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EXCHANGE RATES AND REAL LONG-TERM INTEREST-RATE DIFFERENTIALS: EVIDENCE FOR EIGHTEEN OECD COUNTRIES

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At the time of writing the authors were, respectively, Principal Administrator and Consultant, on leave from Swarthmore College. We would like to thank Michael Feiner, Gerald Holtham, Jeffrey Shafer and Martine Durand for helpful comments; and Marie Christine Bonnefous and Rich Lyons for research assistance.

The bivariate relationship between real exchange rates and the real long-term interest rate differential has been investigated in a number of recent studies. By exchange-rate-equation standards, this specification does a relatively good job of tracking the historical movements in the dollar-Deutschemark and the dollar-yen bilateral exchange rates, and the dollar effective exchange rate; but does a poor job for the dollar-sterling rate. This paper extends the analysis to 18 OECD countries, in bilateral as well as effective terms. Results from earlier studies are confirmed, but in general the estimation results are sufficiently mixed to suggest that the absence of any risk premia variables may be an important omission.

* * * * * * * * *

La relation entre les deux variables, taux de change réels et variations du taux d'intérêt réel à long terme, a été étudiée dans un certain nombre d'études récentes. Comparée aux équations sur les taux de change, cette spécification permet de retracer assez valablement les mouvements dans le temps des taux de change bilatéraux du dollar par rapport au deutschemark et du dollar par rapport au yen ; il en va toutefois différemment en ce qui concerne le taux du dollar par rapport à la livre sterling. Le présent document élargit cette analyse en la faisant porter sur 18 pays membres de l'OCDE et prend en compte tant les taux de change bilatéraux que les taux de change effectifs. Les résultats obtenus confirment les études antérieures, mais les estimations sont dans l'ensemble suffisamment erratiques pour suggérer que l'absence de toute variable de primes de risque constitue peut-être une omission importante.

EXCHANGE RATES AND REAL LONG-TERM INTEREST-RATE DIFFERENTIALS: EVIDENCE FOR EIGHTEEN OECD COUNTRIES

1. Real long-term interest-rate differentials have recently received considerable attention in discussions of exchange-rate determination, partly reflecting the fact that the 1980-84 appreciation of the U.S. dollar coincided with rising real long-term interest-rate differentials in favour of the United States [cf. the charts presented in OECD (1984), pp.78-82]. But this focus on long-term differentials also reflects the inability of short-term interest-rate differentials and most conventional measures of the risk premium to explain the 1980-84 exchange-rate movements. Econometric studies by Shafer and Loopesko (1983), Hooper (1984) and Sachs (1985) have provided support for a limited number of countries for an important link between the dollar's real exchange rate and real long-term interest-rate differentials. This note examines the robustness of this relationship with an expanded data set covering 18 OECD countries. Section I outlines the theoretical basis for a relationship between real exchange rates, real long-term interest-rate differentials and the risk premium. Section II briefly reviews previous empirical studies and presents new results for 18 countries' effective and bilateral exchange rates. Section III discusses the limitations of the economic analysis, particularly the absence of a risk premium, and suggests directions for further research.

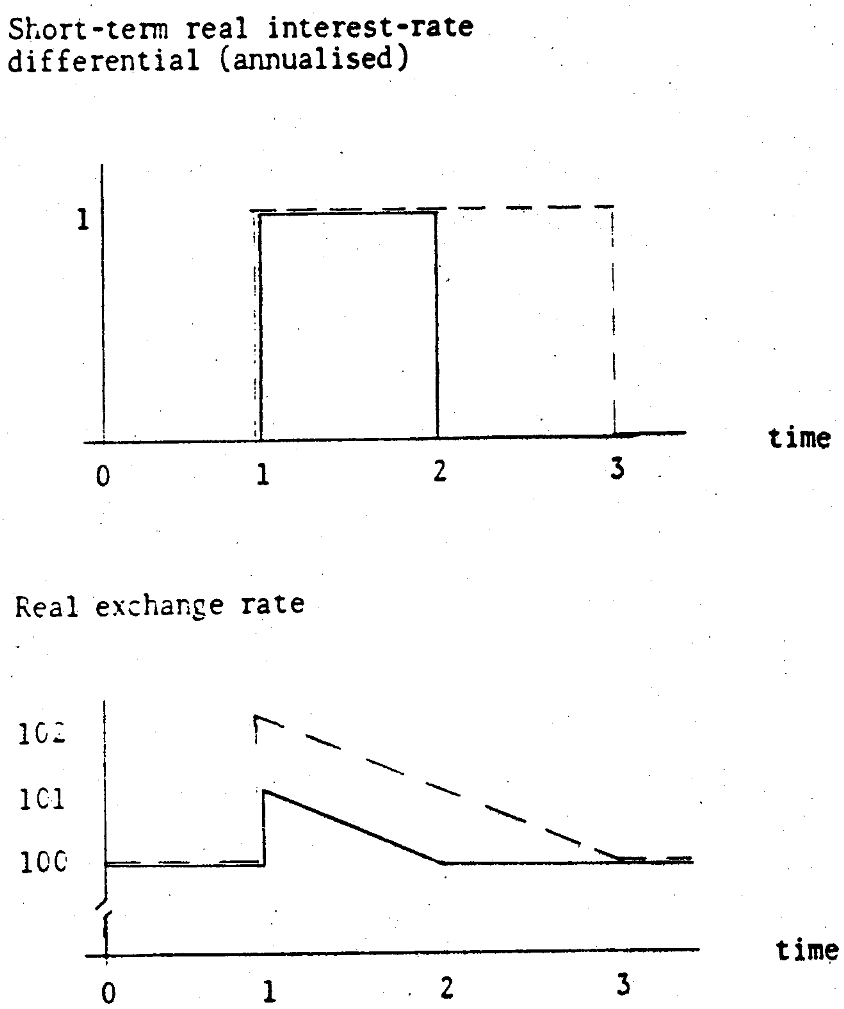
I. Theoretical background (1)

2. Our starting point is the interest parity condition that the domestic interest rate plus the expected appreciation of the domestic currency is equal to the foreign interest rate plus a risk premium. This relationship holds over any time horizon and in real as well as nominal terms. The advantage of viewing the interest-parity condition as a long-run real relation becomes clear if we assume that the exchange rate is expected to return to purchasing-power-parity (PPP) in the long run, but not in the short run (2). In this case, the exchange rate will be expected to change over a long time span, and we have to look to the end of the adjustment period to pin down the level of the real exchange rate.

3. Before developing the model analytically, it may be helpful to consider an example, depicted in Figure 1. Assume that the risk premium is zero and that the United States and Germany start out at time 0 with identical nominal interest rates and inflation, and that the dollar/mark rate is at an equilibrium PPP level (the real exchange rate equals 100). At time 1, U.S. short-term interest rates increase, with no change in expected inflation, and are expected to stay at this higher level for one period (solid lines). The dollar will appreciate in real terms, giving rise to an expected depreciation back to purchasing power parity at a rate equal to the interest differential. The extent of the dollar appreciation in period 1 depends on the expected

Figure 1

EXCHANGE RATES AND THE TERM STRUCTURE OF INTEREST RATES



——— Short-term real interest-rate differential rises for 1 period.

-------- Short-term real interest-rate differential rises for 2 periods.

level of the interest-rate differential in period 2. If the dollar interest rate stays at its higher level until period 3 (dashed lines), the dollar must be expected to depreciate correspondingly over this entire interval in order to maintain interest parity. The dollar must therefore jump to a higher level in period 1 than if the short-term interest differential in favour of the dollar lasts only from period 1 to 2. In this case the movement of the spot exchange rate is related to the two-period interest differential rather than the one-period differential. Assuming that the expectations theory of the term structure holds, i.e. long-term interest rates are essentially a weighted average of expected future short-term rates, the movement of the spot exchange rate will be related to the long-term interest-rate differential.

4. More formally, the interest-parity condition can be written, in nominal terms,

$$s^e = n(i^* - i) + n.RP, \qquad [1]$$

where s^e is the expected per cent change in the exchange rate over n years, i is the interest rate of maturity n expressed at an annual percentage rate, RP is a measure of the risk premium on domestic assets expressed at an annual percentage rate and * denotes the relevant foreign variable. The risk premium is zero only if foreign and domestic assets are perfect substitutes. The exchange rate is expressed as the foreign-currency price of domestic currency, so that an increase represents appreciation of the domestic currency. Let p^e denote annual expected inflation, and q^e the expected change in the real exchange rate over n years. The interest-parity relation can be expressed in real terms as,

$$q^e = s^e + n(p^e - p^{*e}) = n[(i^* - p^{*e}) - (i - p^e)] + n.RP, \qquad [2]$$

or, letting r be the real interest rate, as,

$$q^e = n(r^* - r) + n.RP. \qquad [3]$$

Finally, we assume that the time span n is long enough for the log of the real exchange <u>level</u> Q to return to its long-run equilibrium Q, i.e., PPP is reached after n years. This implies,

$$q^e = Q - \bar{Q}. \qquad [4]$$

Substituting [4] into [3] yields the relation between the current real exchange rate Q and the long-term real interest-rate differential and the risk premium,

$$Q = \bar{Q} + n(r - r^*) - n.RP. \qquad [5]$$

5. Equation [5] states that a 1 per cent annualised real <u>long-term</u> interest differential is associated with an n per cent deviation from PPP. The impact of the risk premium is magnified in an analogous manner. If n is of the order of 10, small changes in either the long-term real interest differentials or the risk premium can engender changes in exchange rates similar in magnitude to those of recent years for the U.S. dollar and other currencies (3). By contrast, a 1 per cent annualised <u>short-term</u> (one year) differential is associated with a 1 per cent deviation of the real exchange

rate from purchasing-power parity, as the real exchange rate must be expected to change by 1 per cent over one year to maintain interest parity.

II. Econometric results

6. Shafer and Loopesko (1983) estimated equation [5], without the risk premium term, for three bilateral exchange rates vis-à-vis the dollar (the German mark, Japanese yen and U.K. pound), with monthly data from August 1973 to March 1982. They tried two proxies for expected inflation in calculating real interest rates: a "rational" expectation using vector autoregression techniques and a "myopic" expectation defined as a twelve-month centred moving average of consumer price inflation. The latter yielded better results and these are reproduced in Table 1. For both the dollar-mark and dollar-yen equations, the estimated coefficients on the real interest-rate differential (n in equation [5]) were correctly signed in the myopic case, with values between 2 and 3. In the dollar-pound equation, however, the estimated coefficient on the real interest-rate differential had the wrong sign using either expectational proxies. Sachs (1985) estimated a comparably specified equation for the dollar-mark exchange rate using a two-year centred moving average to proxy inflation expectations, with quarterly data from 1977Q1 to 1984Q4. The estimated coefficient on the real interest-rate differential was 6.5 (Table 1).

7. Hooper (1984), who also did not include a risk premium variable, used the Federal Reserve Board's ten-country trade-weighted effective dollar exchange rate, and a similarly weighted real interest-rate differential, with quarterly data from 1974Q2 to 1983Q4. Expected inflation was proxied by a three-year centred moving average of consumer price inflation, although Hooper reports that very similar results were obtained with a backward-looking moving average. The estimated coefficient on the real long-term interest-rate differential is near 6. Hooper used a version of this equation in the Federal Reserve Board's multicountry model (MCM) to study the international repercussions of a change in U.S. fiscal policy. This equation did a better job of tracking the recent dollar appreciation than the previous MCM exchange-rate equation which was a function of short-term interest-rate differentials and a risk premium proxied by cumulated capital flows.

8. Given these econometric results and the visual correlations noted above, we have experimented with a real long-term interest-rate differential in the simultaneous estimation of effective exchange-rate equations for 18 countries on semi-annual data from 1973II to 1983II. This work has been carried out in the context of an ongoing project to improve the tracking and simulation properties of FINLINK, the financial/exchange-rate block of the OECD's multicountry INTERLINK model. In FINLINK, international consistency implies cross-equation parameter restrictions; in particular for a variable such as the real long-term interest-rate differential, which is constructed analogously to the effective exchange rate, this consistency requirement is that the relevant parameter be identical for all countries (4). Preliminary results where this restriction was imposed often yielded significant and positive estimated coefficients on the real long-term interest-rate differential. The size of the estimated coefficients, however, was always much smaller than those obtained by Shafer and Loopesko, Sachs and Hooper; indeed, the coefficient estimates were usually less than unity, which would

Table 1

REAL EXCHANGE RATES DETERMINED BY LONG-TERM
REAL INTEREST DIFFERENTIALS:
RESULTS FROM OTHER STUDIES (a)

Study	dependent variable (real)(b)	constant	L-T real interest differential	R^2	DW
Shafer & Loopesko (monthly, 8/73 to 3/82)	dollar-mark	-1.49 (0.01)	2.74 (0.32)	0.24	na
	dollar-yen	-6.04 (0.01)	2.19 (0.21)	0.51	na
	dollar-pound	0.66 (0.02)	-0.35 (0.42)	0.01	na
Sachs (quarterly, 77Q1 to 84Q4)	dollar-mark	4.62 (0.01)	6.5 (0.56)	0.81	0.71
Hooper (quarterly, 74Q2 to 83Q4)	effective dollar(x100)	457.0 (0.9)	5.9 (0.5)	0.80	0.70

Sources: See references.

(a) Standard errors in parentheses.

(b) All the real exchange-rate variables are in logarithms. In Shafer and Loopesko the exchange rate is defined as the price of a dollar in units of domestic currency. We have multiplied Shafer and Loopesko's coefficients on the long-term real interest differential by -1 to make them comparable to the other studies.

seem inconsistent with the long-term adjustment assumption in the model sketched out above.

9. In order to elucidate these results, we then estimated unconstrained single country equations for both real effective as well as real bilateral exchange rates for the 18 FINLINK countries. The equations were estimated by ordinary least squares to be comparable with those reported in Table 1; estimates using two-stage least squares with the lagged interest differential and real GNP growth differentials as instruments did not change the character of the results. The real long-term interest rate (ILR) is defined as the nominal long-term interest rate minus either a three or a six semester moving average of the annual growth rate of the GDP deflator (PG). Except for Ireland, Norway and Switzerland, the shorter lag on inflation worked better (5). The definitions of the long-term interest rates are given in an appendix. The specification of the equations is comparable with those discussed above, but the level of time aggregation, data definitions and estimation periods differ.

10. The bilateral exchange rate (EXCH) is defined as the U.S. dollar price of a unit of domestic currency and hence an increase in the domestic real interest rate relative to the U.S. real interest rate (IRLUS) would increase the exchange rate. As can be seen from Table 2, the bilateral equation "works", in the sense that the estimated coefficients on the real interest-rate differential are correctly signed and larger than unity, for Japan, Germany, France, Austria, Belgium, Denmark, Ireland, the Netherlands, Norway, Sweden and Switzerland. Of these, the equations for Germany, Austria, Denmark and the Netherlands "explain" 40 to 50 per cent of the total variation in the real bilateral exchange rate. For the remaining six countries, the estimated coefficients are either small and/or perversely signed. The average value of the estimated coefficients in the 17 equations is 1.54.

11. Table 2 also reports the estimation results for the effective exchange rates (EXCHEF). The weighting matrix used to define the effective exchange rate, as well as the foreign GDP deflator (PGF) and the foreign real long-term interest rate (ILRF), reflects the currency composition of foreign outstanding assets and liabilities for the 18 countries (cf. data appendix). The estimated coefficients on the real long-term interest differential are positive and greater than unity for the U.S., Germany, France, Austria, Belgium, Denmark, Ireland, the Netherlands and Switzerland. The equations for the United States, Austria and Denmark explain roughly half of the total variation. For the other countries, the estimated coefficients are either small and/or perversely signed. The average value of the estimated coefficients in the 18 effective exchange-rate equations is 0.88; excluding the U.S. equation, the average is 0.63.

12. In the model presented in Section I, the constant term in the estimated equations represents the equilibrium real PPP exchange rate. In a preliminary report on the OECD Purchasing Power Parity project, Hill (1984) has presented estimates of real PPPs. These are defined in terms of domestic prices relative to U.S. prices and are reported in column 1 of Table 3. Given the definition of the real bilateral exchange rates, it is necessary to calculate the exponential of the negative of the constants reported in Table 2 to make them comparable with the PPPs. These transformations are reported in Table 3 in column 2. For Japan, Canada, Australia and Austria the estimated constants differ by less than 10 per cent from the real PPPs; while for Germany, France,

Table 2

REAL EXCHANGE RATES DETERMINED BY
LONG-TERM REAL INTEREST DIFFERENTIALS

Bilateral: ln(EXCH*PG/PGUS) = a1 + b1*(ILR-ILRUS)
Effective: ln(EXCHEF*PG/PGF) = a2 + b2*(ILR-ILRF)(a)

	Bilateral				Effective			
	a1	b1*100	R^2	DW	a2	b2*100	R^2	DW
United States					0.11 (0.02)	5.15 (1.05)	0.56	0.82
Japan	-5.47 (0.03)	1.33 (0.84)	0.12	0.49	0.003 (0.02)	0.43 (0.64)	0.02	0.59
Germany	-0.79 (0.03)	4.19 (1.23)	0.38	0.57	-0.15 (0.03)	3.22 (1.32)	0.24	0.44
France	-1.58 (0.04)	5.31 (2.06)	0.26	0.83	-0.13 (0.04)	2.63 (2.34)	0.06	0.55
United Kingdom	0.48 (0.05)	-1.31 (0.96)	0.09	0.15	-0.33 (0.05)	-1.17 (0.88)	0.08	0.13
Italy	-6.94 (0.07)	0.15 (1.11)	0.003	0.43	-0.18 (0.04)	-0.42 (0.77)	0.02	0.43
Canada	-0.16 (0.01)	-1.56 (0.49)	0.35	0.35	0.04 (0.02)	-2.55 (0.77)	0.37	0.44
Australia	0.09 (0.02)	-0.62 (0.40)	0.11	0.45	-0.03 (0.01)	-1.02 (0.33)	0.34	0.71
Austria	-2.74 (0.02)	3.88 (0.85)	0.52	0.65	-0.14 (0.01)	3.32 (0.79)	0.48	0.67
Belgium	-3.57 (0.04)	2.75 (1.29)	0.19	0.16	-0.16 (0.04)	1.45 (1.21)	0.07	0.13
Denmark	-1.98 (0.03)	3.42 (0.71)	0.55	0.64	-0.19 (0.03)	2.65 (0.72)	0.42	0.46
Finland	-1.39 (0.04)	0.80 (0.60)	0.09	0.38	-0.08 (0.03)	0.09 (0.47)	0.002	0.34

Table 2 (continued)

Bilateral: ln(EXCH*PG/PGUS) = a1 + b1*(ILR-ILRUS)
Effective: ln(EXCHEF*PG/PGF) = a2 + b2*(ILR-ILRF)(a)

	Bilateral				Effective			
	a1	b1*100	R^2	DW	a2	b2*100	R^2	DW
Ireland(b)	0.54 (0.03)	0.81 (0.52)	0.11	0.49	-0.16 (0.02)	0.54 (0.46)	0.07	0.45
	0.56 (0.03)	1.76 (0.85)	0.19	0.48	-0.13 (0.03)	1.35 (0.77)	0.15	0.50
Netherlands	-0.85 (0.03)	4.48 (1.20)	0.42	0.64	-0.12 (0.02)	2.86 (1.19)	0.23	0.39
Norway(b)	-1.71 (0.03)	0.43 (0.77)	0.02	0.43	-0.10 (0.02)	-0.66 (0.53)	0.08	0.48
	-1.64 (0.04)	2.96 (1.31)	0.21	0.62				
Spain	-4.54 (0.06)	-0.44 (1.05)	0.01	0.28	-0.24 (0.06)	-0.46 (0.91)	0.01	0.31
Sweden	-1.59 (0.05)	1.29 (1.62)	0.03	0.29	-0.15 (0.04)	-0.50 (1.43)	0.01	0.20
Switzerland(b)	-0.63 (0.04)	1.34 (0.86)	0.11	0.40	-0.08 (0.03)	0.37 (0.78)	0.01	0.37
	-0.57 (0.04)	3.22 (1.15)	0.29	0.47	-0.03 (0.04)	2.09 (1.05)	0.18	0.43

(a) All equations are estimated by OLS on semi-annual data from 1973II to 1983II (N=21). See text for definitions of variables. Standard errors are given in parentheses, the standard errors on b1 and b2 have been multiplied by 100.

(b) In the second equations the long-term real interest rate has been defined using a six semester average of annual inflation rates with weights w0 = 0.15, w1 = 0.15, w2 = 0.02, w3 = 0.2, w4 = 0.15, w5 = 0.15.

Table 3

REAL PURCHASING POWER PARITIES AND THE ESTIMATED CONSTANTS FROM THE BILATERAL EQUATIONS

	PPP (1)	e^{-a1} (2)	(2/1)
Japan	248	237	0.96
Germany	2.57	2.20	0.86
France	5.69	4.85	0.85
United Kingdom	0.53	0.62	1.17
Italy	824	1 033	1.25
Canada	1.10	1.17	1.06
Australia (a)	0.98	0.91	0.93
Austria	16.5	15.5	0.94
Belgium	39.7	35.5	0.89
Denmark	8.06	7.24	0.90
Finland	5.08	4.01	0.79
Ireland (b)	0.50	0.58	1.16
		0.56	1.12
Netherlands	2.74	2.34	0.85
Norway (b)	6.79	5.53	0.81
		5.10	0.75
Spain	69.1	93.7	1.36
Sweden (a)	5.83	4.90	0.84
Switzerland (a)(b)	2.42	1.88	0.78
		1.77	0.73

Sources: Hill (1984) and Table 2.

(a) Purchasing-power parities were provided by the Statistics Division of the Economics and Statistics Department.

(b) The second line is based on the second equations reported in Table 2.

the United Kingdom, Belgium, Denmark, Finland, Ireland, the Netherlands, Norway and Sweden the estimated constants differ by 10 to 20 per cent from the real PPPs. These results should be interpreted cautiously since the estimated constants in the regressions will be the sample mean of the real exchange rate if the sample mean of the interest differentials are zero.

III. Conclusions and implications for further work

13. To summarise, although we have used different data frequencies, data definitions and estimation periods, the bilateral equations for Japan, Germany and the U.K. are consistent with those obtained by Shafer and Loopesko and Sachs, and the effective equation for the U.S. is similar to Hooper's. The finding that an increase in the long-term real interest-rate differential of one percentage point is associated with a more than equi-proportionate currency appreciation of some 2 to 5 per cent appears to hold for a number of countries, but does not generalise to all of the countries studied here. Nor does the real interest-rate differential alone explain a large part of the variation in real exchange rates for most countries, as evidenced by the relatively low R^2s.

14. There are several possible reasons for the mixed empirical support the theory receives from the data for these eighteen countries. First, adaptive measures of inflation expectations may be inadequate in some instances. For example, during the 1976 sterling crisis, anticipations of accelerating U.K. inflation may have been understated by moving averages of past inflation, so that U.K. real interest rates were lower than our measures suggest (6). Second, for some countries interest rates may respond endogenously to exchange rates, if exchange rates enter monetary policy reaction functions. In the U.K., for example, the Bank of England often tightens monetary policy when sterling is weak. Thus, if sterling weakens for some reason other than interest-rate differentials, increases in interest-rate differentials in favour of the U.K. may be associated with sterling depreciation, instead of the appreciation suggested by the theory presented here (7).

15. A more fundamental problem with the approach adopted here and in the referenced studies may be the absence of any proxies for the risk premium, such as the outstanding stock of foreign assets. Theoretically this is troublesome because it means that the exchange-rate equation is not consistent with a portfolio balance specification of international capital flows. And the absence of any variable representing the outstanding stock of assets has the strong policy implication that foreign exchange market intervention cannot be effective. The presence of positive serial correlation of the error terms in all of the estimated equations in Tables 1 and 2, which is indicative of the absence of relevant variables, suggests that risk premium proxies may be an important omission (8). Most recent studies, however, have found little empirical support for imperfect substitutability, i.e. the importance of risk premia, in structural exchange-rate models [cf. Tryon (1983)]. Exceptions are FINLINK where a significant, albeit small, coefficient was obtained on a risk premium proxied by cumulative current-account imbalances [cf. Holtham (1984)], and Fukao (1985).

16. There are a number of possible reasons why other studies have failed to obtain structural estimates of risk premia. One reason is that most exchange-rate models assume a rapid adjustment to equilibrium. As noted

above, if the focus is on a long-term adjustment to the equilibrium exchange rate, the size of the coefficient on the risk premium is potentially much larger than if a short-term adjustment is assumed. Thus, the model presented above may be an especially appropriate one to test for the importance of risk premia, if forward-looking measures of the risk premia can be obtained.

17. Another reason is that many studies have concentrated on the dollar-mark exchange rate. The risk premium between these two currencies may in fact be low, in part because the U.S. and Germany have made relatively little use of capital controls. Japan and many European countries, with the exception of the Netherlands, have had restrictions on capital-account transactions through part or all of the floating exchange-rate period. Capital controls may entail divergencies from interest parity, i.e., imperfect substitutibility of assets across currencies, for at least two reasons: firstly, capital controls, if at all effective, raise transactions costs of portfolio adjustments and reduce the willingness of investors to arbitrage away differences in expected yields [cf. Giavazzi and Giovannini (1985)]; and secondly, capital controls may be associated with greater political risk and uncertainty about future capital controls, which raises the variability of expected yields, reducing arbitrage by risk-averse investors [cf. Claasen and Wyploz (1982)].

18. The problem is that most proxies for the risk premium are based on net foreign asset stock positions and these have indicated increasing dollar risk over the last three or four years, a period during which the dollar has strongly appreciated. Given that exchange-rate equations without a risk premium have badly underpredicted the strength of the dollar, the underprediction would presumably have been even worse with conventionally measured risk premium proxies. Nevertheless, by end-1985, the dollar has depreciated and it is widely considered that further dollar depreciation is likely. Furthermore, exchange-market intervention in the last half of 1985 appears to have had a significant impact on exchange rates, at least in the short run.

19. This suggests that either conventional measures of the risk premium, or the way they are specified in the exchange-rate equation, may be inadequate. It is likely, for example, that a richer specification than simply cumulated current-account imbalances, as a proxy for the stock of net foreign assets, is needed. Additional risk premium variables might include, for example, the stock of outside domestic wealth including both physical capital as well as the stock and currency-composition of government debt. Alternative specifications of the risk premium, such as in Fukao (1983, 1985) which incorporate explicit measures of risk aversion, are also needed. It also seems sensible to broaden the interpretation of the risk premium to include variables such as oil prices, relative growth rates, relative profitability, etc., which may be forward-looking indicators of current-account imbalances, and hence the risk premium (9).

20. Current work on FINLINK is attempting to incorporate some of these risk premium proxies, as well as real long-term interest-rate differentials, into the expected exchange-rate equation. Because of the need to insure international consistency, as well as the small number of semi-annual observations for any single country, this work is being pursued in the context of simultaneous cross-country estimation techniques rather than the single country estimates presented above.

21. In conclusion, long-term interest parity theory indicates that a 1 per cent change in real long-term interest-rate differentials in favour of a given country is associated with a more than equi-proportionate appreciation of that country's currency. The theory receives mixed support in single-country regressions in an eighteen-country sample. In most bilateral and effective exchange-rate equations, the estimated coefficient on the real long-term interest-rate differential is correctly signed, but is sometimes close to or less than one. Thus real long-term interest-rate differentials are likely to be important determinants of exchange rates, but they should be part of a more complete model incorporating proxies for the risk premium.

NOTES

1. The hypothesis that long-term real interest-rate differentials provide an explanation of large deviations of exchange rates from purchasing-power parity was advanced by Fellner (1980) and developed in Isard (1982) as well as Shafer and Loopesko (1983), Hooper (1984), Frankel (1985) and Sachs (1985).

2. This assumption reflects the standard presumption in exchange-rate models that adjustment speeds in goods markets, where arbitrage guarantees PPP in the long run, are slow compared to financial markets.

3. Interest rates are themselves endogenous variables, of course, and cannot be regarded as the ultimate source of exchange-rate changes.

4. See Holtham (1984) for a description of FINLINK. The consistency condition is derived from the weighting matrix used in the definition of the effective exchange rates. This results in the effective exchange rates weighted by the fixed point vector (from the weighting matrix) summing to zero. Imposing identical coefficients on the real interest-rate differential in each effective exchange rate equation ensures that international consistency is respected.

5. The results were quite similar under either definition of the real interest rate except for Belgium and Finland where the estimated real interest-rate coefficient was negative using the six period definition in both the bilateral and the effective equations; and Italy and Sweden where the same sign reversal occurred in the bilateral equations.

6. But recall that results similar to ours were obtained by Shafer and Loopesko and Sachs who proxied U.K. inflation expectations with a <u>centred</u> moving average, which is partially forward looking.

7. A third possibility, suggested in discussion by Jeffrey Shafer, is that the effective maturity or "duration" of a long-term bond may be considerably less than the actual maturity for countries with high nominal interest rates and inflation. Inflation offset by high nominal interest rates effectively shortens the maturity of a bond by increasing interest payments relative to amortization of principal; the former payments are relatively high shortly after issue and the latter increase as the bond approaches maturity.

8. The Durbin-Watson statistics were not reported by Shafer and Loopesko. Given the similarities between their equations, Sachs', Hooper's and those reported in Table 2, it can be inferred that their equations also suffer from autocorrelated errors. Thus all the estimated equations reported here are likely to have biased standard errors and tests of significance.

9. Sachs (1985) also estimated an equation with the real GNP growth differential; there was little effect on the size of the estimated coefficient on the real interest differential but the Durbin-Watson statistic improved to about 1.4. We have also had promising preliminary results with real growth differentials and mixed results with oil price variables. Inclusion of an oil-price variable in the U.K. equation reported in Table 2, for example, does not reverse the perverse sign of the estimated coefficient on the real interest-rate differential, even though the oil price variable is correctly signed, highly significant, increases the R^2 markedly and reduces serial correlation.

Data Appendix

The GDP deflators and exchange rate are from the OECD Main Economic Indicators. The long-term interest rates are those used by the Monetary and Fiscal Policies Division and are from either OECD Main Economic Indicators (MEI) or OECD Financial Statistics (FS). Summary definitions of the long-term interest rates are:

United States:	New AAA Corporate Bonds (MEI).
Japan:	NTT subscriber bonds (telegraph and telephone) (FS).
Germany:	Festversinsliche Wertpapiere (FS).
France:	Public and semi-public sector bonds -- public corporate bonds (FS).
United Kingdom:	20-year government bonds (FS).
Italy:	Private sector bonds (FS).
Canada:	Long-term government bonds (MEI).
Australia:	Long-term government bonds (MEI).
Austria:	Yield of bonds on the secondary market (data provided by the Austrian government).
Denmark:	Long-term bonds (MEI).
Belgium:	Long-term central government bonds (MEI).
Finland:	Bond yield at issue -- other bonds (FS).
Ireland:	Long-term government bond yield (MEI).
Netherlands:	Long-term government bonds (MEI).
Norway:	Government bonds (MEI).
Spain:	Electricity Company bonds -- Secondary Market (FS).
Sweden:	Long-term government bonds (MEI).
Switzerland:	Confederation bonds (FS).

The effective exchange rates, foreign interest rates and foreign price levels are constructed using a weighting matrix which represents estimates of the currency composition of foreign assets and liabilities of each country at end-1983. These estimates are based on the Bank for International Settlements' (BIS) data on the currency breakdown of external assets and liabilities of reporting banks, which are assumed to be representative of the composition of the financial component of foreign assets and liabilities for all countries. The currency distribution of direct investment assets was assumed to be proportional to trade weights while direct investment liabilities are assumed to be in domestic currency.

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