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REAL LONG-TERM INTEREST RATES: THE EVIDENCE FROM POOLED-TIME-SERIES

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INTRODUCTION

Real long-term interest rates are key determinants of longer-term saving and investment decisions, while their influence on business spending, household investment and the consumption of durable goods plays a key role in the business cycle and transmission of macroeconomic policies. During the past two decades there have been some substantial shifts in world-wide levels of real interest rates. A major increase in real interest rates took place between the 1970s and 1980s. In the early 1990s there was a tendency for real interest rates to decline in most countries but this was followed by a sharp reversal in 1994 and, in a number of countries, a significant widening of real interest differentials *vis-à-vis* the major economies. From a policy perspective it is important to identify the sources of these trends and to assess the extent to which they may be driven by policy-related factors. In particular, concerns that real interest rates are "too high" due to potential policy-related saving shortages need to be assessed.

This article reviews some of the main potential determinants of real interest rates and develops an empirical model for estimating their influences. A key feature of the estimation is the use of a pooled time-series sample using data for 17 OECD Member countries; the estimation imposes consistency requirements between the behaviour of real interest rates through time and the determination of cross-country differentials. The approach thus exploits the information contained in cross-country comparisons, which may be particularly important in identifying the impact of fiscal deficits on real interest rates.

A plausible contributing factor to the rise in real interest rates between the 1970s and the 1980s is the removal of financial regulations which had held interest rates artificially low. Because of the substantial structural change that this involved, the main empirical work focuses only on the post-1980 period. However, estimates of the preferred model extended back into the 1970s suggest that the empirical model does explain a significant proportion (around half) of the overall increase since that time, leaving the remainder to be potentially explained by factors that are not modelled, including financial deregulation. Within the post-1980 period, a key empirical finding is that monetary and fiscal policy variables have a significant influence on the trend in long-term real interest rates and on cross-country differentials, but that most of the short-run variation in these interest rates appears to be driven by changes in expectations.

The paper is organised in five parts covering respectively: a discussion of the longer-run trends and possible determinants of real interest rates; the theoretical rationale and details of the empirical model; the estimation results; an explanation of the rise in real long-term rates since the 1970s; and concluding remarks which emphasise the policy implications of these results.

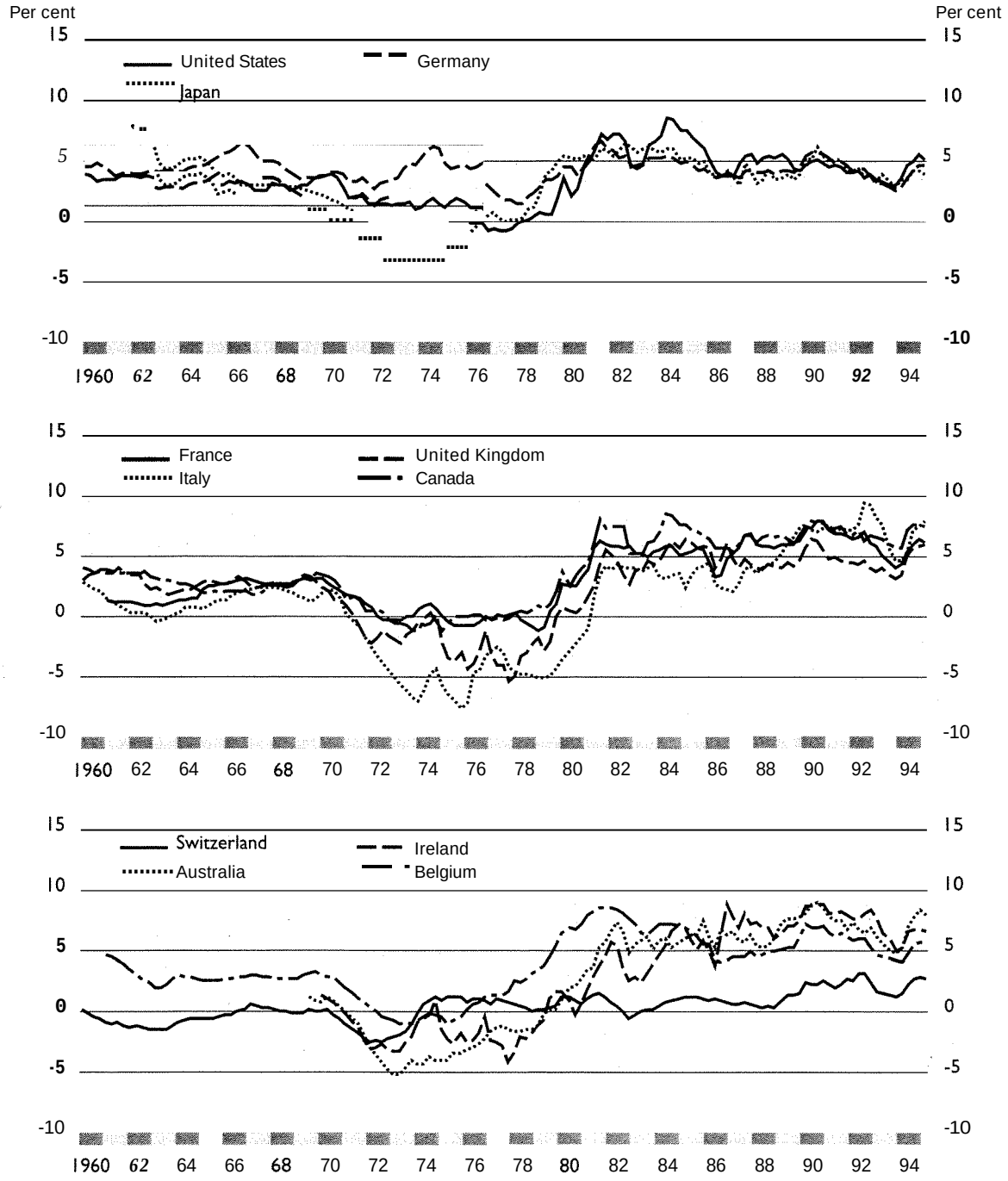
REAL LONG-TERM INTEREST RATE TRENDS AND POSSIBLE DETERMINANTS

For the purposes of this paper, long-term interest rates are taken to refer to representative low-risk government bonds, generally public sector bonds with a maturity of about 10 years (see *Annex).* Several advantages arise from the decision to focus on these rates, including their ready availability and relative comparability across countries and through time, and the low default risk on such securities. Nonetheless, such a focus introduces several possible distortions when comparing real interest rate trends both over time and across countries First, the use of a single real long-term rate ignores differences between rates available to different agents, cross-country differences in the relative importance of maturity structures in financing, and different risk premia facing similar categories of borrowers. Second, no account is taken of the different tax regimes across countries or over time (see, for example, Scott, 1993) Third, financial liberalisation occurred at different times and speeds across countries, affecting the measurement of effective interest rates and possibly putting upward pressure on real rates through a negative impact on saving (see Hayashi, 1985) With regard to the latter two concerns, commencing the empirical analysis in the early-1980s may help reduce any potential distortions, given the general decline in marginal tax rates during the 1980s (see OECD, 1990*a* and Dean *et al.*, 1990) and the progress made in financial liberalisation by this period (see Blundell-Wignall *et al.*, 1991, OECD, 1991a and OECD 1992).

A remaining difficulty concerns the measurement of *ex ante* real long-term interest rates in the absence of comparable data on long-term inflation expectations The difference between the yield on non-indexed and index-linked government bonds provides one measure, although it may also capture the effect of factors other than inflation expectations, including differences in tax treatment, inflation uncertainty, and liquidity premia.[1] At a more practical level, the existence of index-linked bonds is relatively recent and confined to only a few countries, *e.g.* among OECD countries, index-linked bonds have existed since 1981 in the United Kingdom, 1985 in Australia, and 1991 in Canada.

In practice, long-term inflation expectations are usually proxied by some estimate of trend inflation A range of alternative proxies for inflation expectations are compared in Orr, Edey and Kennedy (1995) They conclude that medium-term trends in real interest rates are not substantially affected by the exact choice among

Figure 1. ***Real long-term interest rates***
H-P inflation definition[1]



1. Inflation expectations generated from the low-frequency component of the GDP deflator using the Hodrick-Prescott filter.
Source: OECD; see Annex for details.

a range of reasonable proxies for trend inflation, although the timing of turning points can differ significantly in periods where inflation is highly variable. The preferred measure used in this paper proxies trend inflation by the low-frequency component of the GDP deflator computed by a Hodrick-Prescott filter (see the *Annex* for a description).*This measure is selected because it incorporates both forward and backward looking elements of the inflation process in a type of "two-way averaging" process.

Real interest rate trends

Estimated real long-term interest rates across a range of OECD countries are presented in Figure 1. Several features are worth noting. First, since the early 1980s real interest rates have been considerably higher than during the previous two decades. Second, there appears to have been an increasing (though incomplete) international convergence (see Throop, 1994). Third, real interest rates in most countries were significantly lower in the early 1990s compared with the peaks recorded in the 1980s and, in most countries, there was a marked further decline in 1992-93. Finally, real rates rose steeply during 1994 in a relatively synchronised manner, although they remained within the range of experience of the past 10 to 15 years. In a number of cases, however, real interest differentials widened during 1994, partly reversing the earlier tendency towards convergence.

When attempting to explain these developments, it seems useful to separate short-run influences, such as monetary policy and cyclical developments, from longer-run influences such as structural shifts in the rate of return on capital, risk, and concerns about fiscal sustainability. These long-run determinants can be thought of as the fundamentals that influence saving and investment trends, while the short-run determinants proxy shifts in expectations about these fundamental factors. Furthermore, in a global capital market with cross-country arbitrage, it is plausible that the long-run fundamentals operate consistently in all countries (*i.e.* they have equal coefficients across countries), while expectations formation varies across countries, given that agents are anticipating country-specific developments. These broad features are incorporated in the structure of the model specified in the third section of this article.

Long-run influences

Saving and investment developments

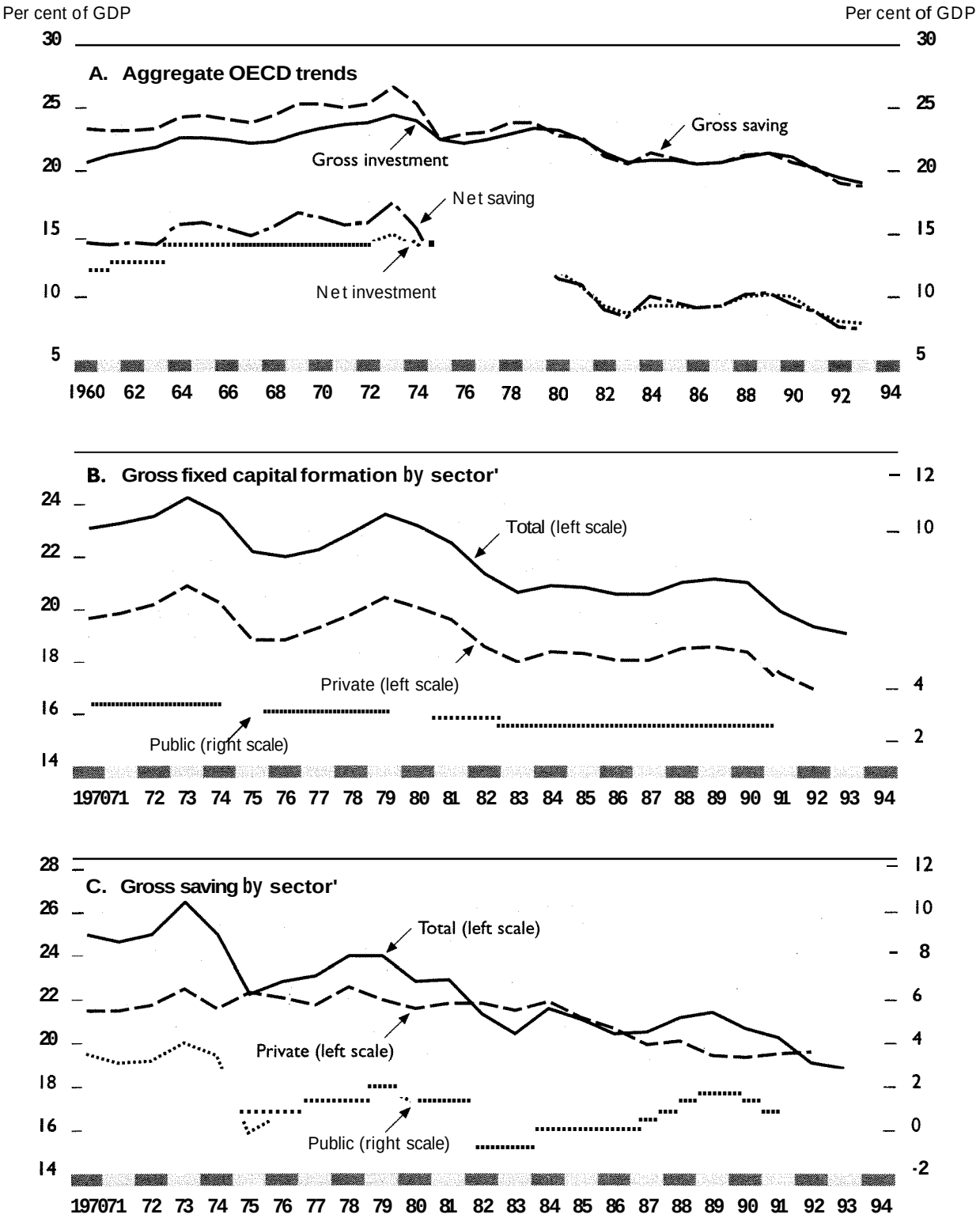
In order to explain the long-run (trend) component of real interest rates it is necessary to identify the exogenous factors which influence saving and investment behaviour. An explanation for rising real interest rates, for example, would require a net balance of factors working in the direction of reducing *ex ante* savings relative to

investment. Trends in aggregate saving and investment (relative to GDP) indicate that both have declined appreciably in the OECD area from their peaks in the early 1970s (Figure 2), although significant measurement problems[3] must be acknowledged. With regard to saving, much of the decline is due to falling government saving. There has also been a substantial shift in the composition of private saving in several countries, with declines in household saving being partly offset by increased business-sector saving. The reverse is true with respect to investment, with most of the decline in nominal investment expenditure (relative to GDP) having arisen in the private sector.

The aggregate decline in saving ratios can be linked to several possible influences, including: financial liberalisation, which may have reduced saving propensities by removing liquidity constraints; lower inflation, which may have reduced the need for precautionary saving; and longer-term demographic factors (see Dean et *al.*, 1990). The main demographic factor likely to be affecting saving is the ageing of populations in most OECD countries, raising dependency ratios (*i.e.* the ratio of the non-working-age to working-age population) and hence potentially lowering national saving. However, the net influence of ageing populations on aggregate saving behaviour is very complex, varying across countries[4] and over time. Some hypotheses, for example, suggest that private saving should actually rise in anticipation of the rise in dependency rates, although it is generally agreed that the demands on public-sector saving will increase given the growing demands for public services and income support associated with an ageing population. If the latter effect is dominant, it is possible that anticipation of future demographic events may give rise to expectations of savings shortages, placing upward pressure on real interest rates well before any actual shortage occurs. This is in contrast to the Ricardian debt-neutrality hypothesis, which stipulates that an anticipated decline in government saving would lead to an offsetting rise in private saving, with little influence on real interest rates (see Barro, 1974 and Nicoletti, 1988).

With regard to investment, exogenous factors putting upward pressure on returns to business investment would translate into higher real interest rates (see Howe and Pigott, 1992). Consistent with this hypothesis is a trend increase in the rate of return on capital in the business sector since the early 1980s.[5] Possible factors responsible for this rise include structural economic reforms, trade liberalisation, lower inflation, and the elimination of restrictions on foreign direct investment. Given that these factors have a positive effect on expected profits, it would appear that the direction of causation runs from an increased return on capital to rising real interest rates, consistent with the impact of technological shocks in a real business cycle framework. Two pieces of evidence in the 1980s appear supportive of this hypothesis. First, the observed rise in price-earnings ratios would be compatible with high real interest rates only if at least partly driven by expectations of higher business profitability (see Blanchard and Summers, 1984). In contrast, if

Figure 2. ***OECD saving and investment trends***



1. Average for **G7** excluding Italy

Source: OECD, National Accounts.

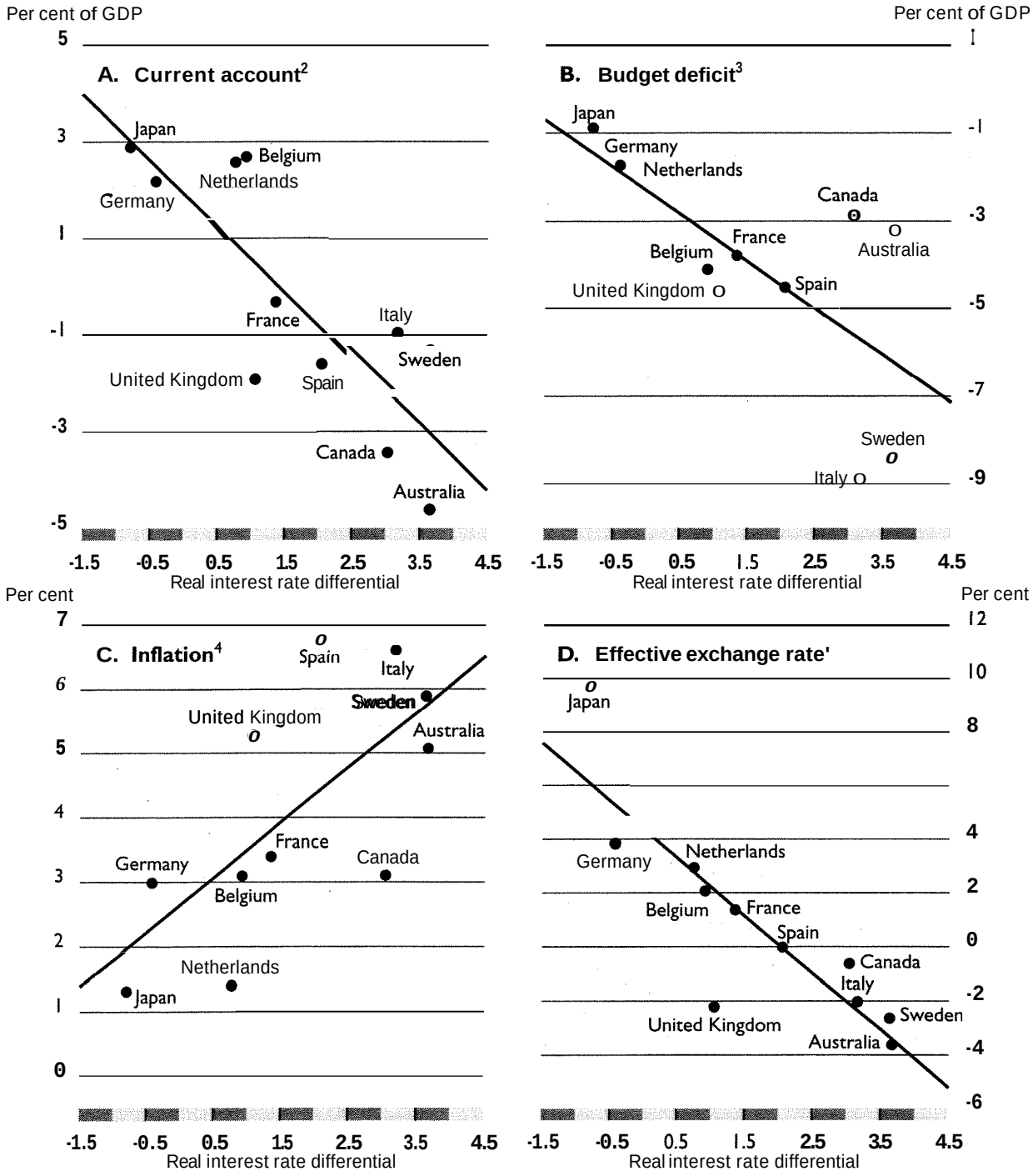
higher real interest rates were the driving force, one would expect to observe a shift away from capital (in favour of labour) in the production process, whereas in fact there is little evidence of this having occurred amongst the major OECD economies (see Tease *et al.*, 1991).

Rising demands for investment funds in non-OECD countries also represent a potential source of upward pressure on interest rates. In particular, it is conjectured that economic policy reforms in central and eastern Europe and in Latin America, may place those economies on a faster growth path and induce substantial rises in investment demand. What is not known is the extent to which faster growth will give rise to increases in domestic savings, making the process largely self-financing, as has tended to be the case in the fast-growing Asian economies. Herd (1989), for example, provides an illustrative calculation of the impact of increased financing requirements on the part of the central and eastern European countries. Assuming that these countries ran increased current-account deficits of the order of 3 to 4 per cent of their GDP, this would still represent an additional financing requirement of less than ¼ of 1 per cent of OECD GDP. Such estimates suggest that a permanent increase in demand for funds from the non-OECD area of this order of magnitude would be unlikely to have a large effect on real interest rates in the OECD countries.

Country-specific influences

In general, global financial integration appears to be leading to a degree of convergence in real interest rates,[6] especially at the longer end of the maturity structure, although significant real interest rate differentials persist across countries (see Obstfeld, 1994 and Throop, 1994). The most common explanation for these differentials is the existence of financial risk premia which vary across countries. These risk premia can be broadly defined as the additional returns required by savers to compensate for uncertainty with respect to such factors as default risk, market volatility and inflation variability. Several interrelated factors are likely to influence the size of these premia, including the expected sustainability of government fiscal positions and perceived degrees of commitment to monetary discipline. With respect to fiscal positions, although government debt tended to rise in all OECD countries over the 1980s, these developments differed significantly across countries. In extreme cases, high public debt may have created perceptions that it will become harder to avoid inflation or higher taxes some time in the future.[7] Past records of inflation control and exchange-rate stability may also be important indicators of the commitment of the monetary authorities to low inflation. Finally, current-account or external debt positions, where these imply persistent imbalances between savings and investment at a national level, may also have led to anticipations of future exchange-rate movements, again influencing the country-risk premia on real interest rates. While the relative importance of these factors is hard to quantify, simple cross-country correlations summarised in Figures 3A to 3D

Figure 3. ***The association between the real interest rate differential and selected economic variables'***



1. Real interest rate differential vis-a-vis the United States in the third quarter of 1994.
2. Annual average 1985-93.
3. 1994; estimate of the structural budget deficit.
4. Average annual rate of change in the GDP deflator, 1985-93.
5. Average annual rate of change in the effective exchange rate, 1985-93.

Source: OECD; see Annex for details.

suggest that a number of them may be related to international differences in real interest rates.

Short-run influences

Cyclical factors, especially related to monetary and fiscal policy developments, are probably the most important transitory influences on real long-term interest rates. These influences may have been strengthened by the integration and liberalisation of global financial markets, which have greatly increased the speed of markets' reactions to new information. With regard to monetary policy, the past three business cycles in the United States, for example, indicated a clear tendency for long-term interest rates to react to both observed and expected changes in policy-controlled short-term rates. In part, this could be explained by the effect of short-term interest rates on the holding cost of long-term securities. However, the signalling effects of changes in official rates are also likely to be important. That is, shifts in official rates have tended to be linked to broader shifts in growth and inflation prospects, both of which are relevant to the determination of long-term bond yields.

The short-run influence of fiscal policy developments on real interest rates is less easy to detect by casual observation, with the expected relationship likely to be weakened in the short-term by general business cycle developments. For example, during an economic downturn, although government borrowing is likely to increase in line with deteriorating budget positions, private-sector investment demands and future inflation expectations are also likely to decrease. Nonetheless, in countries where fiscal problems are extreme (for example, Italy and Sweden), even cyclical fiscal deteriorations appear to have had a major effect on bond markets if they are perceived to threaten fiscal sustainability.

A MULTI-COUNTRY MODEL OF REAL LONG-TERM INTEREST RATES

Following the above discussion, it appears that an empirical analysis of the determinants of real long-term interest rates ideally should identify the fundamentals which determine the long-run developments in real rates, but also allow actual market rates to deviate from the trend in response to short-run factors influencing expectations. In addition, given the global integration of capital markets and the scope for cross-country influences (especially from large to small countries), any estimation should also identify the process by which real interest rates move together internationally, albeit allowing for persistent cross-country differentials. This section aims to develop an empirical framework which satisfies some of these requirements.

The following model of real long-term interest rates is based on the analytics of international interest-rate linkages in an environment of flexible exchange rates

(see Throop, 1994). The basic premise is that investors in a global market shift capital between countries in search of the highest risk-adjusted return, and in so doing, ensure international consistency in real interest-rate determination. However, cross-country differentials in real interest rates can persist and vary over time, reflecting factors such as: the extent to which their economic fundamentals diverge, as reflected in the uncertainty regarding expected real exchange-rate changes; factors which may differentiate foreign from domestic assets, including liquidity, credit risk and tax treatment; and differences in government policies and/or institutions which impede financial flows across borders.[8]

In this portfolio-type framework, the long-run trend component of the real interest rate in each country is modelled as a function of the observable slower moving fundamentals, which indicate saving and investment developments, as well as indicators of any risk premium required by investors. This relationship for country (i) in time (t) is specified as:

$$\hat{r}_{it} = \delta_1 \rho_{it} + \delta_2 gd_{it} + \delta_3 \beta_{it} + \delta_4 \bar{ca}_{it} + \delta_5 (\bar{\pi} - \pi^e)_{it} + \hat{e}_{it} \qquad [1]$$

where: $\hat{r}$ is the trend long-term real interest rate,

ρ is a measure of the rate of return on capital,

gd is an indicator of the government's saving position, for example the government deficit relative to GDP (defined so that a deficit is a positive number) or their net debt to GDP position,

β is a measure of the domestic portfolio risk of holding bonds,

ca is the current-account balance relative to CDP computed as a five-year moving average, (defined so that a positive number represents a surplus),

$\bar{\pi}$ is a long-term average of past inflation,

π^e is the Hodrick-Prescott measure of expected future inflation, and

$\hat{e}$ is the error term.

Precise definitions of all the variables used in the estimation are provided in the Annex.

The first term in equation [1], the rate of return on capital, proxies the opportunity cost of holding a bond. This can be thought of as the minimum return required on bonds before an investor would consider the purchase of bonds versus some other asset (see Howe and Pigott, 1992). In principle, as economic fundamentals converge to their steady-state values, so do the rates of return on capital and consequently this component of real long-term interest rates. Including the domestic rate of return on capital, rather than some proxy of the world rate, thus makes it

possible to estimate a temporary equilibrium in which the international convergence process has not yet been completed. Undiversifiable domestic portfolio risk (proxied by β) captures the risk of holding bonds versus equities in a particular country. This captures the risk premium to compensate for the uncertainty about the future value of wealth entailed in holding bonds. The government deficit and/or net public debt are indicators of exogenous influences on net saving trends. A persistent deficit or rising net public debt, for example, might suggest some *ex ante* shortage of domestic saving relative to investment, necessitating *ceteris paribus* higher current real interest rates.

Ideally, in a portfolio framework, one would model returns as dependent on outstanding stocks of domestic and foreign assets. However, this approach raises a number of serious measurement difficulties, for example, measuring the size of the total portfolio of domestic and foreign wealth. Hence, the approach adopted in this paper is more eclectic, incorporating both stock and flow variables, although in practice it is the latter which dominate in the empirical results.

The remaining variables in equation [1] can be thought of as proxies for the premium component of the trend real interest rate associated with exchange-rate risk. A history of persistent current account (ca) deficits, for example, may lead to expectations of a depreciation of the real exchange rate. In an international market, this would necessitate a risk premium on domestic rates to attract investors. The final term captures the risk premium related to inflation credibility. If the long-run historical performance on inflation (IT) relative to existing expectations (π^e) is poor, some additional yield on bonds may be required by investors over and above the market's average inflation expectation. In a sense, this is counter to the Fisher hypothesis, whereby nominal rates are assumed to fully reflect expected inflation. In an international financial market, low inflation credibility would be embodied in the expectation of a real exchange rate depreciation.

In a world of mobile capital, it is intuitively sensible to treat developments in these long-run variables consistently across countries. International investors are assumed to form views about the required real yield on a country's long-term bond by comparing developments in the country's fundamentals both over time and relative to other countries. Arbitrage activity by investors in the world bond market thus ensures that profit opportunities – where real yields in one market are persistently higher than another after having accounted for differences in their fundamentals – are limited. This suggests that it is sensible to think of equation [1] as applying with the same parameters to all countries, so that risk factors are consistently priced both over time and across countries. This assumption has two appealing properties. First, any pair of equations can be subtracted to imply an equation in the same form for the real interest-rate differential as a function of differences in fundamentals. Second, the equations, in principle, can be aggregated to arrive at a model for a world average real rate in the same form. In this aggregate equation,

current-account positions would sum to zero (if taken over a large enough group of countries), so this factor would drop out as an explanation for the world real interest rate.

When estimating real long-term interest-rate developments, it must be recognised that short-run influences also exist. As discussed above, these generate further cross-country variation in real rates, as well as leading actual rates to diverge temporarily from their trend levels. This feature is captured in the estimation by using an error-correction estimation framework, whereby actual real rates move toward their long-run level with a speed of adjustment (λ) as specified in equation [2] :

$$\Delta r_{it} = \lambda (\hat{r}_{it-1} - r_{it-1}) + \gamma_i \Delta z_{it} + \hat{u}_{it} \qquad [2]$$

In the estimation procedure, λ is constrained to be equal across all countries, primarily to simplify the estimation technique. Allowing the value of λ to vary across countries would necessitate non-linear cross-equation restrictions on the long-run coefficients. The short-run factors included in the z variables in equation [2] consist of a lagged dependent variable, real short-term interest rates, the structural budget deficit and quarterly changes in actual inflation and in each of the variables appearing in the long-run component. Also included in the z variables are changes in the three largest countries' real long-term interest rates, in recognition of the fact that large country developments influence real rates in smaller countries. This necessitates the use of a simultaneous-estimation procedure, where instrumental variables are used for the first differences in G3 real rates.[9]

In sum, equation [2] represents the basic model which is estimated simultaneously, using instrumental variables, for 17 OECD countries. The long-run component of the equation is augmented, in the case of the smaller countries, by the inclusion of the real interest rate of a G3 country (with the US rate chosen for Canada, New Zealand and Australia, and the German rate for the remaining non-G3 countries).[10] The coefficients on the short-run variables are unconstrained across countries, reflecting an assumption that these are proxying unobservable expectations regarding country-specific developments. In such a situation, developments in similar variables across countries, for example short-term interest rates, can imply significant short-run impacts on cross-country differentials.

EMPIRICAL RESULTS

The empirical results are largely summarised in Tables 1 and 2 below. A general-to-specific approach to the estimation was followed, with in general only those variables statistically significant at the 95 per cent level remaining. This procedure led to variation across countries as to the final specification of the short-term dynamics, although all variables are consistently signed across countries in accordance with our priors. All of the variables entered into the equation were

Table 1a. **Real long-term interest rate equation**[1]

17 country simultaneous estimation

Dependent variable: first difference of real long-term interest rates
Quarterly data from 1981Q2 to 1994Q2

Variable	ECM coefficient	t-statistic	Implied long-run coefficient
	Constrained coefficients		
Error correction	−0.079	−8.42	
Return on capital	0.019	5.06	0.24
Risk	0.122	4.44	1.54
Past minus expected inflation	0.027	3.31	0.34
Current account	−0.012	−2.31	−0.15
Government deficit	0.012	2.32	0.15

1. See data sources and definitions in the Annex

Table 1a *(cont'd)*. **Real long-term interest rate equation**[1]

17 country simultaneous estimation

Dependent variable: first difference of real long-term interest rates
Quarterly data from 1981Q2 to 1994Q2

	Foreign rate	t-statistic	Foreign rate/time	t-statistic	Long-run coefficient
	Unconstrained coefficients: foreign rates[2]				
United States					
Japan					
Germany					
France	0.027	3.06			0.33
Italy	−0.048	−2.98	0.25	3.85	−0.60
United Kingdom					
Canada			0.16	5.23	
Australia	0.023	2.00			0.28
Austria	0.011	2.38			0.14
Belgium	0.024	2.31	−0.11	−3.28	0.30
Denmark	0.029	1.69			0.36
Ireland					
Netherlands					
New Zealand					
Spain			−0.16	−2.03	
Sweden	0.019	1.52			0.24
Switzerland			−0.07	−2.41	

1 See data sources and definitions in the Annex
2 For the G3 countries, both "foreign' G3 rates were included For the smaller countries, the foreign rate is Germany, except for the United Kingdom, Canada and Australia for which it is the United States rate

Table 2*a*. **Real long-term interest rate equation: unconstrained coefficients'**

17 country simultaneous estimation (t-statistics in parentheses)

Dependent variable: first difference of real long-term interest rates
Quarterly data from 1981Q2 to 1994Q2

Variables	United States		Japan		Germany		France		Italy		United Kingdom		Canada	
Lagged dependent	0.17	(1 85)	−027	(-3.65)	0.10	(1.94)	0.17	(3.00)	0.11	(1.49)				
A foreign rate														
i) United States					0 19	(481)					042	(554)	069	(1306)
ii) japan					027	(649)								
iii) Germany	0.72	(349)	087	(6.31)			072	(6 16)	032	(1 98)				
A short rate	0.30	(369)	029	(306)	0 19	(552)	0 19	(606)	032	(688)	034	(886)	0 15	(6.37)
A inflation	0.36	(281)	023	(204)	0 11	(232)	008	(1 77)	040	(466)	024	(453)	0 12	(2.59)
A return on capital					041	(263)								
A risk														
A current account balance														
A structural deficit														
A exchange rate									−003	(-1 68)	−002	(-1 98)		
R^2	0.35		0 43		0 65		0 58		0 51		0 63		0 86	
Standard error of estimated equation	0.53		0 44		0 23		0 37		0 54		0 45		0 26	
LM^2	1 .84		2 10		3 74		171		0 47		2 07		1 48	
ADF^3	−23.7		−1 1 8		−12 4		−15 4		−8 6		−178		−23 3	

For notes, see Following page

Table 2*a (cont'd).* **Real long-term interest rate equation: unconstrained coefficient'**

Dependent variable: first difference of real long-term interest rates
Quarterly data from 1981Q2 to 1994Q2

Variables	Australia		Austria		Belgium		Denmark		Ireland		Netherlands		Spain		Sweden		New Zealand		Switzerland	
Lagged dependent			0.38	(7.16)	0.10	(1.62)	0.21	(2.71)					0.30	(3.64)	0.33	(4.48)	..	..	0.18	(1.98)
A foreign rate																				
i) United States	054	(533)															−014	(−085)		
ii) Japan																				
iii) Germany			053	(905)	050	(544)	090	(4.13)	085	(3.84)	059	(745)	048	(225)	043	(273)			0 28	(3 33)
A short rate	023	(558)	008	(325)	016	(574)	024	(663)	013	(487)	031	(910)	026	(576)	024	(645)	019	(3.76)	013	(4.03)
A inflation	022	(3.11)	006	(262)	023	(429)	045	(585)	0.11	(124)	037	(975)	045	(519)	024	(459)	019	(355)	0.16	(4.30)
A return on capital					031	(253)													009	(1 08)
A risk	1.43	(397)					1 12	(2 18)												
A current account			−0 55	(−2 97)	−0 55	(−345)														
A structural deficit			0 11	(1 45)					029	(2 24)										
A exchange rate	−002	(−2 23)															−0.07	(−454)		
R^2	0 45		0 72		0 54		0 42		0 36		0 82		0 39		0 49		0 25		0 46	
Standard error of estimate	0 55		0 18		0 29		0 71		0 71		021		0 69		0 49		0 93		0 23	
LM[2]	2 58		3 13		0 79		3 69		2 66		7 10		2 75		2 18		5 36		2 58	
ADF[3]	−11 5		−14 6		−15 9		−18 8		−36 1		−18 7		−18 1		−19 4		−27 4		−19 2	

1 See data sources and dehnitions in the Annex
2 LM is the F-form of the Lagrange multiplier test for up to 4th order residual autocorrelation. with a 5 per cent (1 per cent) critical value of 2 69 (4 02)
3 Augmented Dickey-Fuller statistic for stationarity of the cointegrating vector from the low-frequency component with a likelihood ratio critical value of −5 13 A test for the uniqueness of the cointegrating vector has not been conducted

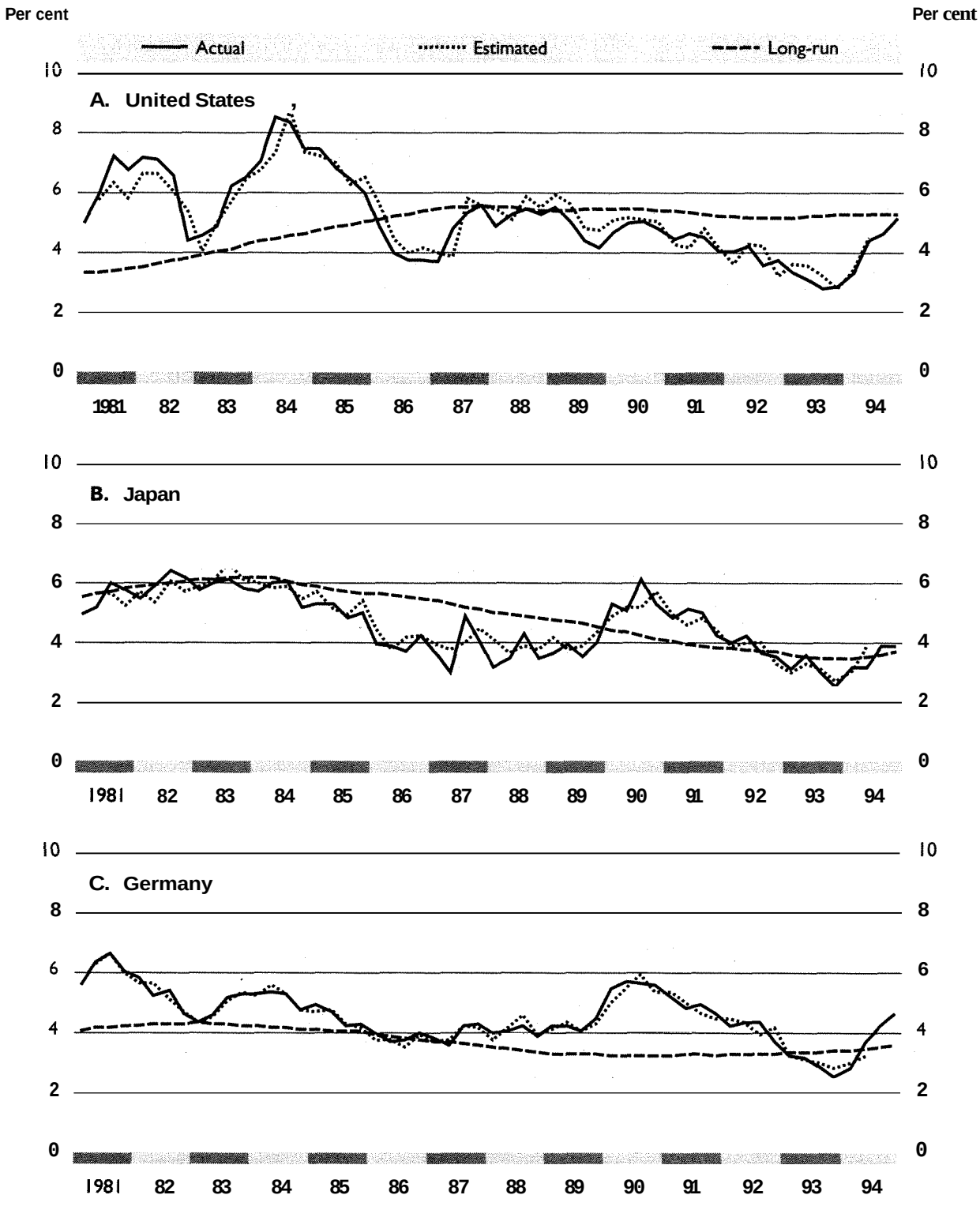
assumed to be I(O) (i.e.stationary) on economic grounds, as confirmed with unit root tests. A co-integrating vector is found for all countries from the long-run regression (see footnote to Table *2a).* In addition, all right-hand side long-run variables in the estimation described in equation [1] are statistically exogenous given that they enter with a lag. Statistically insignificant variables were deleted from the relationship. The insignificant variables included lagged exchange rate movements, structural budget balances and public sector debt ratios. The actual budget balance proved to be the most consistently significant of the fiscal variables and was retained.

From Figure 4 it can be seen that the estimated real rates track the actuals quite well. At the same time, although the long-run components explain very little of the shorter-run movements, they follow the general trend in real rates and thus appear plausible. Nonetheless, the estimated rates deviate from their long-run trend for considerable periods of time. The diagrams also enable an interpretation of the 1994 rise in real rates across the OECD, which appears to be a correction toward the estimated trend, after having declined in 1993 on a cyclical basis. Several countries also experienced a rise in their trend real interest rate. This can be viewed either as a positive development if driven by a rise in the rate of return on capital (e.g.the United States),or a detrimental outcome due to a deterioration in relative fundamentals (e.g.a decline in Germany's relative current-account position).

The long-run determinants

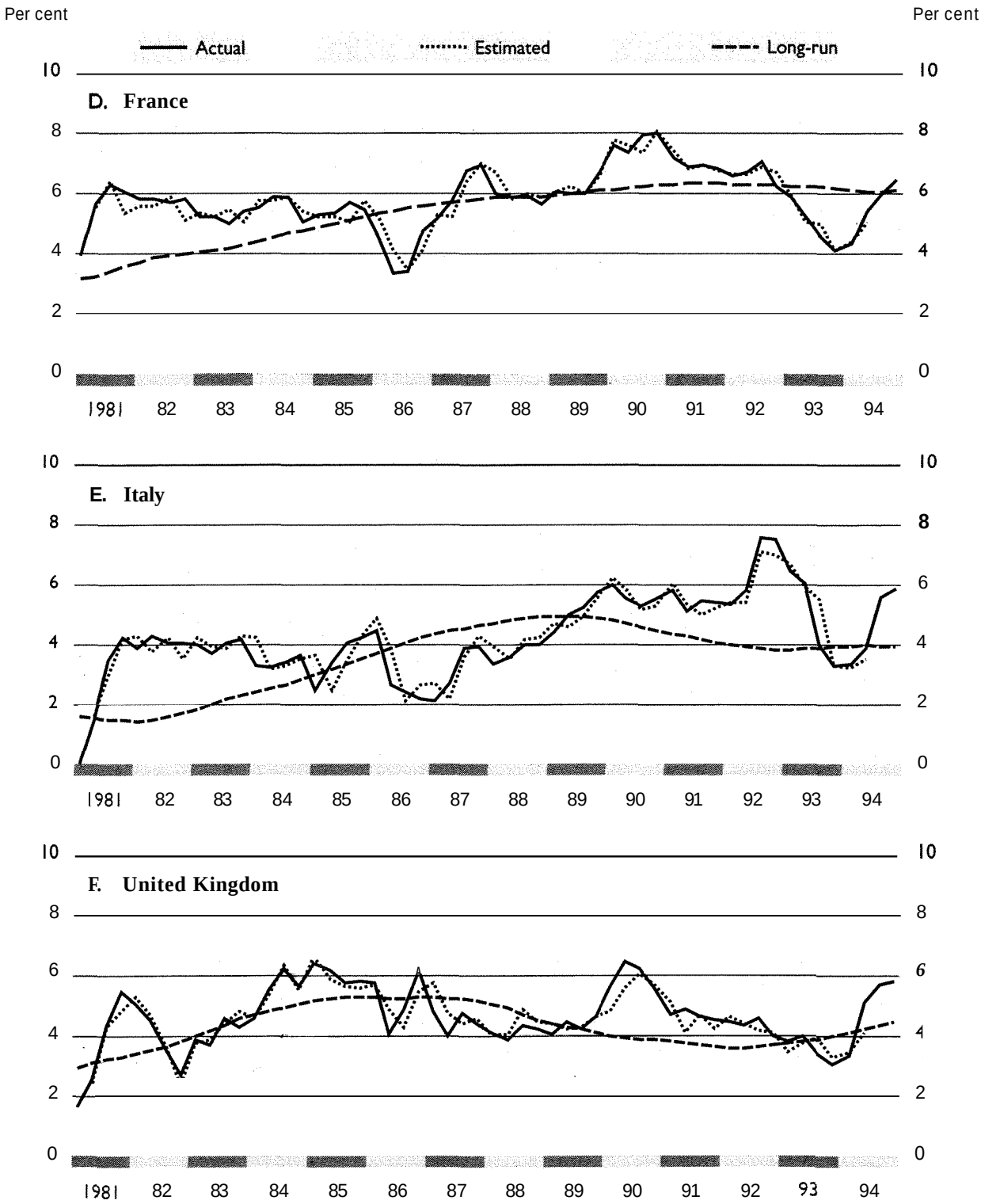
Consistent with the framework discussed above, the coefficients on the fundamentals – the long-run determinants – are constrained to be equal across the 17-countries, including the error-correction term. Given both the theoretical rationale for the restrictions and the complexity of non-linear estimation needed to relax them, these restrictions have not been tested. The level of a foreign G3 country real rate (r^*) is also included in each equation for the smaller countries, although the coefficient was not constrained to be equal across countries. A significant positive coefficient implies that a country pays a premium on its own real long-term rate above that suggested by its fundamentals. Some possible explanations for an additional risk premium could include: domestic and foreign assets not being perfect substitutes, leading to home-country preferences on the part of large-country investors; the relative depth of financial markets, with larger countries perhaps offering more variety in terms of the types of assets available; and greater concern over a smaller country's policy stability, given their greater exposure to exogenous external shocks. The possibility of a temporary risk premium was also accommodated through the inclusion of the foreign real rate divided by a time trend (r^*/t) as an additional regressor.'[1] A positive (negative)coefficient implies that the risk premium was declining (rising) over the sample period.

Figure 4. ***Real long-term interest rates: actual, estimated and long-run component***



Source: OECD.

Figure 4 *(continued)* ***Real long-term interest rates: actual, estimated and long-run component***



Source: OECD.

The estimation results in Table 1*a* suggest that a number of countries which have followed a fairly hard-currency option (*i.e.* France, Austria, Belgium, and Denmark) or are highly integrated with a major capital market (*i.e.* Australia and Sweden) have had an additional risk premium on their real rate related to the level of the foreign real rate.[12] Only Canada has a declining risk premium (*vis-à-vis* the United States), while Belgium, Spain and Switzerland have experienced an increase in their premia (*vis-à-vis* Germany) over the sample period. The negative premium on the Italian real rate is difficult to justify and may be more indicative of measurement concerns than any fundamentals. The level of Italian real rates are probably understated given the relatively short maturity of Italian government debt, especially in the early part of the sample. The results were not significantly changed when the Italian long rate was excluded from the model. It should also be noted, however, that the empirical results are not substantially altered if the relevant G3 real rate was dropped from all equations. The constrained coefficients on the fundamentals remain significant and deviate little from the values in Table 1.

Inflation uncertainty or mismeasurement?

The significance of past inflation (relative to current expectations) in a real interest rate model can be interpreted in two ways. First, it can be viewed as a proxy of the monetary authorities' inflation credibility, with investors demanding a risk premium on the real rate of return in proportion to the degree to which past inflation exceeded expectations. The fact that this variable is a 10-year moving average of past inflation implies that real rates will adjust only slowly to an improved inflation track record,[13] implying credibility is slow to establish. Nonetheless, the coefficient on past inflation suggests that gaining credibility (which is captured in the model by holding actual inflation at current levels for several years) could lead to a decline in real rates by as much as one third of a percentage point.

The second rationale for the significance of past inflation is that it is a correction for any mismeasurement of inflation expectations. This is consistent with the view that *ex ante* real interest rates vary considerably from their *ex post* approximations, possibly given the slow adjustment of inflation expectations.[14] In order to assess the validity of the inflation expectations hypothesis, the final specification outlined in Tables 1 and 2 was re-estimated as a nominal interest-rate model. That is, the inflation expectations series – generated using the Hodrick-Prescott filter – was treated as an explanatory variable, in addition to the current and 10-year moving average of actual inflation. The coefficients on these variables were again constrained to be equal across countries. The coefficient on inflation expectations was found to be insignificantly different from unity, with the remaining inflation variables statistically insignificant and their coefficients summing near to zero – implying a long-run pass through of inflation into nominal rates. In sum, it

appears reasonable to interpret the results in Table 1 as a real rate specification, with some risk premium attached to monetary policy credibility.

The rate of return on capital

The rate of return on business capital is a statistically important determinant of the level of real long-term interest rates. This variable can be viewed as a proxy for the opportunity cost of holding bonds and is a substitute for equity price indices sometimes used in time-series analysis of interest rates, as for example Barro and Martin (1990).The estimated long-term coefficient suggests that the rise in the rate of return on capital from the early-1980s to 1994 (from a G7-weighted average of 13 per cent in the first half of the 1980s to 16 per cent in 1994) accounts for around ¾ of a percentage point of the total rise in real long-term interest rates.

More generally, the time path and cross-country comparison of rates of return on capital appear to provide a credible story of economic "catch-up" across the OECD countries, which fits well with the longer-run properties of the empirical model. That is, real long-term interest rates converge to their domestic rate of return on capital in the medium-term, with real rates converging internationally only in the longer run as factor returns equalise. It is important to note, however, that the other explanatory variables remain relatively robust even when the rate of return on capital is replaced either with a single constant or some weighted average of the G3 real rates (*i.e.* imposing a stricter form of convergence).

Saving and investment imbalances

The estimation results indicate that current-account balances and government deficits are important determinants of movements of real interest rates. The latter result is consistent with Ford and Laxton (1995), although they emphasise the government's net debt position rather than the deficit.[15] The statistical significance of these two variables is possibly indicative of several related factors. As noted earlier, a persistent current-account imbalance will raise the probability of a future correction, leading to uncertainty about the future value of the exchange rate. Persistent current-account imbalances also reflect a structural domestic saving-investment imbalance, possibly due to a persistent government deficit. In the case of persistent external and/or government deficits, real long-term rates will come under upward pressure, both compensating foreign investors for any exchange rate risk and acting to correct any domestic saving-investment imbalance. The estimated coefficients suggest that a rise in a country's public deficit by one per cent of GDP could raise real interest rates by around ⅙ of a percentage point, if financed exclusively by the domestic private sector. If, however, the deficit results in an equivalent current-account deterioration (i.e.the deficit is financed entirely from abroad), the corresponding rise in real interest rates would be approximately twice

as large. These results appear consistent with casual empiricism. For example, those countries which have experienced high government deficits but fairly balanced current-account positions (e.g. Belgium and the Netherlands) have had relatively low real interest-rate differentials over the past 15 years. In contrast, Australia has had a history of relatively balanced government finances but a persistent current-account deficit, resulting in higher real rates. Finally, Canada has a history of both higher-than-average current account and public deficits, and relatively high real interest rates. A virtuous policy circle apears evident with respect to fiscal policy: reduced government deficits, especially those which positively influence the current-account balance, will lead to lower real long-term interest rates over time and hence reduced financing costs.

The short-run determinants

From Figure 4, it is noticeable that developments in the longer-run fundamentals explain very little of the shorter-term movements in real interest rates. Most of the explanatory power of the model is derived from the short-run dynamics, more specifically, the interactions between G3 and non-G3 countries' real rates and domestic monetary policy. The initial set of short-run explanatory variables included first differences in all of the above long-run determinants, in addition to a lagged dependent variable, quarterly inflation changes and proxies of the stance of monetary and fiscal policy (Table 2). The latter two variables were respectively proxied by the first differences of the real short-term interest rate and the structural budget balance (as a ratio to GDP). The first difference in a G3 country's real rate was also included contemporaneously (necessitating estimation using instrumental variables), allowing for the simultaneous determination of real rates globally. Again, details of these variables are given in the Annex.

Movements in real short-term interest rates were significant in all countries, consistent with the view that monetary policy actions – in response to cyclical developments – lead long-term real interest rates to deviate from their trend. In addition, the short-term influences of G3 monetary policy actions are transmitted across countries. A recent example of international monetary policy transmission was the United States' policy tightening in 1994, which was followed by rising long-term rates both in the United States and internationally. As mentioned above, the positive coefficient on real short rates appears consistent with both their effect on the holding cost of longer-term securities and a signalling effect of changes in official rates: movements in official rates may tend to be linked to broader shifts in perceptions about prospects for growth and inflation, factors which are relevant to the determination of longer-term bond yields. Short-run fiscal policy developments, as proxied by changes in the structural budget balance, only appear significant in two countries (Austria and Ireland) although, as noted earlier, the fiscal indicator has an important explanatory role in the longer-run trend. A possible reason for the

lack of significance in the short-run specification is the need to interpolate annual fiscal data, which is likely to give a poor proxy for dynamic influences on real interest rates.

EXPLAINING THE RISE IN REAL LONG-TERM INTEREST RATES SINCE THE 1970s

As a means of determining whether the model is capable of explaining the rise in real long-term rates between the 1970s and 1980s, the model structure outlined in Tables 1 and 2 was re-estimated over the sample period 1975Q1 to 1994Q2, which incorporates a considerable rise in real interest rates across all countries. The long-run coefficients remained significant and of the same sign and similar magnitude, except for the risk (β) variable and the government deficit which are both insignificant when estimated over the longer time period (see Table 3). The magnitude of the error-correction coefficient was considerably reduced, however, suggesting longer deviations of actual rates from their long-run trend.

A simulation of the model over the period 1975-1994 for the G7 countries suggests that around half of the 4 percentage points average increase in real interest rates which took place between the 1970s and 1980s can be explained by the fundamental factors included in the model (see Figure 5). Lagged adjustments to the major swings in inflation rates appear to constitute the most important explanatory factor, while the rise in the rate of return on capital consistently explained about 10 per cent of the trend rise across countries.

In sum, it appears that the estimated model can only explain part of the observed rise in real long-term rates in the 1980s. It seems likely that the removal of financial regulations, which had artificially suppressed interest rates in the 1970s, would also explain a significant part of the observed increase, although this is not explicitly modelled.

CONCLUSIONS

Pooled-time-series analysis suggests that the rate of return on capital, a country's past history of inflation, current-account balances and government deficits are all important determinants of trend real long-term interest rates – both as a group and relative to one another. However, developments in these fundamentals explain very little of the shorter-run movements in real rates, with divergences of actual from trend real interest rates persisting for long periods. This means that the analysis cannot support a strong interpretation of volatile interest-rate movements from quarter to quarter, which appear to be driven by largely unobservable shifts in market expectations. However, over longer periods, the analysis provides a partial basis for interpreting real interest-rate trends and for explaining persistent cross-country differentials.

Table 3. **Real long-term interest rate equation estimated from 1975**[1]

17 country simultaneous estimation

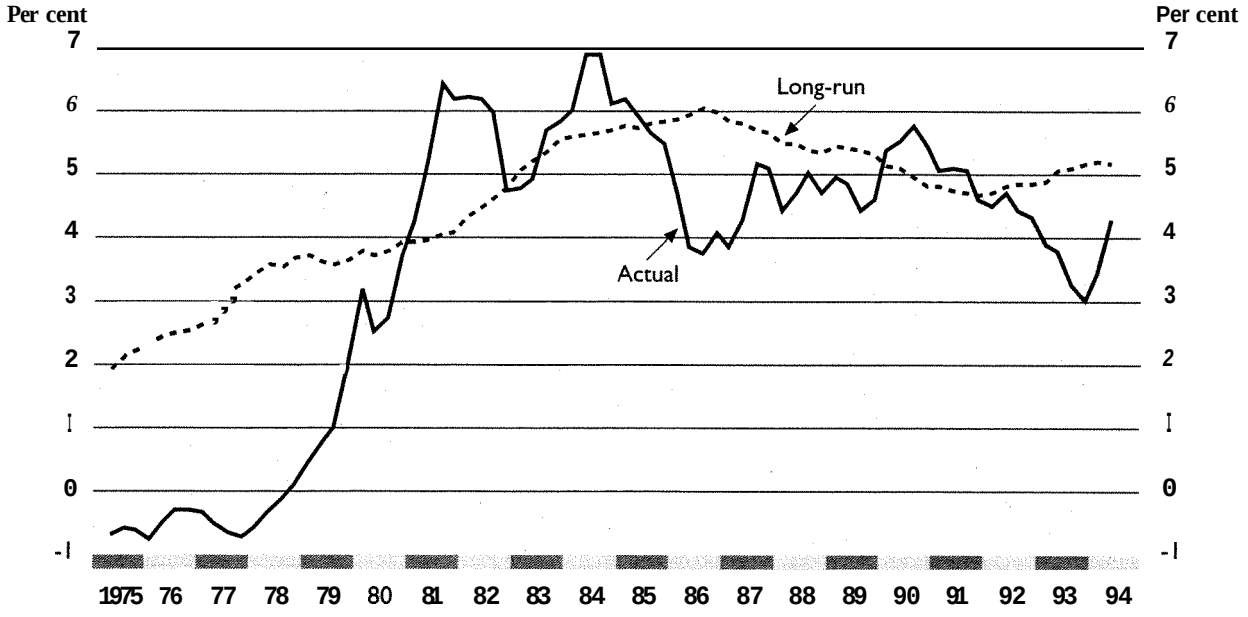
Dependent variable: first difference of real long-term interest rates
Quarterly data from 1975Q2 to 199402

Variable	ECM coefficient	t-statistic	Implied long-run coefficient
	Constrained long-run coefficients		
Error correction	–0.044	6.71	
Return on capital	0.012	4.63	0.27
Risk	0.021	0.77	0.48
Past minus expected inflation	0.022	3.21	0.50
Current account	–0.010	–2.22	–0.23
Government deficit	0.004	0.81	0.09

1. See data sources and definitions in the Annex

Figure 5. ***Major seven real long-term interest rate estimated from 1975***

GDP-weighted actual and long-run component



Source: OECD.

The significance of the longer-run explanatory factors outlined above suggests a number of specific policy conclusions. First, maintaining low and stable inflation can be expected to result in lower real interest rates. However, the rewards are likely to come after a considerable period of time, as policy credibility takes a long time to establish. Second, public deficits have a significant influence on the level of real interest rates. Maintaining a relatively balanced budget over the business cycle can be expected to result in lower real interest rates, and possibly set in motion a virtuous circle – given the lower future cost of servicing any public debt. Third, to the extent that reduced government deficits raise national saving and improve the current-account balance, the beneficial effects of fiscal consolidation on real interest rates are reinforced. Finally, an additional risk premium on real long-term interest rates can possibly be expected in cases where a hard-currency commitment is made but economic fundamentals have not fully converged to those of the anchor country.

NOTES

1. See Deacon and Derry (1994) and Duenwald (1994). The inflation risk premium may arise if agents are willing to pay more (that is, accept a lower real yield) for an asset whose real yield is guaranteed. In addition, the inflation expectations of financial markets may not be those of the public at large (i.e. ordinary savers'or borrowers), implying saving and investment decisions are influenced by different "real" yields. The market for index-linked bonds also differs in the degree of liquidity across countries, implying some variation in the liquidity premium.

2. This method of trend estimation is described in King and Rebelo (1989).

3. Trends in saving and investment aggregates are affected by a number of measurement problems. In broad terms these affect the measurement of total income, the exact classification of expenditures between consumption and investment, and the measurement of the sectoral allocation of these aggregates between household, business and government sectors. Empirical efforts have been made to adjust saving ratios (as calculated in an SNA framework) for several of these measurement concerns (see Elmeskov et al., 1991). Some of these adjustments do have significant effects on measured levels of saving and investment, for example using different deflators, although most do not affect the overall balance between saving and investment at an aggregate level.

4. Dependency ratios have trended upwards since the 1950s in the United States, Japan and Europe. However, this effect has to some extent been offset by rising labour force participation rates, particularly in the United States. In the United States, the support ratio (i.e. the ratio of the labour force to the total population) has been increasing since the 1960s and is not expected to peak until around the year 2010. In Japan and Europe, the projections show the peak having been reached in 1990. See Cutler et al. (1990), Auerbach et al. (1989) and Hagemann and Nicoletti (1989).

5. The gross rates of return on business capital are subject to measurement errors, especially with regard to the absence of a deflator for the total capital stock. This has necessitated using a gross business investment deflator which, since the relative price of these goods has been declining, may bias downward the rate of growth of the value of the capital stock. This in turn would imply overstatement of the increase in the rate of return on capital. See Keese et al. (1991).

6. It is important to remember that the convergence of real long-term interest rates on government debt still leaves open significant opportunity for other rates to differ, for

example, those to businesses and households, based on their credit-worthiness, tax position and investment opportunities.

7. It could be argued that more recently the extent to which countries are able to inflate their debt away has declined, with the low-inflation objectives of central banks becoming more transparent. This greater transparency has also often occurred in association with some form of increased independence from government decision-making (as, for example in Spain, Italy, France, Mexico and New Zealand), providing increased institutional resistance to the ability to inflate.

8. The analysis could be derived from the Mundell (1968) and Fleming (1962) model which ensures that interest rates converge across all countries when domestic and foreign assets are perfect substitutes and real exchange-rate expectations are constant. Throop (1994) shows why interest rates diverge across countries once the strict assumptions of the Mundell-Fleming model are relaxed. Kasman and Pigott (1988) also provide a general discussion of persistent interest-rate differentials.

9. The instruments for the G3 countries' real long-term rates included one-quarter lags of actual and quarterly changes of real long-term and short-term interest rates, the government deficit and the current-account balance, the rate of return on capital and the beta statistic.

10. Further empirical analysis could refine which large-country foreign rate is most relevant in the small-country equations, including some weighted average. For example, the Ireland specification may benefit from the inclusion of the UK real rate in addition to the German rate.

11. The time trend commenced in 1981Q2, the same as the data sample. This may not be optimal, however, with several countries undergoing regime shifts during the sample period. For example, Spain and the United Kingdom made relatively late commitments to the ERM, while several countries shifted into a deregulated financial environment. Future empirical refinements could include varying the commencement of the time trend to coincide with these country-specific dates.

12. The Netherlands is a surprising exclusion given its strong commitment to the ERM. It is possible, however, that their integration with the German economy is at such an advanced stage that only divergences in the fundamentals explain any real rate differentials.

13. Several moving averages of past inflation were assessed in the initial specification (e.g. 3, 5, 8 and 10-year periods), with the 10-year average consistently the most statistically significant.

14. Such an explanation could reduce significantly the measured gap between real rates in the 1970s and 1980s, with inflation consistently above expectations in the 1970s and below expectations in the 1980s.

15. Government gross and net debt positions were tested in our specification but were found to be insignificant.

Annex

DATA SOURCES AND DEFINITIONS

Real long-term interest rates (r): are defined as the pre-tax nominal long-term interest rate minus expected inflation.

Nominal long-term interest rates: are the yields on benchmark public sector bonds of around 10 years maturity. For the United States, Japan, the United Kingdom, Denmark, Australia and New Zealand: 10-year government bonds; Germany: 7-15 year public sector bonds; France: 10-year public and semi-public sector bonds; Italy: 10-year net Treasury bonds; Canada: over 10-year long-term federal government bonds; Austria.: public sector bonds; Belgium: central government bonds (more than 5-years); Ireland: 15-year government bonds; Netherlands: 5-8 year central government bonds; Spain: government bonds (more than 2 years); Sweden: 5-year long-term government bonds; Switzerland: 10-year private sector bonds. *Source:* OECD Analytical Database.

Inflation expectations (π^e): are generated using the low-frequency component of the annual percentage change in the GDP deflator using a Hodrick-Prescott filter. A lambda value of 1 600 is used in the filtering process. *Source:* OECD Secretariat.

Past inflation ($\bar{\pi}$): is a 10-year moving average of the annual percentage change in the GDP deflator. *Source:* OECD Secretariat.

Inflation: is the annual percentage change in the GDP deflator index. *Source:* OECD Analytical Database.

Real short-term interest rates: are benchmark 3-month yields minus annual inflation. The benchmark 3-month yields are: for the United States: 3-month Treasury bills; Japan. 3-6 month CD; Germany, France, Italy, United Kingdom, Denmark, Spain: 3-month interbank rate; Canada: 90-day commercial paper; Austria: day-to-day money; Belgium: 3-month Treasury certificates; Ireland: 91-day Exchequer bills until 1983, 3-month interbank rate from 1984; Netherlands: 3-month Aibor; Sweden: 3-month Treasury discount notes; Switzerland: 3-month deposit rate; Australia, New Zealand: 90-day bank bills. *Source:* OECD Analytical Database.

The return on capital (ρ): is calculated as gross operating surplus of the enterprise sector divided by the enterprise sector's capital stock. See Keese *et al.*

(1991) for a full description of the sources and methods used to calculate the capital stock data. *Source:* OECD Analytical Database.

Risk is the beta coefficient β: defined as a 12-month moving average of the covariance between the *ex post* bond yield and the return on a domestic portfolio, divided by the variance of the *ex post* return on the domestic portfolio. The domestic portfolio includes domestic bonds and equities, weighted by their respective proportion of the total value of domestic bonds and equities. In calculating the capital gains on domestic bonds, an average effective duration of 6½ years is assumed. *Source:* OECD *Financial Accounts,* Part 2; UK Central Statistical Office, Financial Statistics; Salomon Brothers, Economic and Market Analysis Bulletin.

The current account balance (ca): is a 5-year moving average of the current account balance as a proportion of GDP. *Source:* OECD Secretariat.

The government deficit (gd): is the general government financial balance as a proportion of GDP. *Source:* OECD Secretariat.

Structural budget balance: is the cyclically adjusted general government financial balance as a proportion of GDP. *Source:* OECD Secretariat.

Exchange rate: is the annual percentage change in the nominal effective exchange rate. *Source:* OECD Analytical Database.

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