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The Real Interest Rate/ Budget Deficit Link: International Evidence, 1973-82

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There is a widespread belief that current and expected federal government credit demands are keeping U.S. real interest rates stubbornly high and may slow the speed and limit the duration of the economic recovery. To shed light on this debate, this study investigates the link between budget deficits and real interest rates by "pooling" annual time series data for the last decade across the seven major industrial countries. The results suggest that short-term real interest rates are systematically and positively associated with central government budget deficits across countries and across time.

There is a widespread belief that current and expected federal government credit demands are keeping U.S. interest rates stubbornly high and may slow the speed and limit the duration of the economic recovery as it matures. This conventional wisdom is generally supported by a body of macroeconomic theory that posits a strong positive causal link between government budget deficits (or outstanding government debt) and real interest rates.

Nevertheless, there are theoretical challenges to this proposition, and empirical support for it is sketchy and largely based on *indirect* evidence derived from simulations of large scale econometric models.[1] Little empirical evidence of a *direct* link running from budget deficits to interest rates has been found.[2] In fact, the conclusion of a recent study by the U.S. Treasury (1984) was that "...high deficits have had virtually no relationship with high interest rates..." during the past two decades.[3] Other recent studies of the U.S. experience (for example, Evans, 1983, Motley, 1983, and Hoelscher, 1983) also have failed to find a significant positive link between U.S. budget deficits and interest rates.

Although considerable research has investigated real interest rate behavior and the relation between real rates and budget deficits, very little of this research has focused on countries outside the U.S. Extending the analysis to other countries could be useful in several ways. For example, it could provide information about the robustness of the result found for the U.S. Also, by extending the analysis, one can conduct joint tests for several countries at once. This could result in more powerful statistical tests of the deficit-interest rate link because more data, that exhibit greater variation, can be exploited.

The latter consideration motivates the strategy of this paper. We pool annual time series data across the seven major industrial countries (the U.S., the U.K., France, Japan, Italy, Canada and Germany) to investigate whether budget deficits are significantly positively associated with real interest rates. Pooling observations increases the variability of the data, both over time and across countries, because of the diversity of experience with real interest rates and budget deficits in the seven countries of the sample.

Using our pooled data sample, we regress short-term real interest rates on budget deficits, holding constant money growth and a cyclical measure of

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economic activity. The results of our empirical work suggest that short-term real interest rates *are* systematically and positively associated with central government budget deficits across countries and across time. To test the robustness of our surprisingly strong result, we test for the budget deficit/real interest rate association in a variety of ways. The basic result does not appear particularly sensitive to the choice of government deficit measure or money growth proxy. However, the budget deficit/real interest rate linkage is weakened somewhat when the cyclical measure (a standardized unemployment rate) is included as an explanatory variable.

On balance, this research provides empirical support for the hypothesized positive linkage between government budget deficits and real interest rates. This evidence is consistent with the view that budget deficits lead to high real rates of interest. To the best of our knowledge, this is the first international evidence supporting the hypothesis.

The next section provides an outline of the methodology we use to analyze the data. Section II follows with a description of the data and the empirical results from estimating the basic model. Section III extends the basic model and presents estimates of various equations designed to test the robustness of the deficit-interest rate relationship found in the preceding section. The paper concludes with a brief summary and some tentative policy implications.

I. Methodology

The purpose of the research reported here is to test the hypothesis that high short-term real interest rates (r) are positively associated with high budget deficits (B), after controlling for other systematic influences on the real rate (Z):

$$r = f(B, Z, \mu) \qquad (1)$$

The vector of other systematic variables, Z, should include all variables that are correlated with short-term real interest rates. We limit Z, however, to a money growth variable (M), a cyclical variable —the standardized unemployment rate (U), and country-specific dummy variables (D).

In searching for the relevant systematic variables to include in Z, we think of real interest rates as influenced by the demand and supply of credit in the economy. As money growth represents a net addition to the supply of credit, it should be negatively associated with short-term real rates. The net cyclical private demand for credit, in contrast, will vary with the fluctuations in business activity—roughly proxied by the unemployment rate variable. The higher the level of economic activity (the lower the rate of umployment), the greater is the private demand for credit. However, higher business activity and income are also generally associated with greater saving—increasing the net supply of credit. The net effect of the cyclical variable on the short-term real interest rate depends on which factor dominates: the increase in private credit demand or private credit supply associated with expanding economic activity.

Thus, although we do not develop a complete structural model of real interest rate determination, our formulation of Equation (1) is consistent with both the familiar IS-LM framework and a simple loanable funds flow model of the bond and money markets.[4] This body of macroeconomic theory predicts a positive relation between budget deficits and short-term real rates and a negative relation between money growth and short-term real rates. The expected sign of unemployment is ambiguous, although most models generally predict a negative correlation with real interest rates.

The dummy variable for each country in the sample is introduced to take into account some of the institutional and structural diversity, such as tax rates, non-homogeneous inflation measures, and political instability among the industrial countries. These differences might explain persistent international discrepancies in real interest rates (beyond those associated with money growth, government budget deficits and cyclical variables). Taking note of them is important because pooling data has the major disadvantage of constraining the estimated coefficients in a model to be equal across countries. Introducing dummy variables is an attempt to capture significant structural differences among countries in the level of real interest rates. It does not capture differences in their cyclical behavior. Nevertheless, it allows us to pool the sample and to use a greater degree of diversity in real interest rates and budget deficits than would otherwise be the case.

The real interest equation that we have estimated is:

$$r_{ti} = b_0 + b_1 B_{ti} + b_2 M_{ti} + b_3 U_{ti} + \sum_{i=1}^{6} b_{3+i} D_{ti} + \mu_{ti} \qquad (2)$$

where r_{ti} = short-term real interest rate at time t in country i

B_{ti} = government budget deficit (percent of GNP) at time t in country i

M_{ti} = money growth rate at time t in country i

U_{ti} = unemployment rate at time t in country i

D_{ti} = 1 for country i for all t, 0 otherwise

μ_{ti} = random error term

The estimation of Equation (2) using pooled data implies that the variation over time and across countries in short-term real interest rates is not purely random but is due to structural (D), cyclical (U), and policy-determined (B and M) differences across countries. In general, estimation on a country by country basis does not provide enough variation in the budget deficits to produce powerful tests of their effect on interest rates. For example, there are only three years between 1973-82 in which U.S. budget deficits were over 2.5 percent of GNP. Pooling data over the seven countries provides numerous observations with deficits of this magnitude or greater.

To obtain the added statistical power for discerning the effects of deficits, we constrain the policy and cyclical variables to have comparable effects across countries and ask, controlling for other variables, does a higher deficit generally imply a higher real interest rate for each country? Our interpretation of OLS (Ordinary Least Squares) estimates of the coefficient b_1 in Equation (2) is that it reflects the correlation of short-term real rates with budget deficits, holding other relevant variables constant.

II. Empirical Results

The data used in our analysis are annual observations for the seven major industrial countries during the 1973-82 period. Only the recent decade was chosen because it represents a significant departure from the economic environment prevailing during the greater part of the 1950s and 1960s. Specifically, the breakdown of the Bretton Woods System of fixed exchange rate parities, disruptive oil supply shocks, rapid inflation and, in many countries, the largest peacetime government deficits ever experienced, distinguish the last decade from the two preceding. We believe therefore that the relation between budget deficits and real interest rates found in the most recent data are likely to have the most current policy relevance.

Annual data are used because they are less likely to be distorted by the transitory shocks that dominate short-term changes in some variables, particularly real interest rates. Annual data also appear preferable because the timing between actual government deficits and Treasury financing may not correspond very closely during shorter periods. Financial markets may adjust to new government debt issues with some lag before reaching a new equilibrium situation. We hope to avoid problems of this nature by using annual data.

The ex-post real short-term interest rate is the dependent variable in the regressions. Annual ex-

Table 1

Real Interest Rate Equations: Pooled Regression for Seven Major Industrial Countries, 1973-1982 Annual Observations

	(1)	(2)	(3)
Constant	.007	.031	.014
	(0.73)	(2.83)	(1.22)
Central Government Budget Deficit	.010	.008	.004
	(4.72)	(4.09)	(1.85)
Nominal Money Growth		−.003	−.003
		(−3.81)	(4.11)
Unemployment Rate			.007
			(3.15)
Dummy Variables:			
U.K.	−.052	−.039	−.061
	(−3.94)	(−3.16)	(−4.50)
France	−.016	−.005	−.022
	(−1.17)	(−0.42)	(−1.74)
Japan	−.059	−.044	−.023
	(−4.06)	(−3.22)	(−1.56)
Canada	−.031	−.032	−.057
	(−2.31)	(−2.59)	(−4.08)
Italy	−1.04	−.063	−.065
	(−5.69)	(−3.19)	(−3.55)
U.S.	−0.03	−.034	−.057
	(−2.48)	(−2.85)	(−4.27)
R^2	.39	.51	.58
Observations	70	70	70
Standard Error	.029	.027	.025

Notes: t-statistics in parenthesis; OLS regressions

post real interest rates were calculated from quarterly average rates (compounded annually) which, in turn, were calculated by subtracting the actual CPI inflation rate over a quarter from the nominal interest rate for that quarter. Short-term interest rates were employed in all countries to obtain a consistent and internationally comparable series of market-determined interest rates.[5]

Our empirical analysis focuses on the influence of central government budget deficit on real interest rates. However, general government budget deficits (combining central and local governments) are employed in several instances to test the robustness of the empirical results to the deficit measure choice. Deficits are measured as a percent of GNP to standardize the figures for international comparison. (The central government budget deficit/gross savings ratio is also employed in several regressions.) Complete data definitions are given in the data appendix.

The results from estimating Equation (2) are presented in Table 1. This table also presents results from several formulations of the basic equation to provide some insight into the stability of the estimated coefficients generally and, in particular, the stability of the budget deficit coefficient.

Coefficient estimates in the various formulations of the model given in Columns (1)-(3) are, without exception, statistically significant with the theoretically predicted signs. The nominal money growth coefficient is not affected by the inclusion of the cyclical variable, unemployment. The budget deficit coefficient is larger, however, when unemployment is excluded from the model. The unemploy-

Table 2

Real Interest Rate Equations:
Real Money Growth and Cyclical Money Growth;
Pooled Sample: 1973-1982 Annual Observations

	Real Money Growth Included		Cyclical Money Growth Included	
Constant	.077	−.009	.005	−.013
	(0.69)	(−0.85)	(0.45)	(−1.22)
Central Government Deficit	.010	.006	.011	.006
	(4.62)	(2.43)	(4.89)	(2.54)
Real Money Growth	.0002	.0001		
	(0.30)	(0.01)		
Cyclical Money Growth			−.001	−.001
			(−1.73)	(−2.06)
Unemployment		.007		.007
		(2.72)		(2.99)
Dummy Variables:				
U.K.	−.051	−.073	−.052	−.074
	(−3.72)	(−4.75)	(−3.94)	(−5.13)
France	−.016	−.032	−.013	−.030
	(−1.14)	(−2.26)	(−0.95)	(−2.17)
Japan	−.059	−.038	−.062	−.039
	(−4.00)	(−2.37)	(−4.27)	(−2.56)
Canada	−.029	−.055	−.031	−.057
	(−2.11)	(−3.38)	(−2.32)	(−3.74)
Italy	−.103	−.106	−.105	−.107
	(−5.57)	(−6.01)	(−5.83)	(−6.37)
U.S.	−.032	−.055	−.031	−.054
	(−2.32)	(−3.52)	(−2.36)	(−3.73)
R^2	.39	.45	.42	.49
Observations	70	70	70	70
Standard Error	.029	.028	.029	.027

Notes: t-statistics in parenthesis; OLS regressions

ment coefficient is statistically significant and positive. This suggests that a cyclical downturn (proxied by an increase in the unemployment rate and given *unchanged* budget deficits and money growth rates) is associated, on average, with a rise in real interest rates.[6]

These results lend support to the commonly held view that large budget deficits (as a percent of GNP) are one factor causing high real short-term interest rates. In particular, these estimates suggest that a one-percentage point increase in the budget deficit/GNP ratio over a one-year period is associated with an average real interest rate increase of between 40-100 basis points. Rapid nominal money growth, on the other hand, is associated with lower real interest rates. A one-percentage point increase in the annual rate of narrow money growth is associated with an average real interest rate decline of approximately 30 basis points. This result parallels those found earlier by Mishkin (1984) in a study of real interest rates in the Euro-deposit market using quarterly data over the 1967-II to 1979-II period.

When combined with the trends in budget deficits and in nominal money growth, these empirical results imply that the sharp increase in short-term real interest rates in the U.S. between 1980-1982 is

Table 3

Real Interest Rate Equations with General Government Deficits and the Central Government Deficit—Gross Savings Ratio as Independent Variables

	General Government Budget Deficits			Central Government Budget Deficits/ Gross Savings Ratio		
Constant	.032	.012	−.021	.034	.016	−.013
	(2.37)	(0.95)	(−1.79)	(3.09)	(1.33)	(−1.10)
General Government Budget Deficit	.005	.001	.004			
	(2.31)	(0.64)	(1.75)			
Central Government Deficit/Savings Ratio				.002	.0007	.0009
				(3.84)	(1.37)	(1.89)
Nominal Money Growth	−.003	−.003		−.003	−.003	
	(−3.74)	(−4.17)		(−3.95)	(−4.23)	
Cyclical Money Growth			−.002			−.001
			(−2.09)			(−1.95)
Unemployment		.009	.009		.008	.008
		(4.23)	(4.07)		(3.18)	(3.05)
Dummy Variables:						
U.K.	−.039	−.066	−.081	−.042	−.063	−.078
	(−2.89)	(−4.82)	(−5.60)	(−3.29)	(−4.62)	(−5.32)
France	−.003	−.027	−.032	−.006	−.024	−.034
	(−0.23)	(−1.99)	(−2.22)	(−0.50)	(−1.85)	(−2.37)
Japan	−.023	−.009	−.021	−.031	−.014	−.027
	(−1.69)	(−0.69)	(−1.60)	(−2.38)	(−1.09)	(−1.95)
Canada	−.018	−.059	−.055	−.032	−.058	−.059
	(−1.37)	(−3.89)	(−3.31)	(−2.56)	(−4.08)	(−3.73)
Italy	−.049	−.056	−.107	−.057	−.059	−.101
	(−2.05)	(−2.65)	(−5.54)	(−2.93)	(−3.28)	(−5.97)
U.S.	−.022	−.059	−.052	−.037	−.059	−.058
	(−1.59)	(−3.98)	(−3.17)	(−3.03)	(−4.43)	(−3.91)
R^2	.42	.56	.47	.49	.57	.47
Observations	70	70	70	70	70	70
Standard Error	.029	.026	.028	.027	.025	.028

Notes: t-statistics in parenthesis; OLS regressions

partly attributable to slower money growth (120 basis points), but that the rise in federal budget deficits over the period probably played a larger role (100-250 basis points).

Experiments using alternative explanatory variable definitions are reported in Tables 2 and 3. The focus of these experiments is to determine the sensitivity of the budget coefficient to alternative specifications. For the regressions reported in Table 2, alternative money supply definitions, real money growth (nominal money growth less actual inflation) and a measure of cyclical money growth (current money growth less the weighted average of money growth during the preceding three years) were used. [7] In the macroeconomics literature, these money growth variables are often offered as alternatives in real interest rate equations to the nominal money growth variable. The use of either of these alternative money supply variables increases the magnitude and significance of the central government budget deficit coefficient as compared to those reported in Table 1 for nominal money growth. The real money growth coefficients are statistically insignificant and of the wrong sign, however.

Other experiments were conducted to address questions about the appropriate budget deficit measure, for example, whether it should be limited to the central government or should also include deficits due to local governments and social security funds. The first three columns of Table 3 give the results from substituting general government deficits (central government plus local governments and national social security funds) scaled by GNP for the central government deficit variable used in the previous regressions. Somewhat surprisingly, the results for general government deficits in Table 3 are similar to the results using the central government budget deficit/GNP ratio presented in Table 1 and Table 2. The coefficient for the general government deficit/GNP ratio is significant in two of the three cases, and the effect of the deficit on real interest rates is similar to that when only central government budget deficits are used. However, when both nominal money growth and unemployment are included in the estimation, the coefficient for the general government budget deficit/GNP ratio falls off in magnitude and significance.

The scaling of budget deficits by GNP rather than some other aggregate may also be questioned. Columns (4)-(6) of Table 3 report on the use of central government budget deficits scaled by gross national savings instead of GNP. This alternative deficit variable measures the degree to which savings in an economy are absorbed by central government deficits and might provide a better indicator of the pressure exerted on real interest rates. [8] These results also generally support the earlier findings. The central government deficit/gross savings coefficient has the anticipated sign in each equation, but, again, it is not significant in the equation that includes unemployment.

In all of the experiments reported in Table 3, the magnitudes and significance levels of the money supply and unemployment variables are similar to those reported in Tables 1 and 2. On balance, the results in Table 3 suggest that there is significant positive correlation between deficits and short-term real interest rates regardless of how deficits are measured.

III. Extensions

Apart from measurement issues, the simple empirical tests we have reported may be criticized on several levels. One criticism concerns the appropriateness of pooling the data, and thereby constraining the slope coefficients of the model to be equal across the seven countries. A second criticism could question the homogeneity of the data across the period of estimation. Some economists have argued that major structural changes in the world economy have occurred since 1979, potentially changing the linkages between budget deficits and real interest rates. These potential objections to the methodology behind the estimates reported in Table 1 are discussed in turn below. [9]

Pooling the Data

Pooling cross-section and time-series data implicitly assumes that all observations come from the same population regardless of country. As a test of the appropriateness of this assumption, we allowed the coefficients of the fully constrained model, that is, the model with a *single* intercept term (no country dummy variables), money growth variable and central government deficit variable, to vary across

countries. Denoting the model with no restrictions across countries (intercept terms, money growth slope coefficients and central government deficit coefficients are all allowed to vary across countries) as the "expanded model," the relevant F-statistic measuring the significance of the reduction in squared errors between the expanded model and the fully constrained model equals 1.43. The critical level of the F-statistic at the 5-percent level of confidence for the test is 1.92. This result suggests that pooling may be appropriate, since the F-value is substantially below the value needed to reject (at the 5-percent level) the null hypothesis that all observations come from the same population. Because this test is also unnecessarily strong, since our model formulations in Table 1 also include unrestricted country-specific intercept terms, one can be even more confident of the result.

Tests for Structural Change

The international evidence reported here contrasts markedly with numerous domestic studies that suggest very little association between budget deficits and real interest rates. In fact, the lack of strong empirical evidence supporting almost any reasonable hypothesis attempting to explain the high levels of real interest rates since 1979 have led some economists to suggest that a major structural change (presumably unquantifiable) has occurred in the process generating real interest rates.

To shed some light on the issue, we split our sample into two periods, 1973-1979 and 1980-1982, and estimated the real interest rate equation for both subperiods. The year 1980 is chosen as the breaking point of the sample because of the rapid run-up in real interest rates that began in that year, and because it is the first year following the October 1979 policy shift by the Federal Reserve toward monetary aggregate targeting. In another structural change test, the budget deficit coefficient alone is allowed to vary between the two sub-periods, while the money growth and country intercept variables are constrained to be equal over the full 1973-82 sample. This allowed us to compare the significance of the budget deficit-real interest rate link in the two periods and, in particular, to test whether the significant positive association noted above has become stronger since 1980.

The estimated equations are reported in Table 4. The results of a Chow test suggests, with a degree of confidence of better than 90 percent (the F statistic equals 2.05), that a structural shift did occur between the two sets of parameter coefficients estimated over the 1973-1979 (Column 1) and 1980-1982 (Column 2) periods. Somewhat surprisingly, the correlation between money growth and real interest rates becomes less significant in the latter period. In contrast, the positive correlation between real interest rates and budget deficits increases substantially. In addition, the structural change test for the budget deficit coefficient alone during the latter period (Column 3 in Table 4) suggests that it has increased significantly, from .006 in 1973-1979 to .01 (.006 + .004) in 1980-1982. Hence, while the evidence suggests that significant structural changes

Table 4

Real Interest Rate Equations: Tests of Structural Change Between 1973-1979 and 1980-1982

	1973-1979	1980-1982	1973-1982
Constant	.026	.016	.026
	(1.89)	(0.85)	(2.36)
Central Government Budget Deficit	.006	.013	.006
	(2.77)	(2.42)	(2.94)
Money Growth	−.002	.0006	−.002
	(−2.15)	(0.25)	(−2.42)
Dummy Variables:			
U.K.	−.015	−.031	−.043
	(−3.81)	(−1.36)	(−3.49)
France	−.054	−.021	.009
	(−1.08)	(−0.73)	(−.80)
Japan	−.047	−.055	−.046
	(−3.07)	(−2.03)	(−3.43)
Canada	−.032	−.036	−.031
	(−2.28)	(−1.69)	(−2.64)
Italy	−.059	−.137	−.034
	(−2.89)	(−2.52)	(−2.87)
U.S.	−.041	−.029	−.034
	(−2.94)	(−1.31)	(−2.87)
D* Central Government Budget Deficit			.004
			(2.24)
R^2	.47	.49	.54
Observations	49	21	70
Standard Error	.026	.023	.026

Notes: t-statistics in parenthesis; OLS regressions

D is a dummy variable and equals zero for the 1973-1979 period and unity for the 1980-1982 period.

have occurred in the world economy in recent years, it appears that the significant positive correlation between budget deficits and real interest rates remained, and may have grown stronger.[10]

IV. Conclusion

This paper presents some simple tests of the hypothesis that high real interest rates in recent years are significantly correlated with large central government budget deficits. We look at international data to explore this linkage. Specifically, we pool annual observations over the last decade for the seven major industrial countries and regress real interest rates on central government deficits, holding constant money growth, standardized unemployment rates and country-specific dummy variables.

The results generally support the hypothesis. We find that a statistically significant positive relation generally holds between real interest rates and deficits, irrespective of included variables, money growth measures and deficit measures. Although there are some exceptions to this conclusion, the positive deficit-real interest rate correlation is sufficiently stable in a variety of model formulations to give us confidence in the robustness of this empirical result.

The policy implications from these results should be drawn cautiously. Strictly speaking, the single equation methodology employed here does not allow us to determine the causal linkage between budget deficits and real interest rates. Nevertheless, our evidence is clearly consistent with the hypothesis that sizeable central government budget deficits in the world's major economies may be an important factor holding up real interest rates in recent years.

The results of our empirical analysis are also consistent with the hypothesis that the recent slowdown in monetary growth may also bear part of the responsibility for current high real interest rates. In particular, the empirical results suggest that the sharp increase in U.S. real interest rates between 1980-1982 is partly attributable to slower money growth (120 basis points), but that the rise in federal budget deficits over the same period likely played a larger role (100-250 basis points). Moreover, in light of the evidence gleaned from splitting the sample into the pre- and post-1980 period, it appears likely that large central government budget deficits are playing an increasingly important role in maintaining real interest rates at their present levels.

DATA APPENDIX

Data Sources: International Monetary Fund, **International Financial Statistics** (IFS); Organization for Economic Cooperation and Development (OECD–1), **Occasional Studies,** June, 1983; Organization for Economic Cooperation and Development (OECD-2); **Economic Outlook,** December 1983.

1. Central and general government deficits as a percent of GDP are from **OECD**-1.
2. Nominal money growth rates are from **IFS**, line 34x.
3. CPI inflation rates are from **IFS**, line 64x.
4. Domestic short term interest rates data are from:
   France, call money rate, **IFS** line 60b
   U.S., Treasury bill rate, **IFS** line 60c
   Germany, call money rate, **IFS** line 60b
   U.K., Treasury bill rate, **IFS** line 60c
   Japan, call money rate, **IFS** line 60b
   Italy, call money rate, **IFS** line 60c
   Canada, Treasury bill rate, **IFS** line 60c
5. Unemployment rates are from **OECD**-2.
6. Country specific dummy variables equal 1 for named country, 0 otherwise.

FOOTNOTES

1. Simulations of the familiar MIT-Penn-SSRC econometric model, for example, suggest a substantial increase in short-term interest rates given a fiscal stimulus (see Friedman, 1982). The Federal Reserve Board's multi-country (MCM) model also predicts a rise in interest rates in response to a fiscal stimulus (see Haas and Symansky 1983). Both of these models are large-scale structural models of the economy.

2. Reduced form estimates of a direct link between budget deficits and interest rates have generally been unsuccessful. Recent work has investigated various aspects of a potential reduced form linkage. Motley (1983) considers the impact of several measures of budget deficits on real interest rates and finds little correlation. Hoelscher (1983), on the other hand, investigates the impact of budget deficits during the post-war period on nominal interest rates and finds no statistically significant relationship. Evans (1983) takes a different perspective and investigates war-time experiences, again failing to find the hypothesized deficit-interest rate relation. One recent empirical study (Sinai and Rathjens, 1983) purports to have found a significant link, however, on interest rates arising from real government deficits per capita in the U.S. Feldstein and Eckstein (1970), in an earlier study, also estimated a significant effect for real per capita federal government debt on interest rates. Nevertheless, a significant body of literature has failed to find any systematic support for a strong deficit-interest rate link.

3. U.S. Department of Treasury (1984).

4. Hoelscher (1983) derives this model and discusses its relationship to the standard IS-LM model. This reduced form equation is consistent with various theoretical frameworks. The important point to note, however, is that this model is a flow model rather than a stock model of interest rate determination.

5. Mishkin (1984) discusses the assumptions implicit in using the ex-post real interest rate as a proxy for the expected (ex ante) real interest rate. Basically, this approach assumes that markets are efficient, that is, all transactors utilize all available information in forming their expectations about future inflation. The assumption that ex-post real interest rates are good proxies for ex-ante expected real interest rates is quite strong, perhaps unnecessarily so. For example, however one proxies inflationary expectations, the assumption that the inflationary expectations are absorbed in nominal interest rates on a one-for-one basis places an additional constraint on the estimation. This constraint can be relaxed by re-arranging equation (2) to make realized inflation the dependent variable and the nominal interest rate an additional explanatory variable. This change in the estimated equation resulted in modest increases in the magnitude and the significance of the budget deficit coefficient. Specifically, the regressions reported in columns 2 and 3 of Table 1 were re-run with realized inflation as the dependent variable and nominal interest rates as an additional explanatory variable. Except for the anticipated change in sign, the coefficients for money growth and for unemployment are virtually unchanged in either magnitude or statistical significance. Regressing realized inflation on the nominal interest rate, the central government deficit, nominal money growth, and the country dummies results in a coefficient (t-statistic) for the central government budget deficit of −0.010 (−4.28) as compared with 0.008 (4.09) in the original formulation. With unemployment included as an explanatory variable, the comparison is −0.006 (−2.10) vs. 0.004 (1.85).

6. Unemployment was included in the estimation equation to attempt to control factors associated with business cycle fluctuations. Unemployment, however, has a significant rising trend component. To address this problem, we constructed a "cyclical" unemployment variable as the deviation of current unemployment from its past weighted average (three previous years; weights equal to .5 for the first year and .3 and .2, respectively, for the second and third years) and used this constructed variable in the equation in column (3) of Table 1. The results of the regression provided strong support for the hypothetical budget deficit/real interest rate link; estimated coefficient values (t-statistics) equal .007 (3.12) for the central government budget deficit, −.003 (−3.89) for nominal money growth and .004 (1.12) for the constructed cyclical unemployment variable.

7. The weights on lagged money growth are .5 for the first year, .3 for the second year and .2 for the third year.

8. Capio, **et al** (1983) discuss the problems involved with using deficit-savings ratios as indicators of interest pressure in both the closed and open economy context. A major criticism of deficit-savings ratios posed by the paper is that deficit-savings ratios are not exogenous indicators and are affected differently across countries given similar exogenous shocks to government deficits.

9. A third potential criticism is the question of simultaneity in the estimation of the real interest rate equations. Although we do not suggest that the observed correlation between budget deficits and real interest rates necessarily implies causation, the empirical results may be interpreted this way by some. Critics of this latter view may therefore raise the simultaneity issue. Specifically, it may be argued that an increase in real interest rates depresses economic activity which, in turn, causes government budget deficits to rise. Thus, the budget deficit/real interest rate correlation may be picking up a reverse causation running from real rates to budget deficits.

To address this issue, we estimated equation (2) in the text using several instrumental variables procedures. The instrumental variable estimates also suggest a positive budget deficit/real interest rate association, but do so less strongly than the OLS results. In particular, the budget deficit coefficient is statistically significant at the 10% level when the unemployment variable is excluded, but drops off in significance when it is included in the instrumental variable estimates. We are not satisfied with our instrumental variable results and do not report them in the text because we could not find an appropriate exogenous instrument for the budget deficit variable for each country.

In addition, it should be pointed out that a similar simultaneity argument is most commonly made to explain why budget deficits may be **negatively** associated with real interest rates. Namely, an exogenous fall in real income may simultaneously cause both a fall in real interest rates and an increase in government budget deficits. Proponents of this view therefore argue that "structural" budget deficits (a hypothetical estimate of the budget deficit based on a full-

employment output level in the economy) are positively associated with real interest rates, even though observed deficits may be negatively associated with real interest rates. This commonly held view suggests that our estimates of a positive correlation between unadjusted budget deficits and real interest rates have a negative bias (for example, should have a stronger positive correlation than is reported), rather than the positive bias discussed in this text.

10. This result is weakened, however, when the nominal money growth coefficient is allowed to vary together with the budget deficit coefficient during the latter period while the other coefficient values are constrained to be equal. Nevertheless, in this instance the evidence also suggests that the influence of budget deficits on real rates of interest has increased in recent years.

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