order to construct *ex* post real rates from a three-month continuously compounded Treasury bill rate that is regressed against a set of explanatory variables. See also Mills and Stephenson (1987) who use this technique to examine real rates in the United Kingdom.

[5] He concludes that 'the post-war period separately offer no support for a positive association between deficits and interest rates.' Yet, Evans uses 2SLS to regress a real one-month Treasury bill rate for October 1979 to December 1983 against the current and two lags of three variables measured as a ratio to trend national real income; real federal spending, real stock of money and real deficits, and finds a positive and significant coefficient for the current deficit. The current deficit coefficient is negative and significant when the lagged variables are omitted from the equation.

[6] For evidence of a positive linkage between nominal rates and (1) deficits, see Barth *et al.* and Russek (1984,1985); Tanzi (1985) and Cebula (1990a, 1991b); (2) structural deficits, see Cebula (1988b); (3) cyclically adjusted federal deficits, see Laumas (1989); (4) deficits (long-term rates or the spread between short and long rates), see Barth *et al,* and Hoelscher (1986), Cebula (1988,1990b, 1990c, 1991a), Cebula *et al,* (1988,1992), (5) unanticipated deficits and the spread between short and long rates see Kim and Lombra (1989) Goff (1990) and Kim and Lombra (1989); (6) unanticipated deficits and three-month Treasury bill rates, see Makin and Tanzi (1984); (7) anticipated deficits and interest rates, see Thomas and Abderrezak (1988a, 1988b); (8) excess government deficits and long rates, see Tran and Sawhney (1988); (9) deficit announcements and interest rates, see Wachtel and Young (1987). Studies which have found empirical evidence indicating that budget deficits have no significant effect on interest rates include, Hoelscher (1983), Mascaro and Meltzer (1983), McMillin (1986), Giannaros and Kolluri (1989), Darrat (1989,1990) and Findlay (1990). A review of this literature appears in Congressional Budget Office (1984), US Treasury Department (1984) and in Barth *et al.* (1991).

[7] Plosser (1987) concludes that (p. 366) 'debts shocks appear to significantly lower real rates in the period 1968-76 but to raise them in the latter period [1977:1-1985:2, albeit not with a high degree of significance. In both cases the quantitative effect is quite small and inconsistent with the view that large increases in debt are responsible for the rise of real interest rates in the 1980s.'

[8] See also Holloway (1988).

[9] Much of the data employed in this paper were obtained from the Citibase data tape. The par value of the privately-held gross federal debt is employed as the debt variable (divided by potential nominal GNP) and is from Cox and Hirschhorn (1983). The data has been updated by Cox through 1988 and by the authors to 1992:2.

[10] Other studies have also used a similar IS—LM framework to examine the effects of deficits on interest rates. For example, see Barth *et al.,* (1985), Holloway (1988) and Evans (1985,1987a), and Allen (1992). A more elaborate model including an aggregate supply curve to determine the equilibrium rate of inflation could also be used, however, given the focused objective of this paper, the more parsimonious model will suffice. For a recent study that employs a loanable funds framework in an effort to determine the effects of different economic linkages impacting on interest rates; see Sosin and Zahn (1995).

[11] The equation resulting from this structural model is of course observationally equivalent to alternative structural specifications. Alternative combinations of assumptions regarding (1) the formation of expectations, (2) behavioural equations, and (3) lags in adjustment can lead to observationally equivalent systems. This equation relates past values of real federal debt and real monetary base (adjusted for potential GDP) and contemporaneous values of other economic variables (also adjusted for potential GDP) to real interest rates. This is not a reduced form equation if contemporaneous values of high powered money and the deficit variable are endogenous variables. In the spirit of previous empirical work in this area, our subsequent empirical estimation employs various definitions of budget deficits, Furthermore, even if interest rates depend on expected future debt (deficits) rather than current and past debt (deficits), as some have argued, a regression of

interest rates on current and lagged values can, nevertheless, capture the structural linkages between debt (deficits) and interest rates *to the extent* that changes in future expected debt (deficits) are reflected in the stochastic process which generated current and past debt (deficits). Of course, if the process changes, then current and lagged debt (deficits) will not necessarily be a good predictor of future debt (deficits).

[12] This paper does not attempt to test Ricardian equivalence. Under Ricardian equivalence lump-sum taxes and government debt are equivalent methods of financing a given level of government expenditures (Seater, 1993). Rose and Hakes (1995) show that while the finding that deficits do not significantly affect real interest rates is an implication of, and consistent with, Ricardian equivalence, such evidence is only a necessary but not sufficient condition for Ricardian equivalence.

[13] There has been some debate over the view that the *stock* of federal debt is more important for the level of interest rates than the flow of debt within the confines of a conventional Keynesian model. See Brunner (1984) on this point.

[14] The tax rate is the annual measure of the average marginal federal tax rate on adjusted gross individual income centred on the third quarter and interpolated for the other quarters. The data prior to 1981 are from Seater (1985, Table 1). For the period 1981-92 the data are computed by the authors using Seater's methodology.

[15] The means for the inflation rate measured by the GDP deflator and the CPI are nearly identical within each period — 5.42 and 5.54 respectively, for the 1961:1-1980:4 period and 4.31 and 4,33, respectively, for the 1981:1 - 1992:2 period. The standard deviation of the CPI inflation rate is approximately one-third higher than the GDP deflator in each period - 3.02 versus 4.05 in the 1961:1-1992:2 period and 1.90 versus 2.58 in the 1981:1-1992:2 period).

[16] Blinder (1980) and Fischer (1981) discuss biases involved in using the CPI to measure the rate of inflation. Alternative measures of inflation have been employed in previous research. Huizinga and Mishkin (1984) have examined *ex post* real interest rates using the CPI, the personal consumption expenditure deflator and the PPI. Clarida and Friedman (1984) use the GNP price deflator. Mills and Stephenson (1987) argue that the wholesale price index is a better measure of inflation for the United Kingdom,

[17] The real interest rate had three distinct periods roughly corresponding to the three decades. The real *ex post* tax-adjusted interest rate was below 1.00 in every quarter between 1970:1-1980:4 except in three quarters for the GDP deflator rate and five quarters for the CPI rate. Following 1980:4, the *ex post* and the ex *ante* real tax-adjusted rate for the GDP deflator was positive in every quarter between 1981:1 and 1992:2 except for 1987:2 for the *ex ante* rate. The mean (standard deviation) of the real ex *post* rate for the GDP deflator and the CPI are 0.40 {1.26) and 0.77 (1.41) for 1961:1-1969:4; —1.68 (2.09) and —2.20 (2.50) for 1970;1-1980:4 and 2.68 (1.46) and 2.65 (2.39) for 1981:1-1992:2. The mean (standard deviation) of the real *ex awe* rate for the GDP deflator and the CPI are 0,21 (0.58) and 0.44 (1,17) for 1961:1-1969:4; —1.32 {1.58) and —1.86 (1.73) for 1970:1-1980:4; and 2.53 (1.31) and 2.48 (1.70) for 1981:1-1992:2.

[18] If the CPI had been used, then the use of the end-of-quarter month interest rates corresponding to 3-month Treasury bills will match the inflation rate measured as the annualized quarterly rate of growth of the CPI measured from the last month of the quarter (surveyed in mid-month) to the value of the CPI three months forward. This method of matching the periods over which inflation and nominal interest rates are measured has been employed by Litterman and Weiss (1985), Bonser-Neal (1990) and Diba and Oh (1991).

[19] Bonser-Neal (1990) employs this approach to generate an *ex ante* real interest rate from the predicted values of a regression of the *ex post* real interest rate on the nominal interest rate, lags of actual inflation rates, growth rates of money supply and industrial production, and changes in the import price index.

[20] The inflation rate was estimated for the 1960:1-1992:2 period. The adjusted R^2 was. 0.73 for the GDP deflator and 0,72 for the CPI.

[21] Given that the deficit is the flow measure of the debt, a trend stationary deficit 'is consistent with a trend stationary first-differenced debt variable.

[22] We also examined other dates in the neighbourhood of 1981:1 and selected 1981:1 as the unique break point based on the fact that this was the break point which minimized the standard error of the regression. Details of 11 unit root tests are not reported to conserve space, however, and are available from the authors upon request.

[23] *Potential* nominal GDP is the GDP price deflator multiplied by the potential real GDP series (see Gordon 0993, Appendix A)). We have scaled by potential nominal GDP on the assumption that the US economy has the

property of homogeneity; that is, doubling real high-powered money, real federal government purchases, real federal debt, real exports, and the size of the economy, leaves real interest rates unchanged.

[24] Substituting the CPI for the GDP deflator to compute *ex-ante* and *ex-post* tax-adjusted real interest rates does not yield different conclusions regarding the significance of the deficit shift variable (D811 *D)* if any of the results reported in Table 1.

[25] The intercept dummy variable was insignificantly different from zero in these regressions as well as those in Table 1 and were thus suppressed.

[26] All equations were also estimated with the deficit variable measured as the primary deficit (i.e. the deficit less interest payments). Allowing again for a structural change in this variable, we find the primary deficit to potential GDP is significant for the post-1981 period when substituted in Equation la at the 5% level, and significant at the 10% level in Equation lb. The NIPA deficit, the cyclically adjusted deficit and the primary deficit figures were provided by the Congressional Budget Office.

[27] All variables are expressed as percentage points of potential GDP. For example, the average value of the NIPA deficit relative to potential GDP is 1.1 % for period 1961:1-1980:4 and 3.646/0 for the period 1981:1-1992:2.

[28] Since the estimation of Equation 1 includes current monetary base, but excludes 'current debt, interest payments, and transfer payments, the coefficient k_4 associated with *G* in Equation 1 represents the effect of a tax-financed increase in current government spending on real tax-adjusted interest rates. However, it should be pointed out that the coefficient k_6 associated with an increase in deficits in this equation (which was derived from a particular structural model in an appendix available upon request) commingles two effects. Since government expenditures are controlled for, an increase in *I)* represents a decrease in taxes which in turn increases consumption expenditures and in turn increases interest rates. In addition, an increase in D also represents as increase in wealth due to the bond financing aspect. This also increases wealth which increases interest rates. The present model is not able to decompose these two effects.

[29] We choose these equations as the preferred equations to make a policy statement, as the constant term of these regressions are in line with the average of real interest rates over the period in question, lending even stronger support towards the economic validity and reliability of these equations.

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