

WORLD PUBLIC DEBT AND REAL INTEREST RATES

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Real interest rates appear to have risen in virtually all industrialized countries in the 1980s and 1990s relative to levels that prevailed in earlier decades. There is concern that this may reflect higher public debt, which is crowding out private-sector activity. There has also been increasing international capital market integration, implying that interest rates in any country may be sensitive to global fiscal developments. This paper estimates the effects of such fiscal developments on real interest rates in nine industrial countries. The results imply that the increase in OECD-wide government debt since the late 1970s was a major factor in the rise in real interest rates.

I. INTRODUCTION

Aside from perhaps unemployment or inflation, no macroeconomic policy issue has attracted as much attention as government deficits. However, the economic consequences of the resulting public-sector debt remain uncertain at the theoretical level. Empirically, there is considerable evidence rejecting the notion that consumers fully offset the effects of government deficits, but little evidence that higher levels of government debt result in higher real

interest rates and, therefore, crowd out private-sector activity.

This paper departs from the bulk of the literature, which has focused on the effect of national public debt levels on national interest rates, to examine the effect of 'world' debt levels on national and 'world' interest rates. This shift in focus is motivated by evidence that capital markets have become internationally integrated, at least among advanced industrial economies. The results imply that the increase

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in 'world' government debt since the late 1970s was a major factor in the rise in real interest rates in all of these countries.

The results have two implications for policy. First, the fact that increases in government debt in any one country will increase real interest rates in other countries suggests that some countries with high levels of government debt may be imposing negative externalities on others. Second, since debt reduction in each country provides long-term benefits for the world economy, there may be an important role for coordination of fiscal policies across countries.

The increase in real interest rates that occurred in most industrial countries in the late 1970s and continued into the late 1990s raised several concerns, including the prospect of lower economic growth owing to the crowding out of private investment expenditure, and adverse fiscal debt dynamics as real interest rates exceeded real growth rates. The factors underlying higher real interest rates remain somewhat obscure, although there are three leading candidates.

The most straightforward and traditional explanation is that persistent government budget deficits and the resulting run-up in public debt in most industrialized countries pushed up real interest rates via the textbook crowding-out mechanism. This mechanism has been seriously challenged at a theoretical level by the Ricardian-equivalence hypothesis. The main finding of this paper, however, is empirical support for crowding out in the context of a capital market that is integrated across industrial countries.

An alternative explanation appeals to the high inflation that prevailed in many industrial countries in the 1970s, until the recession of the early 1980s dramatically reduced it. There are two main variants. The first is that monetary policy has been tight since then, and this stance has raised real interest rates. Certainly, the sharp tightening of monetary policy in the late 1970s in many countries caused a spike in real rates which triggered the subsequent economic downturn. However, theoretical considerations suggest that monetary policy works only on nominal variables, except in the short run when prices are sticky. It is difficult to believe that the short run

would extend to 15 years or more, especially as most countries have since passed through a complete business cycle. The other variant is that inflation expectations have been extremely slow to follow actual inflation down. That is, *ex-ante* real rates, which are the ones relevant for economic behaviour, have been systematically below *ex-post*, or measured, real interest rates. While inflation expectations may be sluggish, it is again difficult to believe that they have taken upwards of 15 years to adjust.

A third explanation is that high real interest rates reflect a shift outward in the productivity of capital. There is some anecdotal support for such a view, notably the increased use of computers, and it would be consistent with the steep rise in equity prices since the mid-1980s. However, computers are still a relatively small part of the capital stock and there is as yet little evidence that aggregate productivity growth has increased.

This paper is an empirical examination of the hypothesis of fiscal crowding out. A key strand of the relevant literature, which is reviewed in the next section, mainly tests the hypothesis that real interest rates at the national level are determined by public debt at the national level. In general, no correlation between these two variables appears to exist. However, if capital markets are internationally integrated, then national interest rates depend on 'world' debt, rather than national debt. This paper tests that proposition by regressing a measure of 'world' debt (as well as other 'world' fiscal variables) on real interest rates in nine OECD countries that have had relatively liberal and integrated capital markets since the late 1970s.

Several regression exercises are carried out. Separate ordinary least squares (OLS) regressions on each of the nine real interest rates yield coefficients on the debt-GDP ratio that are always positive and generally statistically significant. Moreover, the point estimates are quite large—the lowest implies that a 1 percentage point increase in the world debt-GDP ratio increases real interest rates by 7 basis points. Because the underlying model of worldwide interest arbitrage suggests that the effect of world fiscal policy should be the same in each country, we also pool the data and constrain the coefficients to be the same across all nine countries. The pooled coeffi-

cient estimate implies that a 1 percentage point increase in the world debt–GDP ratio raises the real interest rate by about 23 basis points. We also consider the possibility that the true regression residuals are correlated across countries by using Zellner’s seemingly unrelated regressions (SUR) technique. Unfortunately, with annual data there are too few observations to estimate the system for all nine countries, so we divide them into two groups. Again, the effects of world debt are economically and statistically significant, and the point estimates are very similar substantially in the two groups. To check the robustness of the results we also add several variables that might be considered to be exogenous influences on real interest rates, but none has much effect on the debt–GDP coefficients.

We conclude that the rise in government debt since the late 1970s has had a statistically and economically significant effect on real interest rates in industrial countries. Between 1978 and 1997 the OECD-wide net debt–GDP ratio rose from 19 per cent to 43 per cent, an increase of 24 percentage points. Based on our pooled parameter estimates, this increase in government debt may have boosted the world real interest rate by about 4 percentage points.

The next section briefly surveys the relevant empirical literature on crowding out and international capital market integration, and presents the economic model underlying the regressions. Section III presents the main econometric results, section IV examines the robustness of these results to changes in specification, and section V concludes.

II. CROWDING OUT AND INTERNATIONAL CAPITAL MOBILITY

For the purposes of this paper, crowding out refers to the familiar proposition that higher interest rates are needed to induce the private sector to hold a higher stock of government debt. Since government and private-sector debt are (imperfect) substitutes,

this results in generally higher equilibrium real interest rates, which in turn lower interest-sensitive components of private-sector activity, particularly investment.² For the past two decades, the academic debate on crowding out has been dominated by the Ricardian equivalence hypothesis—see Barro (1989), Bernheim (1989), and Eisner (1989) for a lively discussion. It is thus worth dwelling on the theoretical arguments and empirical evidence regarding Ricardian equivalence.

In brief, the Ricardian equivalence hypothesis is that the choice of financing a given stream of government expenditures—that is, the choice between tax and debt finance—is irrelevant. Intuitively, consumption does not depend on the timing of taxes and disposable income because a household can borrow against future income to attain its desired consumption path and, in particular, to offset the timing of taxes. It is worth emphasizing that the hypothesis depends on the key assumptions that households have access to capital markets on the same terms as the government and that they are not liquidity constrained.

Though it is theoretically elegant, the empirical evidence on Ricardian equivalence is mixed, in that studies of consumption behaviour suggest households offset public debt only partially whereas studies of interest-rate responses to public debt find little link. It is now well established that consumption behaviour does not accord with the strict permanent income hypothesis, as would be expected in a Ricardian world of forward-looking agents facing efficient capital markets—see Flavin (1985, 1993). Research has also shown that some households are liquidity constrained—see Jappelli and Pagano (1989), and Zeldes (1989). These households cannot borrow and lend to offset the effects of the timing of taxes, even if they want to. Direct econometric studies of the effect of public debt on consumption find that the private sector only partially offsets changes in government deficits—see Bernheim (1987) and Nicoletti (1988). In sum, the empirical evidence on consumption suggests that public debt should partially crowd out private-sector activity.

² There are at least three other types of crowding out. First, taxes and transfers drive a wedge between private and social costs, causing deadweight output losses. Second, government consumption, as distinct from transfers, directly diverts resources from the private sector, even if financed by non-distorting taxes. Third, the path of public debt may be unsustainable, in that it violates the government’s intertemporal budget constraint, which would presumably result eventually in debt monetization or outright default, either of which would be economically disruptive.

There is a second category of relevant evidence, pertaining to the relationship between real interest rates and public debt. Because crowding out occurs through interest-rate increases, higher government debt (and, perhaps, deficits) should cause higher real interest rates. Yet, the bulk of the evidence points to the conclusion that interest rates have not been very responsive to public debt—see, for example, Evans (1985), Tanzi (1985; 1987), Evans (1987, 1988), Spiro (1987), Bovenberg (1988), and Barro and Sala-i-Martin (1990). This conclusion supports the Ricardian view.

In this paper, we address the issue of the link between debt and interest rates in the context of internationally integrated capital markets. This approach is motivated by the accumulating evidence that financial liberalization has increased the integration of international capital markets. Although strict real interest rate parity is empirically rejected, it now seems reasonable to suppose that capital markets are to a substantial extent integrated across advanced economies, and that international arbitrage between instruments of different currencies is effective in reducing deviations between country-specific interest rates. In the limit, one could speak of a world real interest rate.³

Cavaglia (1992) examines cross-country differentials in 1-month Euromarket rates for five countries. He finds that these differentials substantially vanish after about 12 months. This suggests that arbitrage effectively eliminates differentials in a relatively short period of time, lending credence to the proposition of capital market integration and to the notion of a world real interest rate.

Brunner and Kaminsky (1994) also find evidence of international capital market integration. They conclude that German, Japanese, and US 3-month real interest rates are cointegrated over the period 1960–93, implying that there is a common stochastic trend toward which the country-specific interest rates converge in the long run. This trend can be interpreted as an estimate of the world real interest rate.

They also examine the role of fiscal policy, as measured by the budget deficit–GDP ratio in each of the three countries, and estimate that innovations in US fiscal policy account for a substantial fraction of the variation in the world real interest rate.

Gagnon and Unferth (1995) estimate the persistence of deviations of three-month Euromarket real interest rates from the average real interest rate for nine OECD countries. At an annual frequency, they conclude that these deviations are essentially white noise, except for the United States, implying convergence of interest rates within about a year. They interpret the average real interest rate as the world rate. These results are consistent with those of Cavaglia, although the methodology and, therefore, the implied world interest rate are different.

From the perspective of crowding out, the key implication of globally integrated capital markets is that, in the absence of full Ricardian equivalence, an important determinant of country-specific real interest rates is world public debt, as distinct from country-specific debt. That is, additional public debt issued by any one country effectively increases world public debt, which results in higher real interest rates in all countries.

It is natural to suppose that changes in world debt will not generally affect the equilibrium spreads between country-specific interest rates, and that therefore a change in the world interest rate will result in an equal change in each country's rate, all else equal. But it is possible that large increases in one country's debt could both raise the world interest rate and the spread between country interest rates. Our model does not investigate interest-rate differentials across countries, though neither does it rule them out.

Rather, we focus on the transmission from world fiscal variables to real interest rates in each country. In this context, a dollar of public debt has the same effect on the world real interest rate regardless of which country issues it. To examine the role of

³ In this sense, we use the term 'world real interest rate' much as macroeconomists use the notion of a real interest rate for a particular country. Thus, country- or currency-specific factors—such as taxes, or the risk of default or of exchange-rate movements—could cause systematic deviations between the world rate and each country's rate, just as variations in characteristics generate relatively stable interest-rate spreads across assets within a country. These factors do not directly affect the arguments presented here.

world public debt, we regress aggregate OECD-wide fiscal variables on real interest rates in each of the nine countries examined by Gagnon and Unferth. These countries were identified by the OECD (1990) as having liberalized capital markets since 1978. This approach avoids the need to construct an explicit world real interest rate, although it has the drawback of conflating the transmission from debt to the world rate with the transmission from the world rate to each country's rate. By way of checking for robustness, however, we examine two *ad hoc* measures of the world rate: the simple average and the first principal component of the nine real interest rates.

One could argue that there is a measure of the world real interest rate implicit in the model. That is, the model can also be thought of as a filter which extracts movements in the world real interest rate that are due to world fiscal policy. The predicted value from the estimated regression would then be a measure of the world real interest rate. We hesitate to push this latter interpretation too far, however.

This paper differs in focus from those of Cavaglia, Gagnon and Unferth, and Brunner and Kaminsky, all of whom are interested principally in the existence of a world real interest rate. As regards fiscal policy, our approach differs substantially from that of Brunner and Kaminsky. We consider more countries and examine directly the influence of world fiscal policy on country-specific interest rates. A key technical difference is that they assume that real interest rates and the relevant fiscal policy variables are integrated, whereas we assume they are not.⁴ Therefore, we do not use cointegration techniques. Nevertheless, like them, we find that fiscal policy has a substantial effect on real interest rates under the assumption of international capital-market integration.

III. THE DATA

The data on real interest rates are those used by Gagnon and Unferth. As described by them, these are rates on 12-month Euromarket certificates of deposit, compiled by the Bank of International Settlements, deflated by national consumer price indices. The interest-rate data begin in December 1977 and end in December 1997. We focus on nine countries with liberalized capital markets: Belgium, Canada, Denmark, Germany, the Netherlands, Japan, Switzerland, the United Kingdom, and the United States.

We use annual data because the influence of fiscal variables on real rates is most likely to emerge at low frequencies; the evidence on interest-rate convergence, although still fragmentary, suggests that it occurs over the span of a year; and the annual frequency avoids overlapping data, which would complicate the estimation.⁵ However, this leaves only 20 observations, which imposes important constraints on estimation methods and on statistical interpretation. Extending the series back would not appear to be appropriate, since capital market liberalization was less widespread in the 1960s and early 1970s.

The real interest rates for each country and their unweighted average are plotted in Figure 1. In most countries, the real interest rate was quite low in the 1970s, although the sample used in this paper captures only the end of this period, and then increased substantially in the early 1980s. During the past decade, real interest rates varied substantially, although in most countries there is little clear trend until recently, when real interest rates have fallen in advanced economies.⁶ As documented by Gagnon and Unferth, interest rates in most countries appear to gravitate towards the average, especially if con-

⁴ Brunner and Kaminsky base their choice on the standard augmented Dickey–Fuller tests. Experience has shown, however, that it can be difficult to distinguish integrated from stationary series. For example, although standard statistical tests indicate that US real GDP is integrated, substantial work has cast doubt on this conclusion and, by implication, on the power to reject integration—see Cochrane (1988) and Stock (1991). Scepticism about the relevant statistical tests leads us to put more weight on the following *ex-ante* presumptions. The fiscal variables, defined as a ratio to GDP, are bounded (except perhaps for debt) and therefore cannot truly be integrated, although they may appear to be so in actual samples. If the real interest rate is ultimately tied down by the marginal product of capital and fiscal policy, then it too should be stationary, according to standard growth theory. In any case, we tried cointegration estimation, and found that: (i) assuming they are integrated, our regressors are cointegrated; and (ii) the implied long-run coefficient on debt is similar to the estimates presented in the paper.

⁵ Overlapping data—e.g. using monthly observations of 12-month returns—can, for example, yield moving average errors.

⁶ Though there has been significant fiscal consolidation, particularly in Europe and the United States, the recent decline probably reflects more than one factor. The regression results are reported below.

Table 1
Correlations of Ex-Post Real Interest Rates

	Average	Belgium	Canada	Denmark	Germany	Japan	N'lands	Switzerland	UK
Canada	(0.81)	(0.44)							
Denmark	(0.62)	(0.63)	(0.43)						
Germany	(0.95)	(0.74)	(0.74)	(0.59)					
Japan	(0.90)	(0.76)	(0.64)	(0.52)	(0.81)				
Netherlands	(0.70)	(0.84)	(0.46)	(0.52)	(0.68)	(0.55)			
Switzerland	(0.74)	(0.51)	(0.51)	(0.54)	(0.80)	(0.58)	(0.41)		
UK	(0.90)	(0.55)	(0.79)	(0.40)	(0.88)	(0.73)	(0.62)	(0.71)	
USA	(0.66)	(0.34)	(0.63)	(0.02)	(0.55)	(0.71)	(0.18)	(0.26)	(0.62)

stant differences over the sample are removed (notably in the cases of Belgium and Switzerland). Table 1 reports the cross-correlations between the real interest-rate measures studied by Gagnon and Unferth when the sample is extended to include data through 1997.

As can be seen in the table, there is generally a significant positive correlation between the real interest rate in one country and the real interest rates in the other countries, and the real interest rate in all of the countries is highly correlated with the average real interest rate.

In the basic regression specification, the country-specific interest rates are explained by three OECD-wide fiscal variables. That is, the regressors are the same in each equation (country). The fiscal variable of most interest is government net debt. An alternative would be gross debt, but it includes intra-government holdings and so in some countries deviates substantially from the net debt position of the public sector *vis-à-vis* the private sector. Interest rates can also be sensitive to fiscal impulses, especially when agents are liquidity constrained. Measuring such impulses is not straightforward, since taxes and transfers respond endogenously to economic conditions. We use real government absorption (consumption plus investment) and its first difference to capture these impulses, on the grounds that this component is relatively insensitive to the business cycle and that most macroeconomic models suggest that the multiplier is much larger for absorption than for taxes or transfers. Each of these series is divided by a national GDP (nominal in the case of debt, real in the case of absorption). The

regressors are weighted averages of these ratios, where the weights are GDPs in common currency calculated using purchasing power parities (rather than actual exchange rates), as published by the OECD. These three aggregate fiscal variables are plotted in Figure 2 against the average real interest rate.

IV. ESTIMATION RESULTS

(i) OLS Estimates

The most straightforward model for estimating the effects of global fiscal policy on real interest rates is:

$$RR_i = a_i + b_i * X + e_i \tag{1}$$

where the subscript *i* refers to the country (the time subscript has been suppressed), *RR* is the real interest rate, and *X* is the vector of the three OECD-wide fiscal variables. All other influences on the real interest rate are buried in the error term, which must be uncorrelated with *X* if the coefficient estimates are to be unbiased. Since these regressions have few degrees of freedom, it is difficult to model these other influences explicitly. However, in section V, we add several candidates to the specification and find that they do not substantially affect the coefficient on debt.

The OLS results are shown in Table 2. For all countries except Belgium, Denmark, and the Netherlands the estimated coefficient on the net public debt variable is significant at the 95 per cent level. There is considerable variability in the point esti-

Figure 1
Ex-post Real Interest Rates—12-month Euromarket
(bar: real interest rate; line: average real interest rate)

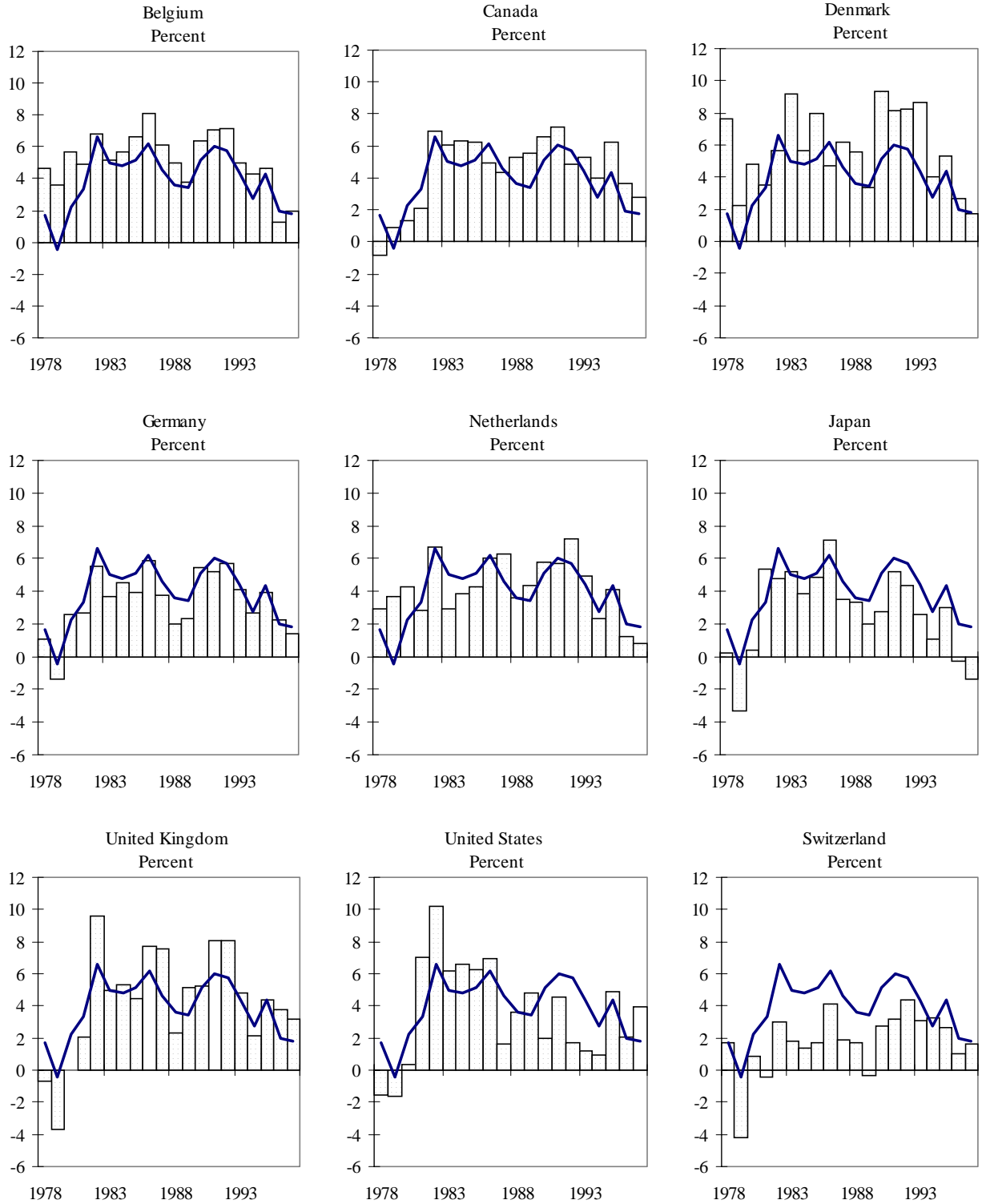


Figure 2
Net Public Debt and Government Consumption Ratios in the OECD: 1978-97
 (line: average *ex-post* real interest rate in 9 countries)

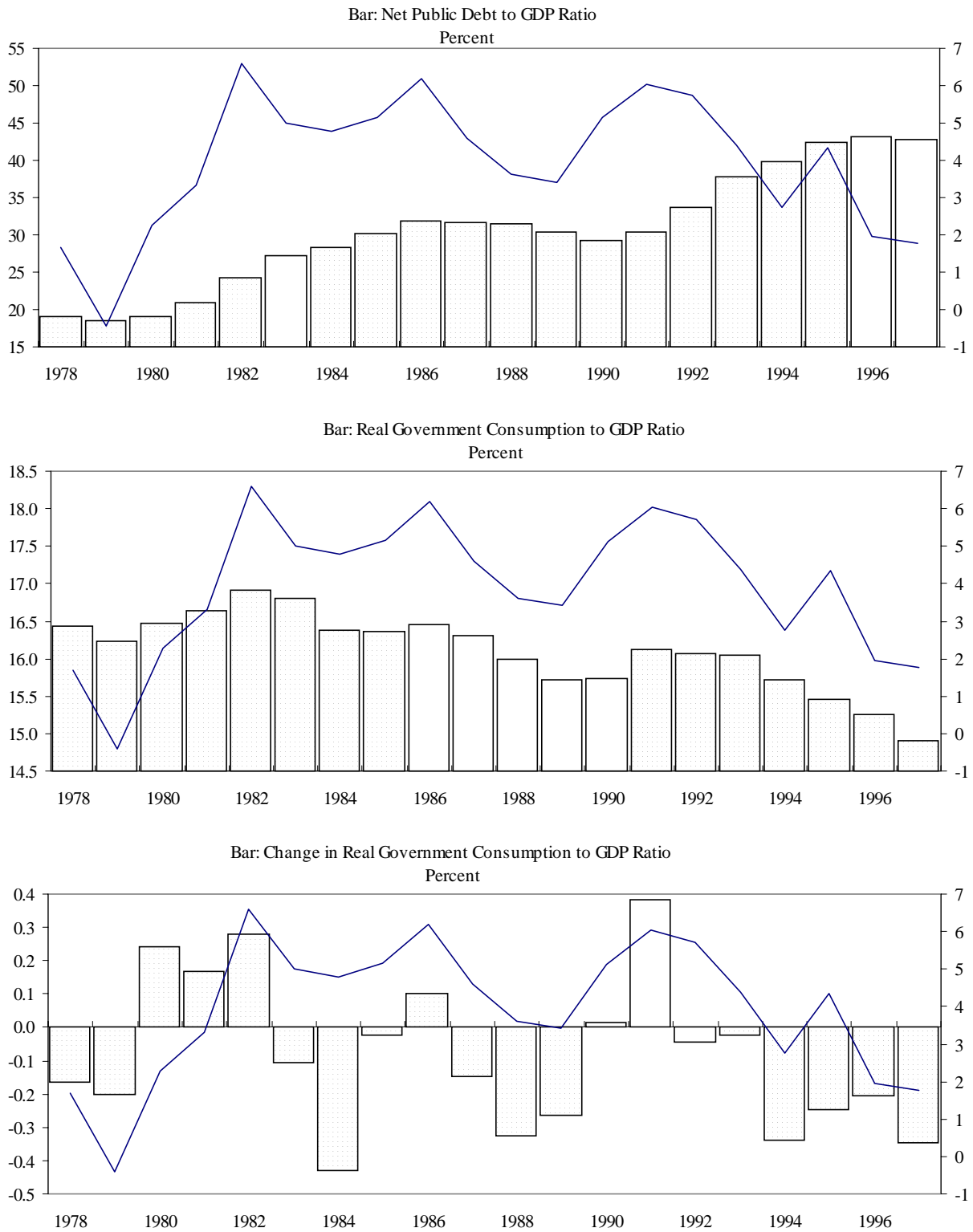


Table 2
OLS Estimation Results^a

	Country constant	OECD debt ^b	OECD public consumption ^c		Std error	R ²	DW
			Change	Level			
Belgium	-37.57 (2.35)	0.09 (1.52)	2.68 (1.85)	2.51 (2.76)	1.22	0.56	1.53
Canada	-49.68 (2.05)	0.28 (3.24)	1.80 (0.82)	2.85 (2.06)	1.86	0.41	0.92
Denmark	-44.70 (1.52)	0.13 (1.28)	1.96 (0.74)	2.89 (1.73)	2.25	0.25	1.66
Germany	-46.94 (2.84)	0.23 (3.97)	3.84 (2.56)	2.71 (2.87)	1.27	0.60	1.95
Japan	-94.79 (4.29)	0.30 (3.90)	3.03 (1.51)	5.50 (4.36)	1.70	0.65	1.49
Netherlands	-23.13 (1.16)	0.07 (1.00)	3.22 (1.78)	1.58 (1.39)	1.53	0.36	1.74
UK	-85.01 (2.82)	0.45 (4.25)	5.60 (2.05)	4.71 (2.74)	2.31	0.58	1.48
USA	-80.23 (2.20)	0.28 (2.19)	2.05 (0.62)	4.68 (2.25)	2.80	0.31	1.21
Switzerland	-43.74 (2.47)	0.26 (4.24)	2.88 (1.79)	2.34 (2.31)	1.36	0.56	2.68

Notes: ^aT-statistics are reported in parentheses under the estimated coefficients. ^bMeasured as a ratio of nominal GDP. ^cMeasured as real government consumption expenditures in the OECD countries divided by real GDP.

mates, which range from 0.07 in the Netherlands—implying that a 1 percentage point increase in the OECD-wide debt–GDP ratio raises the Dutch interest rate by 7 basis points—to 0.45 for the United Kingdom. The coefficient on the absorption–GDP ratio is positive for all countries, and is significant for most. The change in the ratio is positive for all countries, but largely insignificant. Despite the aggregate nature of the regressors, the explanatory power of the regressions, as judged by the R-squared, is quite good. For most countries, the Durbin–Watson statistics and the residuals, which are plotted in Figure 3, suggest little residual serial correlation, although this conclusion is based on a very limited number of observations.

These results broadly support the hypothesis that world debt is an important determinant of national real interest rates. However, the precision of the

estimates is limited by the few degrees of freedom. Moreover, the underlying logic of interest rate determination in integrated capital markets suggests that world debt and deficits may affect each country's interest rate equally. Although our model does not rule out the possibility that national debt variables are also important, we find little evidence that they add much to the basic model once the aggregate debt variable is included in the regression. Table 3 reports the estimated parameter estimates and t-statistics when we augment the simple OLS regressions reported in Table 2 with measures of own-country debt ratios.⁷ In no case is there a significant positive coefficient on these own-country debt variables. However, for the United Kingdom and the United States there appears to be a significant negative effect, confirming some earlier findings in the literature that it is possible to generate perverse effects by focusing on own-country fiscal variables.

⁷ The results for Switzerland are not available because we could not obtain data on net public debt.

Figure 3
Fitted Values and Residuals from OLS Regressions
(solid line: real interest rate; dotted line: fitted values; bar: residuals)

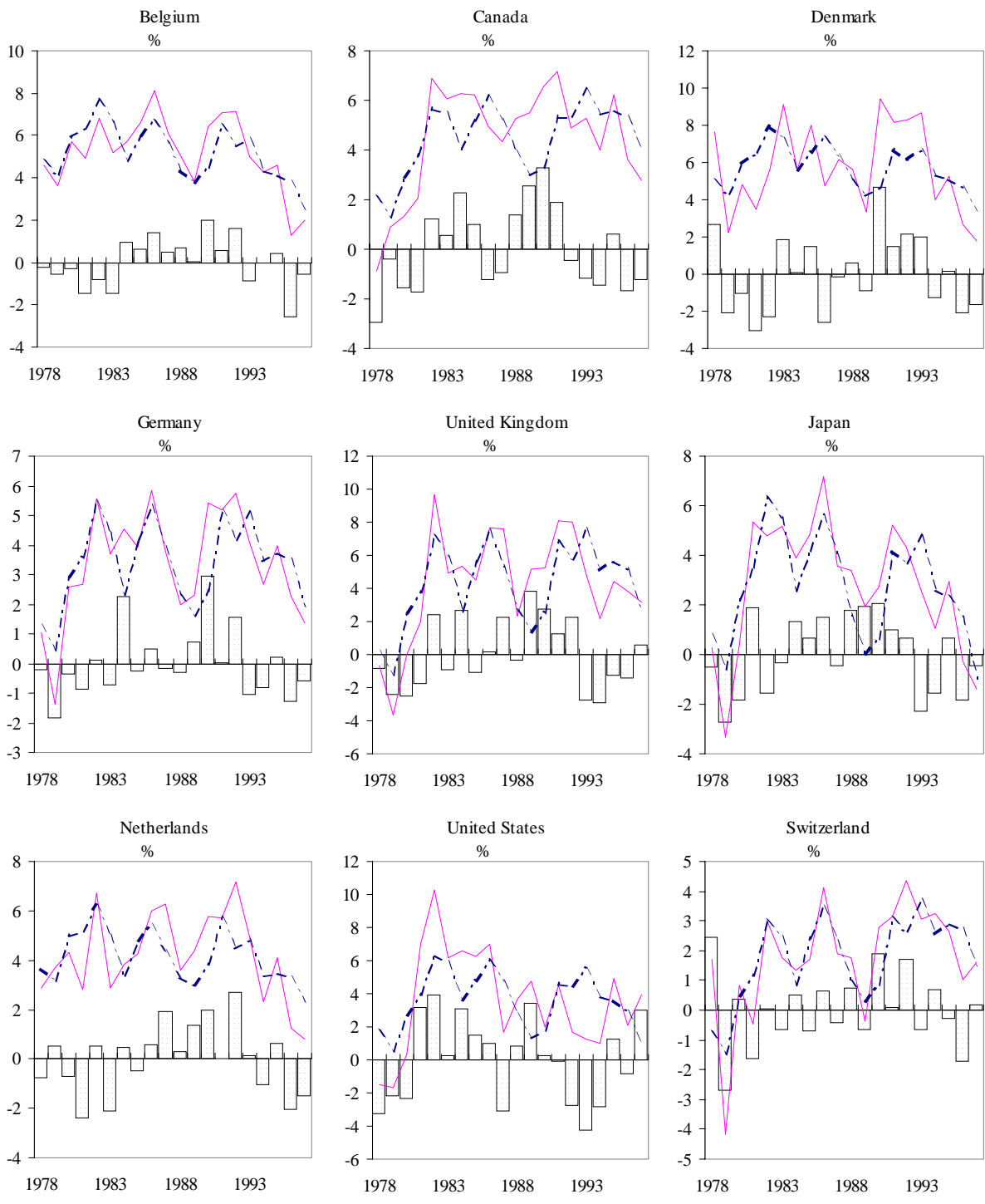


Table 3
Tests for Own-country Debt Effects^a

Own country	Debt variable ^b
Belgium	0.07 (2.78)
Canada	0.02 (0.15)
Denmark	0 (0)
Germany	-0.16 (1.91)
Japan	0.04 (0.70)
Netherlands	0 (0.03)
UK	-0.17 (3.03)
USA	-0.51 (2.36)

Notes: ^aT-statistics are reported in parentheses under the estimated coefficients. ^bMeasured as a ratio of nominal GDP.

More information can be extracted from the limited sample by imposing cross-equation restrictions. Alternatively, constraining coefficients across equations (countries) can be thought of as a way of extracting a common trend from the nine individual interest rates. We therefore consider systems estimates.

(ii) System Estimates

We first consider a simple pooling of the observations, where the slope terms, but not the constants, are assumed to be equal across countries. In terms of parameter estimates, this amounts to regressing the three aggregate fiscal variables against the unweighted sample mean of the nine real interest rates. The model is:

$$RR_i = a_i + b * X + e_i, \quad (2)$$

The results of this model are shown in Table 4. The coefficients of all three explanatory variables are positive and statistically significant and for most countries the explanatory power remains good. The

coefficient on debt implies that a 1 percentage point increase in world public debt raises each country's interest rate by 23 basis points. There is, however, a deterioration in the residual pattern, relative to the OLS results. Although pooling increases efficiency, especially in view of the few available degrees of freedom, it may introduce bias if the restrictions are incorrect. The standard F-test for 24 linear restrictions cannot reject pooling at the 5 per cent level.

The pooling estimator assumes that the residuals are uncorrelated across equations (countries), although it seems more natural to assume instead that they are correlated. It is likely that there are factors other than world fiscal policy that affect all country-specific interest rates, especially on the assumption that capital markets are integrated. Zellner's seemingly unrelated regression estimation (SURE) technique allows estimation of covariances of the equation errors, but there are not enough observations in our sample to estimate the system with all nine countries.⁸ We, therefore, divide the countries into two groups and estimate two separate systems, and impose the same coefficients within each system.

⁸ For the same reason, we cannot test the pooling restrictions in the SUR estimates.

Table 4
System Estimation Results^a

	Country constant	OECD public consumption ^c			Std error	R ²	DW
		OECD debt ^b	Change	Level			
Belgium	-54.92 (3.46)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	1.38	0.37	1.17
Denmark	-54.38 (3.38)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	2.10	0.21	1.56
Germany	-56.75 (3.56)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	1.16	0.58	1.85
Netherlands	-55.93 (3.52)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	1.58	0.24	1.49
Switzerland	-58.37 (3.66)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	1.41	0.43	2.01
Canada	-55.64 (3.47)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	1.80	0.31	0.89
Japan	-57.39 (3.60)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	1.70	0.61	1.12
UK	-55.89 (3.49)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	2.39	0.52	1.08
USA	-56.53 (3.57)	0.23 (4.10)	3.01 (2.24)	3.31 (3.69)	2.54	0.30	1.12

Notes: ^aT-statistics are reported in parentheses under the estimated coefficients. ^bMeasured as a ratio of nominal GDP. ^cMeasured as real government consumption expenditures in the OECD countries divided by real GDP.

One intuitively appealing group is Germany and the four smaller European countries, all of which have close economic ties to Germany. Another is the four largest countries, all of which have important world currencies and large capital markets, plus Canada, which is linked closely to the United States. This yields two groups of five countries each, with Germany being in both groups.

Examination of the covariance matrix of the residuals from the OLS regressions, shown on Table 5, lends support to this partition. For example, the US residual is negatively correlated with those of the smaller European countries, but is positively correlated with Germany and the United Kingdom. The German residual is highly correlated with many of the large countries, and also with those of some small countries, such as Belgium and Switzerland.

Subject to the choice of these two five-country systems, the SUR estimates are shown in Table 6.

In both systems, the coefficient on the debt variable is significant, very similar, and lower than in the pooled regressions. The absorption variables remain significant, with the coefficient on the level of absorption also being lower than in the pooled regressions.

(iii) Proxies for the World Real Interest Rate

All the regressions confirm the influence of world fiscal variables—including the debt–GDP ratio—on real interest rates in several industrial countries. As described, the logic underlying these regressions assumes the existence of a world capital market and even a world interest rate. Another test of the hypothesis of crowding out at the world level would be to regress world fiscal variables directly against an explicit world interest rate. To explore this issue further, the two definitions of the world real interest rate proposed by Gagnon and Unferth—the simple average and the first principal component of the

Table 5
Residual Correlations of OLS Residuals

	Belgium	Canada	Denmark	Germany	Japan	N'lands	Switzerland	UK
Canada	(0.46)							
Denmark	(0.46)	(0.35)						
Germany	(0.76)	(0.61)	(0.48)					
Japan	(0.58)	(0.54)	(0.24)	(0.65)				
Netherlands	(0.76)	(0.46)	(0.35)	(0.63)	(0.27)			
Switzerland	(0.63)	(0.07)	(0.56)	(0.64)	(0.34)	(0.36)		
UK	(0.49)	(0.63)	(0.20)	(0.75)	(0.55)	(0.63)	(0.35)	
USA	(-0.01)	(0.52)	(-0.34)	(0.27)	(0.54)	(-0.13)	(-0.15)	(0.44)

interest rates of the nine countries—are regressed against the fiscal variables used in the previous section. These two proxies are plausible in that they are fairly highly correlated with each of the country-specific interest rates—see Table 1 for the unweighted sample average and Table 7 for the factor loadings of the first principal component (which, as shown, are equal to the correlations of the principal components with each interest rate). Also shown in Table 7 are the transformed factor loadings used as weights to compute a world real interest rate that is comparable to the raw real interest rate series.⁹ The weight is very low for the United States and Denmark. For the United States, this result seems counterintuitive in view of the size of its financial market. This may reflect important idiosyncratic shocks in US financial markets, such as the large increase and subsequent decline in the exchange rate in the mid-1970s, which would be consistent with Gagnon and Unferth's finding that the US interest rate has not converged very rapidly to the world rate. This result is, however, consistent with the OLS and pooled regressions.

The regression results are summarized in Table 7. For the simple average these are identical to the pooled regression, and are repeated here only for convenience. The results with the weighted average are very similar, but the debt coefficient for the first principal component regression is below even the SURE results.

V. EXTENSIONS TO THE BASIC MODEL

As a test of the robustness of the results, several regressors were added one at a time to the basic specification, using annual data. These are, like the fiscal regressors, aggregates across countries. The results for the average world interest rate (corresponding to the pooled system estimate), the first principal component, and the two SUR systems are shown in Table 8. In the interest of brevity, only the coefficients on the added variable and on debt are shown, along with significance statistics.

Theory suggests variables that should affect the real interest rate. In standard growth models, higher labour force or productivity growth (both of which affect real output growth) lowers the steady state capital–output ratio and so raises the interest rate. The change in public debt—the public-sector borrowing requirement—may crowd out activity in addition to its effect on subsequent levels of debt, as in Brunner and Kaminsky.

In general, the coefficients on the additional variables are themselves statistically insignificant and do not affect the sign of the public debt variable and, especially in the cases of changes in the labour force, employment, real GDP, and net public debt, typically do not much affect its size or significance either.

⁹ The loading factors are computed from normalized (zero mean and unit standard deviation) interest-rate series, rather than from the raw series. For the regression, these factors were rescaled so their sum of squares equalled one, and the raw interest-rate series were averaged using the squares of the rescaled factors.

Table 6
System Estimation Results with SURE^a

	Country constant	OECD debt ^b	OECD public consumption ^c		Std error	R ²	DW
			Change	Level			
Five European countries: LLF = -157.713							
Belgium	-38.20 (2.91)	0.18 (3.93)	3.16 (2.66)	2.37 (3.17)	1.32	0.37	1.13
Denmark	-37.66 (2.87)	0.18 (3.93)	3.16 (2.66)	2.37 (3.17)	2.08	0.20	1.57
Germany	-40.02 (3.05)	0.18 (3.93)	3.16 (2.66)	2.37 (3.17)	1.17	0.59	1.73
Netherlands	-39.21 (2.99)	0.18 (3.93)	3.16 (2.66)	2.37 (3.17)	1.49	0.26	1.55
Switzerland	-41.64 (3.18)	0.18 (3.93)	3.16 (2.66)	2.37 (3.17)	1.39	0.43	2.05
Five large countries: LLF = -182.417							
Canada	-38.91 (2.88)	0.17 (3.67)	2.95 (2.41)	2.38 (3.09)	1.82	0.29	0.77
Germany	-40.02 (2.96)	0.17 (3.67)	2.95 (2.41)	2.38 (3.09)	1.18	0.59	1.68
Japan	-40.66 (3.01)	0.17 (3.67)	2.95 (2.41)	2.38 (3.09)	1.83	0.59	0.99
UK	-39.16 (2.90)	0.17 (3.67)	2.95 (2.41)	2.38 (3.09)	2.51	0.51	1.01
USA	-39.79 (2.94)	0.17 (3.67)	2.95 (2.41)	2.38 (3.09)	2.60	0.29	1.04

Notes: ^aT-statistics are reported in parentheses under the estimated coefficients. ^bMeasured as a ratio of nominal GDP. ^cMeasured as real government consumption expenditures in the OECD countries divided by real GDP.

As stated earlier, it is sometimes argued that the rise in real interest rates was caused by the disinflation process in the early 1980s. In order to test this hypothesis, Table 8 includes results when the change in the GDP inflation rate is added to the basic specification.¹⁰ While the parameter estimates on this variable are significant in some cases, we obtain very similar estimates for the parameter on the debt variable. In addition, very similar results are also obtained when we use the CPI indices instead of the GDP deflators to develop an aggregate measure of inflation in the OECD countries.

VI. POLICY IMPLICATIONS

This paper has presented evidence that the ratio of OECD public debt to world GDP has had a substantial effect on real interest rates in nine industrial countries that have had liberalized financial markets since the late 1970s. These findings provide support for the hypothesis that there is significant international integration of capital markets.

However, there are a number of reservations worth raising at this point. First, the sample is quite short—

¹⁰ Similar results are obtained if the change in the GDP inflation rate is added for each country rather than using an OECD measure of inflation.

Table 7
Estimation Results with Average and Principal Components^a

	Constant	OECD public consumption ^c			Std error	R ²	DW
		OECD debt ^b	Change	Level			
First principal component	-32.10 (3.67)	0.12 (4.05)	1.74 (2.20)	1.77 (3.54)	0.67	0.62	1.28
Average real interest rate	-56.20 (3.57)	0.23 (4.20)	3.01 (2.11)	3.31 (3.69)	1.21	0.63	1.20
Weighted-average real interest rate	-57.33 (3.55)	0.24 (4.28)	3.21 (2.19)	3.35 (3.64)	1.24	0.63	1.21

Load factors and corresponding weights for the first principal component:

	Load factors	Weights ^d
Belgium	0.81872	0.117
Canada	0.79102	0.110
Denmark	0.64660	0.073
Germany	0.96270	0.162
Japan	0.88657	0.138
Netherlands	0.74469	0.097
Switzerland	0.75650	0.100
UK	0.89168	0.139
USA	0.60019	0.063

Notes: ^aT-statistics are reported in parentheses under the estimated coefficients. ^bMeasured as a ratio of nominal GDP. ^cMeasured as real government consumption expenditures in the OECD countries divided by real GDP. ^dWeights are derived by squaring the load factors and dividing by their corresponding sum.

necessarily so, given that capital-market liberalization and integration are relatively recent phenomena. As a result, the parameters are not very precisely estimated, and we would not place great weight on the point estimates themselves. For example, consider the debt coefficient of about 0.18 from the SURE exercise. While a coefficient of this size could be rationalized in a macroeconomic model, it strikes most readers as rather large.¹¹ And the coefficient on government absorption seems very large indeed. But these could be cut in half, for example, and would still, in our judgement, be consistent with the evidence presented in this paper.

Second, as mentioned earlier, this paper does not examine individual country interest rates or the evolution of spreads across countries. Spreads might change owing to country-specific fiscal developments, though our simple test and the literature on country-specific fiscal policies suggest otherwise.

Third, while we have characterized the capital markets in the countries used in our sample as being internationally integrated, it is clear that financial markets have evolved significantly since the late 1970s. This observation suggests that there might be mileage in investigating how changes to interna-

¹¹ The long-run effects of government debt will depend to a large extent on the sensitivity of consumption expenditures to changes in the real interest rate. Faruqee and Laxton (1999) show that these estimated effects of world government debt on real interest rates would be consistent with an intertemporal elasticity of substitution around 0.2. While this type of estimate is in the low end of the range from a survey of empirical studies, it is not uncommon to find estimates of this magnitude in the literature.

Table 8
Robustness Tests: Adding Other Variables

Model	Added variable Estimated parameter	Debt variable Estimated parameter
Growth rate of the labour force		
Average real interest rate	0.97 (t = 0.65)	0.27 (t = 3.28)
Weighted average real interest rate	1.15 (t = 0.76)	0.29 (t = 3.42)
System #1: 5 European countries	1.83 ($\chi^2 = 2.27$)	0.25 ($\chi^2 = 7.84$)
System #2: 5 large countries	0.48 ($\chi^2 = 0.46$)	0.20 ($\chi^2 = 4.23$)
Growth rate of employment		
Average real interest rate	0.83 (t = 1.35)	0.28 (t = 4.35)
Weighted average real interest rate	0.90 (t = 1.44)	0.29 (t = 4.49)
System #1: 5 European countries	1.02 ($\chi^2 = 3.62$)	0.20 ($\chi^2 = 8.11$)
System #2: 5 large countries	0.56 ($\chi^2 = 1.18$)	0.22 ($\chi^2 = 6.67$)
Real GDP growth		
Average real interest rate	0.41 (t = 0.95)	0.26 (t = 4.14)
Weighted average real interest rate	0.44 (t = 1.00)	0.27 (t = 4.23)
System #1: 5 European Countries	0.42 ($\chi^2 = 1.23$)	0.20 ($\chi^2 = 6.79$)
System #2: 5 Large Countries	0.35 ($\chi^2 = 0.90$)	0.21 ($\chi^2 = 6.26$)
Growth rate of labour productivity		
Average real interest rate	0.45 (t = 0.62)	0.23 (t = 3.95)
Weighted average real interest rate	0.44 (t = 0.59)	0.24 (t = 4.02)
System #1: 5 European countries	-0.07 ($\chi^2 = 0.17$)	0.18 ($\chi^2 = 5.87$)
System #2: 5 large countries	0.30 ($\chi^2 = 0.53$)	0.18 ($\chi^2 = 6.78$)
Change in net public debt		
Average real interest rate	-0.37 (t = 1.29)	0.31 (t = 3.85)
Weighted average real interest rate	-0.40 (t = 1.38)	0.33 (t = 3.99)
System #1: 5 European countries	-0.23 ($\chi^2 = 0.94$)	0.22 ($\chi^2 = 6.35$)
System #2: 5 large countries	-0.10 ($\chi^2 = 0.43$)	0.20 ($\chi^2 = 3.13$)
Change in GDP inflation		
Average real interest rate	-0.26 (t = 0.94)	0.21 (t = 3.38)
Weighted average real interest rate	-0.24 (t = 0.87)	0.22 (t = 3.44)
System #1: 5 European countries	0.13 ($\chi^2 = 22.43$)	0.23 ($\chi^2 = 5.64$)
System #2: 5 large countries	-0.32 ($\chi^2 = 21.82$)	0.15 ($\chi^2 = 4.99$)

tional capital markets have affected the relationship between world debt and interest rates. The logic of this paper suggests they should be more closely linked now than they were 20 years ago. However, the extent and sophistication of such an investigation would remain limited by the relatively small sample size.

From a policy perspective, capital market integration expands the opportunities for public debt man-

agement for all countries, just as free trade in goods and services expands each country's consumption set. If the public debt policies of each country were optimal (in some sense), then integration would raise world welfare, just as free trade does. On the other hand, integration raises the problem of spillovers, or external effects, of public debt. Any country that issues a significant amount of debt will tend to raise interest rates, and induce crowd-

ing out, worldwide. The incentives faced by each government are thereby tilted towards more debt issue. Put differently, the international integration of capital markets has provided governments with greater scope to issue debt by reducing the domestic

cost of doing so. This observation provides a building block for increased international concern about the fiscal policies of each country, which would no longer have only, or even predominantly, domestic effects.

APPENDIX: DATA SOURCES AND DEFINITIONS

The data on real interest rates were obtained from the Federal Reserve Board of Governors. The other individual country data were taken from the OECD Analytical Database (ADB) and the OECD *Economic Outlook*. The OECD aggregates were constructed by weighting the individual country variables by GDP–PPP weights published by the OECD. The weights used were: Czech Republic (0.62); Denmark (0.55); Finland (0.46); France (6.18); Germany (8.10); Greece

(0.60); Hungary (0.45); Iceland (0.03); Ireland (0.25); Italy (5.80); Japan (14.1); Korea (2.29); Luxembourg (0.06); Mexico (3.04); Netherlands (1.48); New Zealand (0.27); Norway (0.47); Poland (1.03); Portugal (0.61); Spain (2.96); Sweden (0.86); Switzerland (0.89); Turkey (1.64); UK (5.45) and USA (32.14). In cases where country data did not exist for the entire sample, we excluded this country from our proxy of world government debt. The trends in the final aggregate estimates were very similar to estimates published by the IMF *World Economic Outlook* and the OECD *Economic Outlook*.

REFERENCES

- Barro, R. J. (1989), 'The Ricardian Approach to Budget Deficits', *Journal of Economic Perspectives*, **3**(2), 37–54.
- Sala-i-Martin, X. (1990), 'World Real Interest Rates', NBER Working Paper No. 3317.
- Bernheim, R. D. (1987), 'Ricardian Equivalence: An Evaluation of Theory and Evidence', *NBER Macroeconomics Annual*, No. 2, 263–304.
- (1989), 'A Neoclassical Perspective on Budget Deficits', *Journal of Economic Perspectives*, **3**(2), 55–72.
- Bovenberg, A. L. (1988), 'Long-Term Interest Rates in the United States', *Staff Papers*, Washington, DC, International Monetary Fund, Vol. 35.
- Brunner, A., and Kaminsky, G. (1994), 'Do Fiscal and Monetary Policies Matter After All?', manuscript, Board of Governors of the Federal Reserve System.
- Cavaglia, S. (1992), 'The Persistence of Real Interest Rate Differentials: A Kalman Filtering Approach', *Journal of Monetary Economics*, **29**(June), 429–44.
- Cochrane, J. H. (1988), 'How Big Is the Random Walk in GDP?' *Journal of Political Economy*, **98**(October), 893–920.
- Eisner, R. (1989), 'Budget Deficits: Rhetoric and Reality', *Journal of Economic Perspectives*, **3**(2), 73–94.
- Evans, P. (1985), 'Do Large Deficits Produce High Interest Rates', *American Economic Review*, **75**(March), 64–87.
- (1987), 'Do Budget Deficits Raise Nominal Interest Rates? Evidence from Six Countries', *Journal of Monetary Economics*, **20**(September), 281–300.
- (1988), 'Are Government Bonds Net Wealth? Evidence for the United States', *Economic Inquiry*, **26**(October), 551–66.
- Faruqee, H., and Laxton, D. (1999), 'Life-Cycles, Dynasties, Saving: Implications for Closed and Small Open Economies', draft available from authors.
- Flavin, M. A. (1985), 'Excess Sensitivity of Consumption to Current Income: Liquidity Constraints or Myopia?', *Canadian Journal of Economics*, **18**, 117–36.
- (1993), 'Excess Smoothness of Consumption: Identification and Interpretation', *Review of Economic Studies*, **60**, 651–66.
- Gagnon, J. E., and Unferth, M. D. (1995), 'Is There a World Real Interest Rate?', *Journal of International Money and Finance*, **14**(December), 845–55.

- Jappelli, T., and Pagano, M. (1989), 'Consumption and Capital Market Imperfections: An International Comparison', *American Economic Review*, 1088–105.
- Nicoletti, G. (1988), 'A Cross-Country Analysis of Private Consumption, Inflation, and the 'Debt-Neutrality Hypothesis'', *OECD Economic Studies*, No. 16, 43–87.
- OECD (1990), *Liberation of Capital Movements and Financial Services in the OECD Area*, Paris, Organization for Economic Cooperation and Development.
- Spiro, P. (1987), 'The Elusive Effect of Fiscal Deficits on Interest Rates: Comment on Tanzi', *Staff Papers*, Washington, DC, International Monetary Fund, Vol. 34, 400–003.
- Stock, J. H. (1991), 'Confidence Intervals for the Largest Autoregression Root in US Macroeconomic Time Series', *Journal of Monetary Economics*, **63**(December), 435–59.
- Tanzi, V. (1985), 'Fiscal Deficits and Interest Rates in the United States', *Staff Papers*, Washington, DC, International Monetary Fund, Vol. 32, 551–76.
- (1987), 'The Effects of Fiscal Deficits on Interest Rates: Reply to Spiro', *Staff Papers*, Washington, DC, International Monetary Fund, Vol. 34, 404–007.
- Zeldes, S. (1989), 'Consumption and Liquidity Constraints: an Empirical Investigation', *Journal of Political Economy*, **97**, 305–46.