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Forward Rates as Predictors of Future Spot Rates:
An Econometric Explanation for Sign Reversal

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Regressing future spot rates on forward rates yields coefficients that are not significantly different from one. Regressing future changes in spot rates on forward premia yields coefficients that are typically negative. We show that, in our data, sign reversals are associated with misspecification or an inappropriate linear restriction. Some additional empirical results suggest that the source of the sign reveral may be in capital rather than foreign exchange markets.

I. Introduction

Regressing future spot rates on current forward rates yields coefficients that usually are not significantly different from one. But regressing future changes in spot rates on current forward premia yields coefficients that are significantly less than one and usually negative. We show that, in our data, sign reversals are associated with misspecification or an inappropriate linear restriction. Some additional empirical results suggest that capital rather the foreign exchange markets may be the source of the inverse relation between forward premia and future changes in spot rates.

The next section describes the standard test equations, the data used to estimate those equations, and the OLS results. The following section discusses the econometric sources of the sign reversals. The

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penultimate section presents the additional evidence, and the last section summarizes our results.

II. Standard Test Equations

Several studies test the unbiased expectations hypothesis by regressing the logarithm of future spot rates s_{t+1} on the logarithm of current forward rates f_t.

$$(1) \qquad s_{t+1} = \alpha + \beta f_t + \varepsilon_t$$

where s_{t+1} is the future spot rate that matches the current forward rate. Under the unbiased expectations hypothesis, which most tests support, α equals zero, β equals one, and ε_t is white noise.[1]

The other popular test regresses changes in spot rates $s_{t+1} - s_t$ against forward premia $f_t - s_t$.

$$(2) \qquad s_{t+1} - s_t = a + b(f_t - s_t) + e_t$$

where s_t is the logarithm of the current spot rate. Estimates of a are usually not significant, b is significantly less than one, often not significantly different from zero, and usually negative.[2]

A. Data

The data were supplied to us by David Longworth and Ross Levine. The Longworth data was used in Longworth, Boothe and Clinton (1983) and later in Gregory and McCurdy (1984, 1986). The Levine data was used in Levine (1989). Observations are averages of bid-ask rates for spot, one month forward and corresponding future spot exchange rates. All rates are U.S dollar prices of other currencies for the period from July 1973 to December 1981. The other currencies are for Britain, West Germany, Canada, Japan, France and Italy, which are from Longworth, and the Netherlands and Switzerland, which are from Levine.

1 Studies include Kohlhagen (1975), Cornell (1977), Longworth (1981), Edwards (1982, 1983) and Chiang (1988).

2 Studies include Hansen and Hodrick (1980), Bilson (1981), Fama (1984), Gregory and McCurdy (1984, 1986), and Boothe and Longworth (1986).

Forward rates and current spot rates are for the last Tuesday of each month in order to minimize 'weekend effects'.[3] Future spot rates corresponding to the forward contract value dates are spot rates in four weeks and two business days.[4]

B. Test Results

Tables 1 and 2 show the OLS estimates of equations 1 and 2. The results are similar to earlier studies. In Table 1, α is significantly dif-

Table 1

OLS ESTIMATES OF EQUATION 1

Country	$s_{t+1} = \alpha + \beta f_t + e_t$ α	β	R^2/D-W
Britain	0.0314	0.9584	0.940
	(0.0177)	(0.0242)	1.451
West Germany	–0.0021	0.9650	0.994
	(0.0189)	(0.0235)	1.913
Canada	0.0016	0.9783	0.977
	(0.0017)	(0.0151)	1.630
Japan	–0.2246#	0.9590*	0.959
	(0.1094)	(0.0198)	1.670
France	–0.0755	0.9512	0.877
	(0.0551)	(0.0359)	1.948
Italy	–0.0326	0.9952	0.974
	(0.1081)	(0.0161)	1.747
Netherlands	–0.0362	0.9593	0.925
	(0.0236)	(0.0272)	(1.881)
Switzerland	–0.0237	0.9691	0.967
	(0.0144)	(0.0178)	1.706

Note: Standard errors in parentheses.

* Significantly different from 1.0 at 5 percent level.

Significantly different from 0.0 at 5 percent level.

[3] See Levi (1978).

[4] See Gregory and McCurdy (1986).

ferent from zero only for Japan, β is significantly different from one only for Japan, and Durbin-Watson statistics do not indicate serially correlated errors.

In Table 2, a is significantly different from zero for Italy, there is no evidence of serially correlated errors, but b is significantly different from zero only for France, where it is negative, and it is positive only for Japan.[5]

III. Analysis of Sign Reversal

A. β Equals Unity?

The first step in understanding the econometric source of sign reversal is to recognize that forward rates are biased predictors of future spot rates. Estimates of β in Table 1, and similar estimates elsewhere, as a group do not support the null that β in equation 1 equals one, even though individually they may support that proposition.

The proposition that the estimates are independent and come from a symmetric distribution with mean 1.0 can be rejected using the simple binomial distribution. In that case, the probability that eight out of eight estimates of β would be less than one is 0.0039. The mean for the estimates of β in Table 1 is 0.967 and the standard deviation is 0.014, which also suggests that the estimates come from a population with a mean close to, but less than, unity.

One might argue that rejection of β equal to one is not warranted because these are not independent estimates of β. But, to the best of our knowledge, almost all estimates of equation 1 yield similar results.[6]

B. Relationship between β and b

The OLS estimates of β in equation 1 can be written as follows:

$$\beta = 1 - (\mathrm{cov}(f_t,\ f_t - s_{t+1})/\mathrm{var}(f_t)) \tag{3}$$

OLS estimates of b in equation 2 can be written as follows:

[5] Estimates using SUR yield essentially the same point estimates with generally smaller standard errors.

[6] Even estimates for a small open country such as Kuwait yield the same results. See Tables 1 and 3 in Pippenger (1990).

Table 2

OLS ESTIMATES OF EQUATION 2

Country	$s_{t+1} - s_t = a + b(f_t - s_t) + e_t$ a	b	R^2/D-W
Britain	-0.0055	-1.5014*	0.031
	(0.0037)	(0.8423)	1.520
West Germany	0.0021	-0.5334	0.001
	(0.0051)	(1.4169)	1.977
Canada	0.0009	-0.4072*	0.004
	(0.0013)	(0.6764)	1.693
Japan	0.0009	0.4815	0.013
	(0.0032)	(0.4197)	1.719
France	-0.0066	-1.8378*	0.043
	(0.0036)	(0.8756)	2.166
Italy	-0.0114#	-0.5556*	0.013
	(0.0044)	(0.4754)	1.883
Netherlands	0.0011	-0.1522	0.001
	(0.0035)	(0.5522)	2.006
Switzerland	0.0098	-1.0672	0.009
	(0.0064)	(1.0912)	1.8168

Note: Standard errors in parentheses.

* Significantly different from 1.0 at 5 percent level.

\# Significantly different from 0.0 at 5 percent level.

$$(4) \qquad b = 1 + (\mathrm{cov}(s_t, f_t - s_{t+1}) - \mathrm{cov}(f_t, f_t - s_{t+1}))/\mathrm{var}(f_t - s_t))$$

Under the unbiased expectations hypothesis, the predictive error $f_t - s_{t+1}$ is uncorrelated with any information available at t and both regression coefficients equal one.[7] But if, as seems to be the case, the true β is less than one, the current forward rate must be correlated with the predictive error. As equation 4 shows, that correlation provides an explanation for negative estimates of b.

7 We refer to $f_t - s_{t+1}$ as the 'predictive error' rather than 'risk premium' because explanations other than risk premia are available for the spread between f_t and s_{t+1}. Transaction costs are one obvious alternative.

Table 3 shows the relevant variances and covariances. Tables 4 and 5 shows how they combine to determine β and b. Cov(f_t, $f_t - s_{t+1}$) is always positive and very small relative to var(f_t). As a result, β is always close to, but slightly less than, one. In Table 3, cov(f_t, $f_t - s_{t+1}$) is always slightly larger than cov(s_t, $f_t - s_{t+1}$). Except for Japan, dividing cov(s_t, $f_t - s_{t+1}$) minus cov(f_t, $f_t - s_{t+1}$) by var($f_t - s_t$), which is very small, makes the result smaller than minus one. As a result, b in equation 4 is negative.

Equations 3 and 4 together with Tables 4 and 5 illustrate the link between estimates of β and b, but they do not provide a statistically significant explanation because, except for Japan, neither cov(s_t, $f_t - s_{t+1}$) nor cov(f_t, $f_t - s_{t-}$) is significantly different from zero. But for four of the seven countries where neither s_t nor f_t individually is correlated significantly with $f_t - s_{t+1}$, together the correlation is significant.

Table 6 shows the results of regressing predictive errors on current spot and forward rates.

$$f_t - s_{t+1} = \lambda_0 + \lambda_1 f_t + \lambda_2 s_t + \omega_t \quad (5)$$

Both λ_1 and λ_2 are at least two standard errors away from zero for Britain, Canada, France and Italy. For those countries, an F test rejects the null that λ_1 and λ_2 are both zero.

As we see in Table 3, f_t and s_t are highly correlated and hence equation 5 has a multicollinearity problem. Dropping a variable is one way to detect the problem. However, where s_t is statistically significant in equation 5, dropping the variable usually results in specification error, which can bias the results.[8]

Equation 5 can be rewritten as equation 6,

$$s_{t+1} = \gamma_0 + \gamma_1 f_t + \gamma_2 s_t + \omega_t \quad (6)$$

where γ_0 equals $-\lambda_0$, γ_1 equals $1 - \lambda_1$, and γ_2 equals $-\lambda_2$. Table 7 shows the results of estimating equation 6. An F test that γ_2 equals zero rejects the null for Britain, Canada, France and Italy. For these countries, equation 1 is misspecified.

[8] Notice that even if there is severe multicollinearity, but the other OLS assumptions are satisfied, OLS estimates are BLUE. Standard errors of the coefficients tend to increase as collinearity increases.

Table 3

VARIANCES AND COVARIANCES

Country	$Cov(s_t, f_t - s_{t+1})$	$Cov(f_t, f_t - s_{t+1})$	$Var(f_t - s_t)$	$Var(f_t)$	$Cov(f_t, s_t)$
Britain	0.000597 (0.162)	0.000626 (0.170)	0.0000117	0.015072	0.015027 (0.999)**
West Germany	0.000671 (0.147)	0.000680 (0.147)	0.0000054	0.019446	0.019265 (0.999)**
Canada	0.000135 (0.137)	0.000139 (0.142)	0.0000031	0.006392	0.006416 (0.999)**
Japan	0.000931 (0.201)*	0.000960 (0.203)*	0.0000535	0.023421	0.022872 (0.999)**
France	0.000388 (0.126)	0.000427 (0.136)	0.0000135	0.008738	0.008572 (0.999)**
Italy	0.000111 (0.020)	0.000167 (0.028)	0.0000362	0.034776	0.034631 (0.999)**
Netherlands	0.000560 (0.138)	0.000601 (0.147)	0.0000353	0.014779	0.014711 (0.998)**
Switzerland	0.001561 (0.170)	0.001589 (0.171)	0.0000137	0.051381	0.050786 (0.999)**

Note: Correlations in parentheses.
* Significant at 5 percent level.
** Significant at 1 percent level.

Table 4

DECOMPOSITION OF β

Country	$Cov(f_t, f_t - s_{t+1})/Var(f_t)$	$1.0 - (Cov(f_t, f_t - s_{t+1})/Var(f_t))$
Britain	0.042	0.958
West Germany	0.035	0.965
Canada	0.022	0.978
Japan	0.041	0.959
France	0.049	0.951
Italy	0.005	0.995
Netherlands	0.041	0.959
Switzerland	0.031	0.969

Table 5

DECOMPOSITION OF b

Country	$\frac{Cov(s_t, f_t - s_{t+1}) - Cov(f_t, f_t - s_{t+1})}{Var(f_t - s_t)}$	$1.0 + \frac{Cov(s_t, f_t - s_{t+1}) - Cov(f_t, f_t - s_{t+1})}{Var(f_t - s_t)}$
Britain	-2.497	-1.497
West Germany	-1.537	-0.537
Canada	-1.406	-0.406
Japan	-0.521	0.479
France	-2.835	-1.835
Italy	-1.557	-0.557
Netherlands	-1.162	-0.162
Switzerland	-2.044	-1.044

Misspecification: For Britain, Canada, France, Italy, the Netherlands, and Switzerland, equation 6 provides an important link between the results for equations 1 and 2.

β in equation 1 can be expressed as follows:

$$(7) \qquad \beta = \gamma_1 + (cov(f_t, s_t)/var(f_t))\gamma_2$$

Since $cov(f_t, s_t)/var(f_t)$ ranges between 0.976 and 1.003 in Table 7, we test the restriction that γ_1 plus γ_2 equals one. In no case is the restriction rejected.

If γ_1 plus γ_2 equals one, then equation 6 implies equation 6′.

$$(6') \quad s_{t+1} = \gamma_0 + \gamma_1 f_t + (1 - \gamma_1)s_t + \omega_t$$

or

$$(6'') \quad s_{t+1} - s_t = \gamma_0 + \gamma_1(f_t - s_t) + \omega_t$$

For all countries, β is close to one because both $cov(f_t, s_t)/var(f_t)$ and γ_1 plus γ_2 are close to unity. For Britain, Canada, France, Italy, the Netherlands and Switzerland, b is negative because, for those countries, γ_1 is negative.

Table 6

OLS ESTIMATES OF EQUATION 5

Country	$f_t - s_{t+1} = \lambda_0 + \lambda_1 f_t + \lambda_2 s_t + \omega_t$				
	λ_0	λ_1	λ_2	R^2/D-W	F
Britain	-0.0197	2.4025	-2.3681	0.101	5.532*
	(0.0176)	(0.8402)	(0.8425)	1.502	
West Germany	0.0246	0.5563	-0.5262	0.023	1.114
	(0.0257)	(1.6913)	(1.7070)	1.928	
Canada	-0.0032	1.6491	-1.6213	0.074	3.937*
	(0.0018)	(0.6809)	(0.6782)	1.703	
Japan	0.2093	0.1686	-0.1307	0.042	2.158
	(0.1265)	(0.4662)	(0.4770)	1.680	
France	-0.0032	2.9112	-2.9177	0.096	5.214*
	(0.0596)	(0.9862)	(1.0046)	2.182	
Italy	-0.0001	-1.5608	1.5623	0.097	5.307*
	(0.1038)	(0.4800)	(0.4818)	1.887	
Netherlands	0.0298	1.1196	-1.0839	0.058	3.068
	(0.0236)	(0.5507)	(0.5526)	1.966	
Switzerland	0.0040	1.4683	-1.4542	0.037	1.936
	(0.0256)	(1.5370)	(1.5549)	1.780	

Note: Standard errors in parentheses.

* Null hypothesis that $\lambda_1 = \lambda_2 = 0$ rejected at 5 percent level.

Table 7

OLS ESTIMATES OF EQUATION 6

$$s_{t+1} = \gamma_0 + \gamma_1 f_t + \gamma_2 s_t + \omega_t$$

Country	γ_0	γ_1	γ_2	R^2 D-W	$F(\gamma_1 = 0)$ $F(\gamma_2 = 0)$	$F(\gamma_1 + \gamma_2 = 1)$ $Cov(f_t, s_t)/Var(f_t)$
Britain	0.0197	-1.4025	2.3681*	0.945	2.7867	2.1446
	(0.0176)	(0.8402)	(0.8425)	1.501	7.9015*	0.9970
West Germany	-0.0246	0.4437	0.5262	0.944	0.0950	0.9906
	(0.0257)	(1.6913)	(1.7070)	1.928	0.0950	0.9906
Canada	0.0032	-0.6491	1.6213*	0.978	0.9105	3.4389
	(0.0018)	(0.6809)	(0.6982)	1.703	5.7152*	1.0037
Japan	-0.2093	0.8314	0.1307	0.959	3.1792	2.7610
	(0.1265)	(0.4662)	(0.4770)	1.680	0.0751	0.9765
France	0.0032	-1.9112*	2.9177*	0.886	4.9845*	0.0277
	(0.0596)	(0.9862)	(1.0046)	2.182	8.5213*	0.9810
Italy	0.0001	-0.5608	1.5623*	0.977	8.2257*	0.0119
	(0.1038)	(0.4800)	(0.4818)	1.887	10.5172*	0.9958
Netherlands	-0.0298	-0.1196	1.0839	0.928	0.0477	1.7502
	(0.0236)	(0.5507)	(0.5526)	1.966	3.8475	0.9954
Switzerland	-0.0040	-0.4683	1.4542	0.967	0.0927	0.3085
	(0.0256)	(1.5370)	(1.5549)	1.780	0.8747	0.9884

Note: Standard errors in parentheses.

* Significant at 5 percent level.

Since there is no sign reversal for Japan, only the sign reversal for Germany remains unexplained. The sign reversal there appears to be the result of an inappropriate linear restriction in equation 2.

West Germany: Subtracting s_t from both sides of equation 6 yields equation 8.

$$(8) \qquad s_{t+1} - s_t = \gamma_0 + \gamma_1 f_t + (\gamma_2 - 1)s_t + \upsilon_t$$

Haynes and Stone (1982) show that the relationship between the restricted coefficient b in equation 2 and the unrestricted coefficients γ_1 and $\gamma_2 - 1$ in equation 8 is as follows:

$$(9) \qquad b = w_1\gamma_1 + w_2(1 - \gamma_2)$$

where

$$w_1 = (\text{var}(f_t) - \text{cov}(f_t, s_t))/\text{var}(f_t - s_t)$$

and

$$w_2 = (\text{var}(s_t) - \text{cov}(f_t, s_t))/\text{var}(f_t - s_t).$$

Since the sum of w_1 and w_2 is one, b is a weighted average of γ_1 and $(1 - \gamma_2)$.

The requirements for sign reversal due to an inappropriate linear restriction are: (1) the value of $\text{cov}(f_t, s_t)$ is between $\text{var}(f_t)$ and $\text{var}(s_t)$, i.e., the signs of the two weights are different, and (2) the term having the negative weight in equation 9 dominates the other term in absolute value. Only West Germany in Table 8 satisfies these requirements. So West Germany is the only country to which we can attribute a negative b to sign reversal due to an inappropriate linear restriction.

The analysis up to this point is an econometric description of the sign reversal between equations 1 and 2. It does not help identify the economic source of the inverse relation between forward premia and future changes in spot rates. Results presented in the next section suggest that the source of the inverse relation is in capital rather than foreign exchange markets.

IV. Possible Source of Inverse Relation

If the assumptions underlying the unbiased expectations hypothesis hold, then covered interest rate arbitrage holds and forward premia

Table 8

ESTIMATES FOR EQUATION

Country	w_1	γ_1	w_2	$(1-\gamma_2)$	$w_1\gamma_1+w_2(1-\gamma_2)$	b
Britain	3.87	-1.4025	-2.87	-1.3681	-1.5013	-1.5014
West Germany	33.52	0.4437	-32.52	0.4738	-0.5352	-0.5334
Canada	-7.69	-0.6491	8.69	-0.6213	-0.4075	-0.4072
Japan	10.23	0.8314	-9.23	0.8693	0.4816	0.4815
France	12.27	-1.9112	-12.27	-1.9177	-1.8379	-1.8378
Italy	4.01	-0.5608	-3.01	-0.5625	-0.5557	-0.5556
Netherlands	1.914	-0.1196	-0.92	0.0838	-0.1512	-0.1522
Switzerland	43.50	-0.4683	-42.51	0.4542	-1.0630	-1.0672

equal interest rates differentials. But the unbiased expectations hypothesis does not appear to hold and, using our data, neither does covered interest rate arbitrage.[9] We turn the following tests to see if there is any link between less than perfect arbitrage and the tendency for premia to mispredict the direction of future changes in spot rates.

First we regress forward $f_t - s_t$ against corresponding interest rate differentials $i_t - i_t^*$.

$$f_t - s_t = g_0 + g_1(i_t - i_t^*) + \pi_t \tag{10}$$

Denote the part of the premium that can be explained by the differential as Π_t so $f_t - s_t$ equals Π_t plus π_t.

We then reverse the regression.

$$i_t - i_t^* = k_0 + k_1(f_t - s_t) + \phi_t \tag{11}$$

Now denote the part of the interest rate differential explained by the forward premium as Φ_t so $i_t - i_t^*$ equals Φ_t plus ϕ_t. In order to try and determine the source of the sign reversals, we regress $s_{t+1} - s_t$ first against Π_t and π_t, and then against Φ_t and ϕ_t.

[9] When premia are regressed against differentials, regression coefficients are not significantly different from one. But when interest rate differentials are regressed against premia, four out of five coefficients are significantly less than one.

A. Data

The exchange rates are the same as in the last section. But the interval is September 1973 to December 1981 rather than July 1973 to December 1981 because we do not have interest rates for July and August 1973. All interest rates are eurocurrency yields. They were supplied by Ross Levine and were used in Levine (1989). Since the Levine data does not have interest rates for Canada, Japan, and Italy, we are forced to drop those countries. Forward and future spot rates are matched in the same way as in the last section.[10]

B. Results

Table 9 shows the results from regressing $s_{t+1} - s_t$ against Π_t and π_t. Table 10 shows the results from regressing $s_{t+1} - s_t$ against Φ_t and ϕ_t.

The part of the forward premium associated with interest rate differentials is inversely related with future changes in spot rates. In three

Table 9

OLS ESTIMATES OF $S_{t+1} - S_t$ VERSUS Π_t AND π_t

Country	$s_{t+1} - s_t = c_0 + c_1\Pi_t + c_2\pi_t$			
	c_0	c_1	c_2	R^2/D-W
Britain	-0.0059	-1.7202*	5.3872	0.051
	(0.0038)	(0.8576)	(4.9626)	1.52
West Germany	0.0029	-0.7516	5.5809	0.006
	(0.0052)	(1.4331)	(10.1210)	2.01
France	-0.0077	-2.1463*	0.5263	0.055
	(0.0037)	(0.9067)	(3.7088)	2.18
Netherlands	0.0066	-3.0017*	0.3658	0.50
	(0.0043)	(1.3827)	(0.5774)	2.15
Switzerland	0.0118	1.3990	2.2592	0.019
	(0.0067)	(1.1501)	(3.4167)	1.83

Note: Standard errors in parentheses.

*Significant at 5 percent level.

10 Using Levine's method yields similar results.

Table 10

OLS ESTIMATES OF $S_{t+1}-S_t$ VERSUS Φ_t AND ϕ_t

Country	$s_{t+1} - s_t = d_0 + d_1\Phi_t + d_2\phi_t$			R²/D-W
	d_0	d_1	d_2	
Britain	-0.0054	-1.5273	-6.9617	0.051
	(0.0038)	(0.8525)	(4.9329)	1.52
West Germany	0.0026	-0.6518	-6.4521	0.006
	(0.0052)	(1.4747)	(10.4157)	2.01
France	-0.0073	-2.1779*	2.7522	0.055
	(0.0037)	(0.9612)	(3.9318)	2.18
Netherlands	0.0017	-0.7770*	2.9015*	0.50
	(0.0060)	(3.0918)	(1.2911)	2.15
Switzerland	0.0110	-1.2177	-3.8972	0.019
	(0.0072)	(1.2928)	(3.8406)	1.83

Note: Standard errors in parentheses.
*Significant at 5 percent level.

out of the five countries, that relationship is significant. For the part of the forward premium that is orthogonal to interest rate differentials, none of the coefficients are significant, but all are positive. For all five countries in Table 10, both the component of the interest rate differential that is correlated with and orthogonal to the premium is inversely related to future changes in spot rates.

The simple interpretation of the results in Tables 9 and 10 is that the source of sign reversal lies in capital rather than foreign exchange markets. A more reliable interpretation will require a formal model. But there is no point in developing such a model unless additional empirical work demonstrates that this pattern holds up across time and space.

V. Summary

OLS regressions of future spot rates on current forward rates yield coefficients that are very close to, but almost certainly less than, one. Although the bias is very small, forward rates are biased estimates of future spot rates.

For four of the seven countries with sign reversal, the reversal is associated with a misspecification. For those four countries, the OLS regression of future spot rates on current forward rates should contain the current spot rate as an explanatory variable. For a fifth country, sign reversal is associated with an inappropriate linear restriction in the OLS regression of future changes in spot rates against forward premia.

These explanations of sign reversal are purely descriptive. They do not give us any insight into the underlying market behavior. But a decomposition of forward premia into the parts correlated with and orthogonal to interest rate differentials suggests that the source of the inverse relation between changes in spot rates and forward premia may be in capital markets.

References

Bilson, J.F.O., "The Speculative Efficiency Hypothesis," *Journal of Business,* 54, 3, July, 1981, 435-451.

Boothe, P. and D. Longworth, "Foreign Exchange Market Efficiency Tests: Implications of Recent Findings," *Journal of International Money and Finance,* 5, 2, June, 1986, 135-152.

Chiang, T.C., "The Forward Rate as a Predictor of the Future Spot Rate — A Stochastic Coefficient Approach," *Journal of Money, Credit and Banking,* 20, 2, May, 1988, 212-232.

Cornell, W.B., "Spot Rates, Forward Rates and Exchange Market Efficiency," *Journal of Financial Economics,* 5, 1, August, 1977, 55-65.

Edwards, S., "Exchange Rates and 'News': A Multi Currency Approach," *Journal of International Money and Finance,* 1, 3, December, 1982, 211-224.

———, "Floating Exchange Rates, Expectations and New Information," *Journal of Monetary Economics,* 11, 3, May, 1983, 321-326.

Fama, E., "Forward and Spot Rates," *Journal of Monetary Economics,* 14, 3, November, 1984, 319-338.

Gregory, A.W., and T.H. McCurdy, "Testing the Unbiasedness Hypothesis in the Forward Foreign Exchange Market: A Specification Analysis," *Journal of International Money and Finance,* 3, 3, December, 1984, 357-368.

———, "The Unbiasedness Hypothesis in the Forward Foreign Exchange Market," *European Economic Review,* 30, 2, April, 1986, 365-381.

Hansen, L.P., and R.J. Hodrick, "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis," *Journal of Political Economy,* 88, 5, October, 1980, 829-953.

Haynes, S.E., and J.A. Stone, "Spurious Tests and Sign Reversals in International Economics," *Southern Economics Journal,* 48, 4, April, 1982, 868-876.

Kohlhagen, S.H., "The Forward Rate as an Unbiased Predictor of the Future Spot Rate," *Journal of International Business Studies,* 6, Fall, 1975, 33-39.

Levi, M., "The Weekend Game: Clearing House vs Federal Funds," *Canadian Journal of Economics,* 11, 4, November, 1978, 750-757.

Levine, R., "The Pricing of Forward Exchange Rates," *Journal of International Money and Finance,* 8, 2, June, 1989, 163-179.

Longworth, D., "Testing the Efficiency of the Canadian-U.S. Exchange Market under the Assumption of No Risk Premium," *The Journal of Finance,* 36, 1, March, 1981, 43-49.

Longworth, D., Boothe, P. and K. Clinton, *A Study of the Efficiency of Foreign Exchange Markets,* Bank of Canada, Ottawa, 1983.

Pippenger, J., "Forward Rates as Predictors of Future Spot Rates in Small Open Economies: The Case of Kuwait," *Open Economies Review,* forthcoming.