NBER WORKING PAPER SERIES

FLOATING EXCHANGE RATES, EXPECTATIONS AND NEW INFORMATION

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Working Paper No. 1064

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

January 1983

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ABSTRACT

This paper analyzes the relationship between forward exchange rates, future spot rates and new information. A stochastic model of exchange rate determination is used to formally show how unanticipated changes in the exchange rate determinants (or "news") affect the spot rate. The empirical analysis indicates that "new information" plays an important role in explaining the market forecasting error, or difference between the spot rate and the forward rate, determined in the previous period.

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1. Introduction

Since a floating exchange rate system was adopted by the major industrial countries in 1973, there has been an increased interest in studying the process of exchange rate determination. In particular, most of the work on the determination of floating exchange rates has been focused on the explanation of the large fluctuations that these rates have displayed in the recent period, and on the poor performance of forward rates as predictors of future spot rates.[1/] The analysis of the extent and causes of the volatility of exchange rates under a floating system, and of the degree of efficiency of foreign exchange markets, is important in order to assess the desirability of government intervention in managing, or even pegging, exchange rates.[2/]

Recently, it has been suggested (i.e., Dornbusch, 1978, 1980; Frenkel, 1981a; Frenkel and Mussa, 1980; Mussa, 1982) that the behavior of exchange rates is affected in an important way by new information that is made available to economic agents in every period. The notion that new information affects exchange rate behavior is directly derived from the fact that exchange rates are the relative price of two assets, and as such, are determined by expectations about future events. This paper investigates the role of new information in the determination of exchange rates behavior. In particular, it analyzes the relationship between forward rates, future spot rates, exchange rate market efficiency, and new information. The empirical evidence presented in this paper indicates that new information partially accounts for the poor performance of forward rates as predictors of future spot rates. However, the results also suggest that there are still elements, in addition to "news", that affect exchange rates behavior.[3/]

The plan of the paper is as follows: Section 2 analyzes the role of new information in exchange rate behavior using a simple stochastic model of exchange rate determination. Section 3 presents empirical results regarding market efficiency and new information for the pound/dollar, DM/dollar, French franc/dollar and lira/dollar rates. Section 4 contains some concluding remarks.

2. Market Efficiency, New Information and the Exchange Rate

An important implication of the asset view of exchange rate determination -- as developed by Dornbush (1976), Frenkel (1976), and Mussa (1976), among others -- is that the exchange rate market, as any other asset market, is efficient.[4/] A market is "efficient" when prices reflect all available information, including the economic model relevant for describing the determination of their equilibrium values. A direct implication of efficiency is that the expectations people have about all the future values of the underlying determinants of the exchange rate are fully reflected in the forward rate, and that the spot rate reflects all the information available at the time it is set. This means that new information that is made available in subsequent periods will result in corrections of the market forecasts about the future spot rate. The new information made available in a certain period will also have an effect on the difference between the spot rate, as set in that period, and the forecast the market made about it in the previous period, when the information was not available.

It has recently been suggested that the divergence between the expected spot rate for period t+1 (as set in t) and the actual spot rate in t+1, or market forecasting error, can be partially explained by the fact that the spot rate in t+1 reflects new information that was not available in t. According to this view, in every period economic agents will use the "news" to revise their forecast about the future spot rate.[5/]

In this section, the relationship between forward rates, future spot rates, and new information is formally derived from a simple stochastic model of exchange rate determination.[6/] The model is presented in equations (1) through (8):

$$i_t - i_t^* = f_t - s_t \tag{1}$$

$$E_t(s_{t+1}) = f_t \tag{2}$$

$$s_t + p_t^* - p_t = d_t \tag{3}$$

$$i_t = r_t + E_t(p_{t+1}-p_t); \quad i_t^* = r_t^* + E_t(p_{t+1}^*-p_t^*) \tag{4}$$

$$r_t = \rho + w_t; \quad r_t^* = \rho^* + w_t^* \tag{5}$$

$$m_t^d - p_t = ay_t - bi_t; \quad m_t^{d*} - p_t^* = a^* y_t^* - b^* i_t^* \tag{6}$$

$$m_t = m_{t-1} + \lambda + v_t + n_t - n_{t-1}; \quad m_t^* = m_{t-1}^* + \lambda^* + v_t^* + n_t^* - n_{t-1}^* \tag{7}$$

$$y_t = y_o + gt + u_t; \quad y_t^* = y_o^* + g^* t + u_t^* \tag{8}$$

where s_t is the natural logarithm of the spot rate; f_t is the log of the forward rate; i_t and i_t^* are the nominal interest rates on one period bonds denominated in domestic and foreign currency respectively; p_t and p_t^* are the log of domestic and foreign price levels; r_t and r_t^* are domestic and foreign interest rates, which are assumed to be equal to a constant term (ρ and ρ^*) plus a random element (w_t and w_t^*); m_t and m_t^* are the log of nominal quantities of money at home and abroad; and y_t and y_t^* are the log of domestic and foreign real output respectively. On the other hand, w_t, w_t^*, v_t, v_t^*, n_t, n_t^*, u_t and u_t^* are independent, serially uncorrelated random shocks, with zero mean and constant variances.

Equation (1) is the interest arbitrage condition, and indicates that asset holders will be indifferent between holding bonds denominated in domestic or foreign currency as long as the interest rate differential is equal to the expected rate of appreciation.[7/] Equation (2) introduces the simplifying assumption of risk-neutral agents, which is made for convenience. If, alternatively, risk-averse agents are assumed, equation (2) could be modified by adding a risk premium term to f_t.[8/] Equation (3) is a deviation from PPP equation. This expression is general enough to allow for a number of assumptions with respect to the degree to which PPP holds. If, for example, it is assumed that PPP holds permanently (in level terms), d_t will be equal to zero.[9/] Equation (4) is the traditional Fisher equation for the domestic and foreign interest rates respectively.[10/] Equation (5), on the other hand, indicates that in each country the real interest rate is equal to a constant element (ρ and ρ^*) plus a serially uncorrelated random term (w_t and w_t^*). Equation (6) depicts the demand for money equations in each country. This formulation of the demand for money does not include random shocks beyond those induced by interest rates and real incomes. This, however, is of no consequence for the final results. Equation (7) represents the money supply processes. According to this equation, in every moment in time the rate of growth of money will diverge from its long-run rate of growth (λ) both by a permanent shock (v_t) and a temporary shock (n_t). Finally, equation (8) depicts the process of real income. In order to simplify the exposition, it has been assumed that in each country real income evolves according to a random walk with trend, where the random element (u_t) is independently distributed from all other shocks in the model.[11/]

The solutions in this model for s_t and $f_{t-1}(=E_{t-1}(s_t))$ can be used to find an expression for the market forecasting error (s_t-f_{t-1}) that is explicitly related to unanticipated changes in exchange rates determinants, or "news".

In order to simplify the exposition, it is assumed that there are random deviations from PPP, so that equation (3) can be written as $s_t - p_t + p_t^* = x_t$, where x_t can be shown to be a serially uncorrelated random element. 12/ 13/ Assuming that the information set in period t includes the model, and the past and current values of all relevant variables, and using the well-known, undetermined coefficients technique to solve difference equations, the following expression for the spot rate is obtained: 14/

$$s_t = (\alpha_o - \alpha_o^*) + (m_t - m_t^*) - (\frac{a}{1+b})\, u_t - (\frac{1}{1+b})\, w_t - (\frac{b}{1+b})\, n_t + (\frac{a^*}{1+b^*})\, u_t^* + (\frac{1}{1+b^*})\, w_t^* + (\frac{b^*}{1+b^*})\, n_t^* \qquad (9)$$

where $\alpha_o = [b(\rho - ag) - ay_o + b\lambda]$ and $\alpha_o^* = [b^*(\rho^* - a^* g^*) - a^* y_o^* + b^* \lambda^*]$

This expression is similar to those obtained by most stochastic asset-view models of exchange rate determination (i.e., Barro (1978), Driskill (1981), Saidi (1980)). It indicates that the spot rate will respond with a unitary coefficient to increases in the stocks of money differentials, and will be affected by the different stochastic shocks that enter the model. In particular, it indicates that unexpected real shocks on income at home (u_t) will drive the exchange rate down, while the opposite will be true when u_t^* rises. On the other hand, an unexpected shock on the domestic real interest rate will generate an appreciation on the exchange rate. Finally, equation (9) indicates that a temporary unexpected monetary shock at home will provoke a movement of the exchange rate in the opposite direction. The reason for this is that since temporary shocks do not affect the future level of the quantity of money (m_{t+1}), people expect $E_t(m_{t+1})$ to decline in relation to m_t, and thus they expect an appreciation of domestic currency.

From equation (9), and using the property of serially uncorrelated random shocks, the following expression for the forward rate for t+1, as determined in t, is found:

$$f_t = E_t(s_{t+1}) = (\alpha_o - \alpha_o^*) + m_{t+1} - v_{t+1} - n_{t+1} - m_{t+1}^* + v_{t+1}^* + n_{t+1}^* \qquad (10)$$

From (9) and (10) it is possible to find an expression that relates the forward rate to the future spot rate. Writing (9) for period t+1 and subtracting (10):

$$s_{t+1} = f_t + [v_{t+1} + (\frac{1}{1+b})\, n_{t+1} - (\frac{1}{1+b})\, w_{t+1} - (\frac{a}{1+b})\, u_{t+1} - v_{t+1}^*$$

$$- (\frac{1}{1+b^*}) n_{t+1}^* + (\frac{1}{1+b^*})\, w_{t+1}^* + (\frac{a^*}{1+b^*})\, u_{t+1}^*] \qquad (11)$$

According to equation (11), the future spot rate (s_{t+1}) will differ from the forward rate determined in the current period by the term in square brackets. This expression summarizes the effect of "news" about unanticipated (as of t) changes in money, real income and real interest rates on the exchange rates. In particular, equation (11) indicates that "news" can help explain the market forecasting error, or divergence between s_{t+1} and f_t. According to (11), "news" about a permanent increase in the domestic quantity of money (v_{t+1}) will have a positive effect (over and above the market forecast) on the spot rate in period t+1. News about a temporary increase of the quantity of money at home (n_{t+1}) will also have a positive effect on the exchange rate over and above the rate forecast in the previous period. However, this effect will be less than proportional, since agents know, under the assumption of full current information, the temporary nature of this shock. Equation (11) also indicates that "news" about unexpected changes in the real interest rate will have a negative effect on the forecasting error. The reason for this is that unexpected changes in the real rate have negative effects on the spot exchange rate while, due to the assumptions of the present model, they do not affect the expected exchange rate for t+1 as set in t. Finally, according to equation (11) "news" about unexpected increases in real income will have negative effects on the forecasting error. The opposite effects are true with respect to "news" regarding the behavior of foreign money, real income and real interest rate.

Equation (11) also indicates that the market forecasting errors across different exchange rates will be correlated. Since all of these rates are expressed in terms of a common currency (the US dollar for example), equation (11) for different exchange rates will have a common element:

$$[v^*_{t+1} - (\frac{1}{1+b^*})n^*_{t+1} + (\frac{1}{1+b^*})w^*_{t+1} + (\frac{a}{1+b^*})u^*_{t+1}].$$

This relationship between the "news" component of different rates can be incorporated into the empirical analysis of exchange market efficiency.

There are at least three ways to empirically test (11): (1) We can directly incorporate unexpected changes of exchange rate determinants to the right hand side of the traditional market efficiency equation. This has been done by Frenkel (1981a), who used the residuals from a forecasting equation for nominal interest rates differentials as an additional independent variable in market efficiency equations. Dornbusch (1980), on the other hand, has included unexpected changes in the current account and real output -- computed as deviations from OECD forecasts -- as a measure of "news" in his regression analysis. (2) A second way to test (11) is to use non-linear, full-information methods, testing simultaneously for market efficiency and rational expectations. This has recently been done by Hartley (1981) in the context of the simple monetary model.[15/] (3) Alternatively, equation (11) can be tested using seemingly unrelated regressions (SURE) methods that recognize that the unexpected changes of exchange rate determinants that appear on the right hand side of (11) correspond to the error terms in forecasting equations for these determinants.[16/] The next section of this paper presents results obtained from using the seemingly unrelated regressions methods for the pound/dollar, DM/dollar, French franc/dollar and Italian lira/dollar rates.

3. Empirical Results

In this section empirical results from the analysis of market efficiency and "news" for the pound/dollar, French franc/dollar, DM/dollar and Italian lira/dollar rates are presented. In most empirical work on efficiency of the exchange market, the following equation has been fitted:[17/]

$$s_{t+1} = a + bf_t + \varepsilon_{t+1} \tag{12}$$

where, under the assumption that the forward rate determined in t is an unbiased predictor of s_{t+1}, a=0, b=1.0 and ε_{t+1} is a white noise process. The results obtained, however, have been only partially favorable to the market efficiency hypothesis. In general, the b's have been estimated in imprecise ways, and the market efficiency hypothesis has been rejected for some rates and accepted for others.

According to the model presented in Section 2, however, the market forecasting error term ε_{t+1} in equation (12) will have a specific form, which can be exploited in tests of market efficiency. Specifically, equation (11) indicated that ε_{t+1} can be expressed as a linear function of unanticipated changes of domestic and foreign money, domestic and foreign real income, and of unanticipated changes in domestic and foreign real interest rates. Assuming, for simplicity, that all unanticipated changes in the quantity of money can be summarized in v_{t+1}, from (12) the market forecasting error term can be written as:[18]

$$\varepsilon_{t+1} = \alpha_o v_{t+1} + \alpha_1 u_{t+1} + \alpha_2 w_{t+1} + \alpha_o^* v_{t+1}^* + \alpha_1^* u_{t+1}^* + \alpha_2^* w_{t+1}^* \quad (13)$$

where, as before, v_{t+1} represents unanticipated changes in the quantity of money, u_{t+1} reflects unanticipated changes in real income and w_{t+1} represents unticipated changes in the real interest rates. As usual, an asterisk refers to the respective variables for the foreign country. As shown in Section 2, the α's (and α^*'s) will depend on the structural coefficients of the model. According to equation (11), it would be expected that α_o, α_1^* and α_2^* should be positive, while α_o^*, α_1 and α_2 should be negative.

Using (13), the market efficiency equation can be rewritten in the following way:

$$s_{t+1} = a + bf_t + [\alpha_o v_{t+1} + \alpha_1 u_{t+1} + \alpha_2 w_{t+1} + \alpha_o^* v_{t+1}^* + \alpha_1^* u_{t+1}^* + \alpha_2^* w_{t+1}^*] \quad (14)$$

Since v_{t+1}, v_{t+1}^*, u_{t+1}, u_{t+1}^*, w_{t+1} and w_{t+1}^* are forecasting error terms from the monies, real income and real interest rates equations, it follows that the estimation of (14), taking into account the cross-error covariance between this equation and the forecasting equations, would yield more efficient results from an econometric point of view. In particular, it would be expected that using Zellner's seemingly unrelated regressions (SURE) method would yield more precise estimates of a and b in (14).[19]

Under the assumption made in Section 2 of uncorrelated random shocks, the covariance matrix of the system given by the market efficiency equation (14) and the forecasting equations for money, real income and real interest rates at home and abroad will be of the following form:[20]

$\Sigma \otimes I$, where

$$\Sigma = \begin{bmatrix} \sigma_{\varepsilon\varepsilon} & \sigma_{\varepsilon v} & \sigma_{\varepsilon u} & \cdots & \sigma_{\varepsilon w^*} \\ \sigma_{\varepsilon v} & \sigma_{vv} & 0 & 0 \cdots & 0 \\ \sigma_{\varepsilon u} & 0 & \sigma_{uu} & 0 \cdots & \\ \vdots & & & \ddots & \\ \sigma_{\varepsilon w^*} & 0 & 0 & \cdots & \sigma_{w^*w^*} \end{bmatrix} \tag{15}$$

and σ_{xy} is the covariance between errors x and y. As may be seen, Σ will only have non-zero elements in the first row, the first column and the principal diagonal.

The estimation of (14) using SURE should improve the results obtained when OLS are used. In particular, if "news" is the main reason why forward rate and future spot rates differ, the use of SURE, that explicitly takes "news" into account, should result in a strong acceptance (non-rejection) of the efficiency hypothesis. Alternatively, if the improvement in the market efficiency results is not significant once "news" is taken into account, it will be an indication that elements besides new information play an important role in the process of exchange rate determination.

Before the market efficiency tests using the SURE procedure can be implemented, it is necessary to determine the specific form of the forecasting equations for the domestic and foreign quantities of money, real income and real interest rates. In order to simplify the analysis, it was assumed that the forecasting equations for these variables can be represented by vector autoregressive processes that include own lagged values and lagged values of all other variables for that country. In all these processes, 6-month lags were used for every variable. Then the residuals from these equations were checked to make sure that they were white noise. For the case of real interest rates, I used the ex-post rate defined as the annualized Euromarket one-month nominal rate minus the corresponding inflation rate. The sources of the data used are given in the appendix.

In Table 1 the exchange rate market efficiency tests for the pound/dollar, franc/dollar, DM/dollar and lira/dollar, using monthly data and OLS, are presented. In addition to equation (12), I report the results obtained from the OLS estimates of:

$$s_{t+1} = a + b\ f_t + c\ f_{t-1} + u_{t+1} \qquad (16)$$

The rationale for fitting this equation is that if the exchange rate market is efficient and f_t contains all the available information for forecasting s_{t+1}, the inclusion of f_{t-1} should not add to the explanation of s_{t+1}. The empirical analysis of the exchange rate market efficiency was started in July of 1973 in order to avoid the effects of the "turbulent" first half of 1973 (see Frenkel and Levich, 1977).

As may be seen from Table 1, when OLS is used the market efficiency hypothesis is not very successful. While it is not rejected for the pound/dollar and DM/dollar rates, it is rejected for the franc/dollar and lira/dollar rates. For the pound/dollar and DM/dollar rates both the individual hypotheses a=0 and b=1.0 and the joint hypothesis a=0 and b=1.0 cannot be rejected at the 5% level. On the other hand, for the franc/dollar and lira/dollar rates, when OLS are used, both the individual and joint hypotheses of efficiency are rejected. For all the cases the D.W. statistic indicates the absence of first order autocorrelation, and the analysis of the autocorrelation functions of the residuals (up to 24 lags) show no autocorrelation of higher order. Finally, the OLS estimation supports the hypothesis that f_{t-1} adds no explanation to s_{t+1} once f_t has been included, since for all cases its coefficient is not significant. In Table 2 the results from the estimation of equation (14) using SURE, which incorporates the cross-error structure between the market efficiency equation and the exchange rate determinant forecasting equations, are reported. The case of the lira/dollar rate is of special interest, since, in opposition to the OLS estimates, the hypotheses $a=0$ and $b=1.0$ can no longer be rejected. This means that when SURE is used it is not possible to reject the hypothesis that the market for the lira/dollar rate has been efficient. For the case of the pound/dollar and DM/dollar rates the previous result that does not reject efficiency is confirmed, while for the franc/dollar rate the SURE results reject, as in the OLS case, the hypothesis of market efficiency.

In Table 3 the estimated values of the α's parameters of the "news" component of the exchange rate forecasting error are presented. These parameters are estimated by dividing the corresponding cross-error covariance by the estimated variance of the forecasting error of the relevant exogenous variable. As may be seen, however, only in eight out of twenty-four cases, the α's have the expected signs.

In Table 4 the results obtained when (12) was estimated, taking into account the cross-error structure between the rates for the different currencies, are presented. From these results, it is clear that the incorporation of this information increases the statistical efficiency of the tests. In this case the hypothesis that $a=0$ and $b=1.0$ cannot be rejected for any of the rates. However, the point estimates of the coefficients are still well below the hypothesized value of one.

Equation (14) was also estimated incorporating unanticipated changes in monies, real incomes and real interest rates as additional right hand side variables. The results obtained, not reported here due space considerations, tend to confirm the results reported in Table 2: While in the lira/dollar rate the efficiency hypothesis cannot be rejected any more, the coefficient of unanticipated changes is frequently of the wrong sign and insignificant. [21/]

The results reported in this section indicate that, as the asset-view of exchange rate determination suggests, new information about exchange rate determinants play an important role in explaining exchange rate behavior. The empirical analysis reported in this paper has been centered on incorporating the role of new information in tests of exchange rate market efficiency. The results were particularly successful for the lira/dollar rate, and when the cross-error structure across rates (Table 4) was taken into account. However, the fact that, even when "news" was taken into account, efficiency was still rejected for the franc/dollar rate, and that the α's from the SURE model were frequently of the wrong sign, indicate that "news" about money, income and real interest rates probably do not account for the whole story. In particular, it is probable that, as Hansen and Hodrick (1980, 1981) have recently suggested, there is a non-constant risk premium that, in addition to news, affects exchange rate behavior.

4. Concluding Remarks

In this paper a model of the determination of the exchange rate in the short run, under a floating system, was derived. The model assumes rational economic agents, and stresses the role of expectations in the determination of the exchange rate. The model also stresses the role of new information on the explanation of exchange rate movements. In particular, it suggests that the market forecasting error (the difference between the actual spot rate and the expected future spot rate determined in the previous period) can be explained by unanticipated changes in exchange rate determinants. This proposition of the model was tested using Zellner's seemingly unrelated regressions procedure in tests of exchange market efficiency. The results obtained indicate that once the role of "news" is allowed into the estimation of exchange rate equations, the efficiency of these tests improves. When efficiency tests were performed and the role of "news" was incorporated, it was not possible to reject the efficiency hypothesis for 3 out of 4 rates. In addition, when the efficiency equation was estimated incorporating the cross-error structure for different rates, the null hypothesis that the exchange market is efficient could not be rejected for any of the rates considered in this study. In general, these results tend to confirm previous findings (Dornbusch, 1980; Frenkel, 1981a) that indicate the new information plays an important role in the explanation of observed market forecasting errors. However, the fact that when the role of "news" is incorporated efficiency is still rejected for one rate (dollar/franc) suggests that there are still elements, besides "news", that affect exchange rate behavior. A likely candidate for this role is a variable risk premium.

Appendix

1. Derivation of p_t, i_t, s_t and f_t

Assuming money market equilibrium at home and abroad [i.e., equation (6) equals equation (7)], and assuming that the expected real rates of interest are equalized across acountries (i.e., $E_{t-1}(r_t) = E_{t-1}(r_t^*)$), it may be shown that the expressions for the equilibrium price level, interest rate and spot exchange rate will be of the following form (see Edwards (1981) for further details):

$$p_t = \pi_o + \pi_1 t + \pi_2 m_t + \pi_3 u_t + \pi_4 w_t + \pi_5 n_t \tag{A.1}$$

$$i_t = \gamma_o + \gamma_1 u_t + \gamma_2 w_t + \gamma_3 n_t \tag{A.2}$$

$$s_t = \beta_o + \beta_1(m_t - m_t^*) + \beta_2 u_t + \beta_3 w_t + \beta_4 n_t + \beta_5 u_t^* + \beta_6 w_t^* + \beta_7 n_t^* \tag{A.3}$$

where expressions equivalent to (A.1) and (A.2) will hold for p_t^* and i_t^*. Rationality requires that:

$\pi_o = [b(\rho-ag) - ay_o + b\lambda]$; $\pi_1 = -ag$

$\pi_2 = 1$; $\pi_3 = -a/(1+b)$

$\pi_4 = b/(1+b)$; $\pi_5 = -b/(1+b)$

and that

$\gamma_o = (\rho-ag+\lambda)$; $\gamma_1 = a/(1+b)$

$\gamma_2 = 1/(1+b)$; $\gamma_3 = -1/(1+b)$

and that

$\beta_o = [b(\rho-ag+\lambda)-b^*(\rho^*-a^*g^*+\lambda^*)+a^*y_o^*-ay_o$; $\beta_1 = 1$

$\beta_2 = -a/(1+b)$; $\beta_3 = -1/(1+b)$

$\beta_4 = -b/(1+b)$; $\beta_5 = a^*/(1+b^*)$

$\beta_6 = 1/(1+b^*)$; $\beta_7 = b^*/(1+b^*)$

Expression (10) for f_t is derived by computing the conditional expected value of (A.3) and using the fact that, from (6), and the assumptions of serially uncorrelated shocks and full current information, $E_t(m_{t+1}) = m_t + \lambda - n_t = m_{t+1} - v_{t+1} - n_{t+1}$.

2. Data Sources

1. Exchange Rates: All exchange rates (spot and forward) are bid prices obtained from the Weekly Review of the Harris Bank. All rates refer to the closest Friday to the end of the month. The forward rates are one month maturity.

2. Prices: For all countries the Consumer Price Index, as reported in line 64 of the International Financial Statistics, was used.

3. Money: Seasonally adjusted M1, as reported in line 34b of the IFS, was used for all countries.

4. Real Income: A seasonally adjusted index of Industrial Production, as reported in line 66c of the IFS, was used for all countries.

5. Nominal Interest Rates: One month maturity Eurocurrency rates, as reported by the Weekly Review of the Harris Bank, were used.

Table 1

Exchange Rates Market Efficiency Tests: OLS Estimates

(monthly data)

Rate	Period	Constant	f_t	f_{t-1}	R^2	S.E.	F	D.W.
pound/ dollar	7/73-9/79	-.036 (.0182)	.953 (.0253)		.952	.028	3.52	1.703
pound/ dollar	7/73-9/79	-.037 (.018)	1.069 (,115)	-.118 (.114)	.952	.028		1.930
franc/ dollar	7/73-12/78	-.526 (.1883)	.830 (.0612)		.742	.032	7.67	2.144
franc/ dollar	7/73-12/78	-.482 (.196)	.743 (.121)	.101 (.121)	.744	.032		1.976
DM/ dollar	7/73-9/79	.022 (.0274)	.971 (.0324)		.926	.032	.78	2.106
DM/ dollar	7/73-9/79	.022 (.028)	.970 (.109)	.002 (.110)	.926	.033		2.103
Lira/ dollar	7/73-12/78	.333 (.1586)	.949 (.0239)		.961	.031	4.56	1.954
Lira/ dollar	7/73-12/78	.332 (.160)	.922 (.121)	.027 (.120)	.961	.032		1.895

Standard errors in parentheses; R^2 refers to the coefficient of determination; F is the joint test for a=0 and b=1.0; S.E. is the standard error of the regression.

Table 2

Tests of Market Efficiency Incorporating
Cross Error Structure Between Forecasting Equations
and Exchange Rate Equation

(SURE - Monthly Data)

$$s_{t+1} = a + b f_t + \varepsilon_{t+1}$$

Rate	Period	Constant	f_t
pound/ dollar	7/73-9/79	-.033 (.0179)	.957 (.0248)
franc/ dollar	7/73-12/78	-.568 (.1792)	.816 (.0583)
DM/ dollar	7/73-9/79	.026 (.0271)	.967 (.0320)
lira/ dollar	7/73-12/78	.246 (.1553)	.962 (.0234)

Standard errors in parentheses.

Table 3

Estimated Values of the α's from the SURE Model of Exchange Rate Market Efficiency

Rate	α_o	α_1	α_2	α_o^*	α_1^*	α_2^*
pound/ dollar	.014	-.254	.189	.189	-.071	.040
franc/ dollar	-.244	.077	-.366	.099	-.403	-.387
DM/ dollar	.373	.318	-.626	.150	-.013	-.151
lira/ dollar	-.384	-.091	-.385	.018	-.374	-.115

Table 4

Tests of Market Efficiency Incorporating
Cross-Error Structure Across Rates

(Monthly Data - SURE)

$$s_{t+1} = a + b\ f_t + \varepsilon_{t+1}$$

Rate	Period	Constant	f_t
pound/ dollar	7/73-12/78	-.026 (.0144)	.964 (.0199)
franc/ dollar	7/73-12/78	-.140 (.1220)	.956 (.0398)
DM/ dollar	7/73-12/78	.031 (.0263)	.962 (.0300)
lira/ dollar	7/73-12/78	.268 (.1353)	.959 (.0204)

Standard errors in parentheses.

FOOTNOTES

*I would like to thank John Bilson, Michael Darby, Jacob Frenkel and Arnold Harberger for helpful comments. I am also indebted to an anonymous referee who made many helpful suggestions. All remaining errors are my own.

1. See, for example, the essays collected in Frenkel and Johnson (1978), Frenkel (1980, 1981a), Mussa (1982), Dornbusch (1978, 1980), Frankel (1979), Artus and Young (1979), Frenkel and Mussa (1980), Genberg (1981) and Isard (1981). For a review of the forecasting properties of recent exchange rate models, see Meese and Rogoff (1981).

2. On the optimal degree of exchange rate management in a stochastic setup, see Frenkel and Aizenman (1981). See also Fischer (1976) and Boyer (1978).

3. It is possible that, as suggested by Hansen and Hodrick (1980, 1981) a non-constant risk premium term plays an important role in exchange rate behavior. This has also been suggested by Frenkel and Razin (1981). It is important, however, to stress the idea that a non-constant risk premium would play a role in addition to "news".

4. For a general description of efficiency in asset markets, see Fama (1976). Levich (1979) and Kolhagen (1978) provide surveys on efficiency and the exchange rate. For empirical studies concerning the efficiency of the exchange market, see, for example, Bilson (1981), Frenkel (1981a), Frankel (1980), and Hansen and Hodrick (1980).

5. See, for example, Dornbusch (1978, 1980), Frenkel (1981a), Edwards (1981), Isard (1981), Hartley (1981), and Mussa (1982).

6. For a detailed discussion of the model, see the Appendix. See also Edwards (1981).

7. This assumes that there is perfect capital mobility and that domestic and foreign bonds are perfect substitutes. Notice, however, that we are ab-

stracting from the problem of political risk. See Aliber (1973), and Dooley and Isard (1980). This expression also abstracts from the taxation issues discussed in Levi (1977).

8. See Isard (1981) for a model that assumes risk averse agents.

9. The empirical evidence available suggests that during the recent floating system, there have been large deviations from PPP in the short run. See, for example, Dornbusch (1978, 1980), Frenkel (1981a, 1981b), Isard (1981) and Darby (1980).

10. These expressions do not consider the effects of income taxes or nominal interest rates. For a discussion of this issue, see Darby (1975).

11. While this assumption greatly simplifies the exposition, it does not alter the results. In Edwards (1981), the model is solved under more realistic assumptions with respect to y_t.

12. This is only a simplifying assumption that captures the fact -- documented by Darby (1980), Dornbusch (1978, 1980), and Frenkel (1981a, 1981b), among others -- that there are short-run deviations from PPP. In Edwards (1981) the model is solved under the (more realistic) assumption that deviations from PPP follow an AR of order one. It is interesting to note that a direct implication of this assumption is that deviations from PPP are related to differentials in real interest rates across countries. This property is also present in the work of Frankel (1979, 1981) and Isard (1981), who also derive models of exchange rate determination based on real interest rates differentials.

13. Some authors -- especially Roll (1979) and Roll and Solnik (1979) -- have indicated that in order to avoid unexploited profit opportunities, deviations from PPP (d_t) should follow a random walk. However, as Darby (1980) has indicated, this need not be the case if, due to unexpected stochastic shocks, and to the existence of adjustment costs that impede instantaneous

reallocation of capital, real interest rates are allowed to temporarily differ across countries. In the model presented in this paper, it is assumed that real interest rates can temporarily differ across countries only due to the unexpected random shocks (w_t and w_t^*). In fact, the expected real interest rates are assumed to be equated across countries (i.e., $E_{t-1}(r_t) = E_{t-1}(r_t^*)$. See Edwards (1981) for further details.

14. If it is assumed that there is incomplete current information, the solution of the model becomes more difficult. The reason for this is that -- as pointed out by Barro (1980) -- when incomplete information and an economy-wide capital market is assumed, these types of models do not have a closed form solution. For a discussion on this issue, see Edwards (1981).

15. There are several problems, however, with this procedure. First, it has the usual problems associated with methods that test two hypotheses jointly. If the hypotheses are rejected, it is not possible to know which one of them has failed. Second -- as indicated by Cumby, Huizinga and Obstfeld (1981) -- in a full-system full-information estimation, the misspecification of a single equation will lead to <u>inconsistent</u> estimates of all the system's parameters. And, third, estimations using this procedure can turn out to be very complicated and costly. In the case discussed in Section 3 of this paper, this method requires that for each rate we use full-information maximum likelihood with 108 cross-equation restrictions. As an example of the problems, Hartley (1981) has indicated that, in his less complex case, the estimation procedure failed to converge in many cases. Preliminary attempts made by this author to use this method have also resulted in non-convergence.

16. One of the advantages of this method is that the misspecification of one of the forecasting equations will not affect the consistency of the market

efficiency equation estimators.

17. See, for example, Kolhagen (1978), Levich (1979), Bilson (1981), Frankel (1980) and Frenkel (1981a).

18. This simplifying assumption allows us to have only one term for unanticipated money in the forecasting term (13).

19. As mentioned in Section 2, this is only one of the alternative ways of testing for the role of "news" in this model.

20. Alternatively, we can assume that v_{t+1}, v^*_{t+1}, u_{t+1}, u^*_{t+1}, w_{t+1} and w^*_{t+1} are the error terms from reduced forms of forecasting equations for money, real income and real interest rates in the domestic and foreign country, respectively. This approach has been followed by Hartley (1981). See, also, Edwards (1981).

21. See Edwards (1982a, 1982b).

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