FORWARD RATE AND RISK PREMIUM

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I. Introduction

Many studies dealing with an examination of the efficiency of the forward exchange market have hypothesised that the forward rate should be an unbiased predictor of the future spot rate. To test this hypothesis Frenkel (1976, 1978, 1981), Agmon and Amihud (1981), Edwards (1983), Murfin and Ormerod (1984), Ott and Veugelers (1986), among others, regressed the current spot rate against the one period forward rate prevailing in the previous period. They expected the constant term to be zero, the slope coefficient to be unity and the error term to be white noise.

Frenkel (1976 and 1978) clearly supported the unbiasedness of the forward exchange rate while Frenkel (1981) reported some mixed results. Nevertheless, the joint hypothesis of zero intercept and unit slope coefficient was not rejected in any of the cases. Levich (1979), Edwards (1983) and Ott and Veugelers (1986) also supported the unbiasedness of the forward rate. Porter (1971), Giddy and Dufey (1975), Giddy (1977), Agmon and Amihud (1981), Murfin and Ormerod (1984) and Peel and Pope (1987a) reported that the current spot rate is a superior predictor of the future spot rate to the forward rate.

The question of the poor performance of the forward rate as a predictor of the future spot rate has sparked interest in the recent past. Many researchers have tried to explain the reason for the findings. Hansen and Hodric (1983), Fama (1984) and Peel and Pope (1987b) find evidence consistent with a time-varying risk premium. Assuming the existence of a risk premium, the forward exchange rate (F_t) could be divided (ex-ante) into two components, viz (a) the expected future spot rate [$E(S_{t+1})$] and (b) a risk premium (P). More formally:

$$(F_t) = E(S_{t+1}) + P_t \quad \ldots\ldots\ldots\ldots \quad (1)$$

Given this relationship the forward rate (F_t) cannot be equal to the future spot rate (S_{t+1}) unless the risk premium (P) is zero. However, if (P) remains constant forever and the market is efficient in its formation of expectation and no information arrives between the time period t and t + 1 one can decompose the (F_t) into $E(S_{t+1})$ and (P) on the basis of the past observed relationship. But in reality we cannot rule out the possibility of new information coming into the market; and (P) could not be expectto the factors that determine the exchange rate, such as relative prices, the international trade and payment

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situation, interest rates etc. Therefore, it seems reasonable to expect (P) to vary over time. Hence, (P) could be a reason for the departure of the observed (S_{t+1}) from its corresponding (F_t).

In brief, the issues can be summarised in three different points, viz (a) the unbiasedness of the forward exchange rate (b) the existence of a time-varying risk premium and (c) the comparative performance of the forward rate vs the current spot rate in predicting the future spot rate. Therefore, this paper aims at examining the following three null hypotheses:

H_{01}: The forward rate is an unbiased predictor of the future spot rate.

H_{02}: The forward rate is the sum of the expected future spot rate and a risk premium and the risk premium varies in an autocorrelated way.

H_{03}: The current spot rate is a better predictor of the future spot rate than the corresponding forward rate.

II. Data and Methodology

This study examines the forward exchange market's behaviour using one month forward exchange rates of ten currencies, namely Austrian schilling, Belgian franc, Canadian dollar, French franc, German mark, Italian lire, Japanese yen, Dutch guilder, Swedish krone and the US dollar. The data required were obtained from the Datastream taking the Pound sterling as the base currency. The sample covers 70 month-end observations from January 1981 to October 1986.

The forward rate (F_t) is said to be a biased estimator of the future spot rate (S_{t+1}) if the difference between the observed future spot rate and the corresponding forward rate (S_{t+1}-F_t) is always either positive or negative. Moreover, in the following relationship,

$$(S_{t+1}-F_t) = a \quad \text{..........} \quad (2)$$

if 'a' is significantly different from zero then the forward rate is said to be biased. Therefore, the estimation of the conventional regression of $\ln S_{t+1}$ on F_t is potentially flawed for examining the hypothesis of unbiasedness due to non-stationarity [see Peel and Pope (1987b)]. Therefore, as suggested by Peel and Pope (1987b), the difference between the observed future spot rate and the corresponding forward rate (S_{t+1}-F_t) and the future spot rate and the current spot rate (S_{t+1}-S_t) is regressed against a constant only. Hence, the equations of the following form are estimated:

$$\ln S_{t+1} - \ln F_t = a_0 \quad \text{..........} \quad (3)$$

$$\ln S_{t+1} - \ln S_t = a_1 \quad \text{..........} \quad (4)$$

Under H_{01}: $E(a_0) = O, E(a_1) = O$

Many studies in the past have reported that the forward rate is a biased predictor of the future spot rate The forward exchange rate may look like a biased predictor of the corresponding future spot rate if the forward rate differs consistently from the expected future spot rate due to other factors (components). Until Fama (1984) suggested the possibility of the existence of a time-varying risk premium in the forward rate the biasedness of the forward rate was regarded as evidence against the efficiency of the foreign exchange market. Most of the recent studies have tried to discover the reason for the biasedness of the forward rate in predicting the future spot rate. One potential source of bias could be the existence of a risk premium in the forward rate. Assuming the validity of the Purchasing Power Parity (PPP) and the Interest Rate Parity (IRP) doctrines the risk arises due to the covariance of the exchange rate with inflation and interest rates, as the exchange rate will change to maintain the PPP and the IRP across countries. Let us reconsider the equation (1)

$$F_t = E(S_{t+1}) + P_t \quad \text{.......} \quad (1)$$

Since the expected future spot rate is not readily observable we cannot measure the risk premium directly. The deviation of the future spot rate from its corresponding forward exchange rate (S_{t+1}-F_t) measured on an ex-post basis cannot be regarded as only a risk premium unless we assume that the market can forecast the future exchange rate without error, but this is not a realistic assumption. Therefore, the deviation is expected to be the sum of the risk premium (P) and forecast error [$E(S_{t+1})-S_{t+1})$]. On an ex-post basis:

$$F_t = S_{t+1} + P_t + e \quad \text{.......} \quad (5)$$

where: $e = [E(S_{t+1})-S_{t+1})]$

By rearranging the equation (5) we get:

$$F_t - S_{t+1} = P_t + e \quad \text{.......} \quad (6)$$

Therefore, the observed difference between the future spot rate and the forward rate is expected to be the sum of the risk premium and forecast error.

Fama (1984) examined the existence and nature of risk premia by estimating the following regression equations:

$$\ln F_t - \ln S_{t+1} = a_1 + b_1 \ (\ln F_t - \ln S_t) = e_{1,\ t+1} \quad \text{.......} \quad (7)$$

$$\ln S_{t+1} - \ln S_t = a_2 + b_2 \ (\ln F_t - \ln S_t) = e_{2,\ t+1} \quad \text{.......} \quad (8)$$

In these equations a non-zero b_1 indicates that the premium component of F_t-S_t varies. Similarly, a non-zero coefficient b_2 will support the proposition that the forward rate contains information about the future spot rate. It is widely recognised that the deviations of b_2 from 1 can be due to a time-varying premium. Fama showed that the deviation of b_2 from unity is a direct measure of the variations of the premium in the forward rate and his results suggest that 'most of the variation in forward rates is variation in risk premia and the premium and expected future spot rate components of forward rates are negatively correlated.

Wolff (1987) used the Kalman Filter Signal Extraction technique on a series of (F_t-S_{t+1}) to identify and measure premia in forward exchange rates. Like Fama (1984), Wolff (1987) also suggested that most of the forecast error is accounted for by the variation in premium terms.

Past studies have focused on the forecast deviation $(S_{t+1}-F_t)$ to discover the existence of a risk premium. The forecast deviation can be divided into forecast error and risk premium. The forecast error could be a result of new information arriving between the period of forward rate determination and the observation of the corresponding future spot rate, and/or failure in expectation building at the time of forward rate determination, i.e. market inefficiency. Therefore, the forecast error $[E(S_{t+1})-S_{t+1}]$ is likely to incorporate the effects of two different factors. Hence $(S_{t+1}-F_t)$ could be a function of risk premium, new information and market inefficiency. As a result, focusing on $(S_{t+1}-F_t)$ cannot distinguish between the effects of these three factors.

Alternatively, we can focus on the difference between the spot rate at time t and the one period forward rate prevailing at the same time, i.e. (F_t-S_t). (F_t-S_t) also could be divided into expected changes in the spot rate and the ex-ante risk premium. More formally:

$$(F_t-S_t) = E(S_{t+1}-S_t) + P \quad \text{..} \quad (9)$$

Unlike $(S_{t+1}-F_t)$, (F_t-S_t) does not incorporate the effects of new information arriving between the period of forward rate determination and the observation of the future rate. Therefore, (F_t-S_t) provides a more meaningful basis for the analysis of risk premium. Of the two components of (F_t-S_t), the anticipated changes in the exchange rates $[E(S_{t+1}-S_t)]$ are not expected to have any regular pattern, while premium may vary over time in an autocorrelated way. However, the measurement (F_t-S_t) will not have any autocorrelation properties if the risk premium also moves randomly, hence the model will not be able to distinguish between expected exchange rate change and risk premium.

The share of risk premium that contributed to the differences between current spot rate and forward rate could be estimated if we are able to divide (F_t-S_t) into $[E(S_{t+1}-S_t)]$ and (P). Since we expect one of its components (P) to vary in an autocorrelated way and the other one (i.e. expected change) randomly[1] we can do the decomposition by

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1 Under the Rational Expectation hypothesis the current rate is the best predictor of the future spot rate but the observed, ex-post change in the exchange rate is expected not to be characterised by regular patterns.

estimating the ARIMA model for (F_t-S_t)[2]

The ARIMA model is able to identify the regularities in the deviations (F_t-S_t) and separate them from irregular movements. In the ARIMA process, no regularities will be observed if the deviation is random which suggests either that there is no risk premium or it moves randomly. If any regularity is observed, this will represent a risk premium varying in an autocorrelated way. Therefore, the predicted / fitted values in the model will represent the risk premium while the residuals from the models will be the expected changes in spot rate $[E(S_t-S_{t+1})]$. Therefore, the null hypothesis (H_{02}) will be tested by estimating the ARIMA model on the differences between the current spot rate and the one period forward rate prevailing at the same time. The coefficients of determination (R^2) for the model will explain the proportion of the deviation explained by the risk premium.

Some recent works on the subject suggest that the forward rate is a poor predictor of the future spot rate and it cannot do better than the current spot rate. Thus, to examine this hypothesis, i.e. to test the null hypothesis (H_{03}), the following three tests will be carried out:

(a) Coefficient of correlation/determination
(b) Comparative standard deviation
(c) Exponential smoothing

Firstly, a weak test, the correlation coefficient between the future spot rate (S_{t+1}) and the current spot rate (S_t), will be computed and compared with that between the future spot rate (S_{t+1}) and forward exchange rate (F_t). The higher correlation coefficient (R) will suggest a better predictive ability. The hypothesis of the better predictive ability of the current spot rate will be rejected if the future spot rate's coefficient of correlation (R) is higher with the forward rate than with the current spot rate.

Secondly, following Fama (1984), the standard deviation of difference between the forward rate and the future spot rate $(S_{t+1}-F_t)$ will be compared with that of the difference between the future spot rate and the current spot rate $(S_{t+1}-S_t)$. The lower standard deviation will suggest the better predictive ability. The null hypothesis (H_{03}) will be rejected if the standard deviation of is lower than that of $(S_{t+1}-S_t)$.

Both tests discussed above examine the comparative performance of the forward rate vs the current spot rate in predicting the future spot rate. Neither of them examines whether the current spot rate is the best predictor of the future spot rate. The current spot rate will be the best predictor of the future spot rate if exchange rates move randomly. Though the randomness of the daily exchange rate movement is rejected by the tests

2 However, before estimating ARIMA models for (F_t-S_t), the autocorrelation properties of the series will be examined.

discussed in Poudyal (1990), it will be tested for monthly data in this paper. Therefore, finally, the Exponential Smoothing Technique will be used to examine the predictive ability of the current spot rate.

In a simple Exponential Smoothing model an Alpha of 1.0 for the best fitted model (model with the smallest squared sum of residuals) will suggest that the current spot rate is the best predictor of the future spot rate and past rates do not have any effect on the expected future spot rate. If the Alpha is not equal to 1.0 then the current spot rate is not the best predictor of the future rate and past exchange rates have some predictive ability for future exchange rates. The following section deals with the results and their discussions.

III Results and Discussion

The first null hypothesis (H_{01}) that "The forward rate is an unbiased predictor of the future spot rate" is tested using the procedure suggested by Peel and Pope (1987b), i.e. equations (3) and (4) and the results are presented in Table 1 These equations are expected to be more appropriate in examining the null hypothesis of the unbiasedness of the forward exchange rate. All the estimated constants for equation (3), i.e. for($\ln S_{t+1} - \ln F_t$), are close to zero as none of them is statistically significant at the 5% level. Similarly, the constant term for equation (4), i.e. for ($\ln S_{t+1} - \ln S_t$), is not significantly different from zero except in the case of the Japanese yen. Thus, this test suggests the unbiasedness of the forward rate, hence (H_{01}) cannot be rejected.

Assuming the validity of the Rational Expectation hypothesis, future spot rate may differ from the corresponding forward rate if the latter contains a risk premium. Therefore, differences between the future spot rate and the corresponding forward rate cannot be regarded as evidence against the Market Efficiency hypothesis without examining for possible risk premia.

Consistent with previous literature, e.g. Fama (1984), the autocorrelations of the changes in spot rate ($S_{t+1} - S_t$) are close to zero (Table 2). This supports the hypothesis that the monthly spot rates move randomly, which is also supported by the Exponential Smoothing technique (discussed below)[3]. Therefore, we can suggest that the monthly changes in spot rate also move randomly.

As in the case of the changes in spot rate, the autocorrelation of the departure of the future spot rate from the corresponding forward rate ($F_t - S_{t+1}$) is also close to zero, which suggests that the risk premium does not have any regular pattern and moves randomly. But it could be an outcome of the random behaviour of the error term, ($F_t - S_{t+1}$), caused by a combination of risk premium, new information and market inefficiency. Therefore, this measurement ($F_t - S_{t+1}$) cannot uncover the behaviour of the risk premium content in the

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3 However, the Random Walk hypothesis was rejected for high frequency (daily) data [Poudyal (1990)].

forward rate (F_t). If the risk premium moves randomly, the series of (F_t-S_t) should also move randomly. However, the autocorrelations of the differences between the forward rate and spot rate prevailing at time t(F_t-S_t), which is the sum of the ex-ante risk premium and the expected changes in spot rate are more meaningful as they are serially correlated in most of the cases. Since expected changes in spot rates [$E(S_t-S_{t+1})$], one of the components of the differences in forward rate and current spot rate at time t(F_t-S_t) vary randomly (consistent with the Rational Expectation hypothesis and supported by the ex-post autocorrelation test), the remaining component (risk premium) should vary in an autocorrelated way over the period. This is consistent with the findings of Fama (1984), Peel and Pope (1987 a,b) and the references cited therein.

Equations (7) and (8) like Fama (1984), are also estimated for this sample set using OLS as well as ZSURE estimation methods and the results are presented in Table 3. The estimated slope coefficient of equation (7), i.e. (b_1), is statistically significant in five out of ten cases in OLS estimation while seven of them are significant in ZSURE estimation. Since the ZSURE estimation is expected to be a more efficient procedure we will be focusing on the results suggested by this method. Of the seven statistically significant coefficients two differ significantly from one, making five out of the ten currency cases away from one, which suggests that the premium component of (F_t-S_t) has variation. Given an efficient market the deviation of b_2 (equation 8) from one is a direct measure of the variation of the premium in the forward rate [see Fama (1984)]. Our results suggest that b_2 departs from one for all currencies except the Italian lire (OLS), the French franc and the Belgian franc (ZSURE). Since the coefficient b_1 is statistically significant in most of the cases (ZSURE), it suggests that the difference in forward rate (F_t) and current spot rate (S_t), i.e. (F_t-S_t), can explain part of the deviations in the future spot rate and the corresponding forward rate, (S_{t+1}-F_t), which is expected to be caused by the premium content in F_t. However, the same explanatory variable, (F_t-S_t), cannot explain the differences between the future spot rate and the current spot rate, (S_{t+1}-S_t), in most of cases. Furthermore, the explanatory power of the equation (7), as explained by the adjusted coefficient of determination, is always higher than that of equation (8). In brief, the results suggest that b_2 departs from one, hence the forward rate contains a risk premium. This is consistent with Fama's findings. Therefore, the autocorrelation tests (Table 2) and the estimation of the equations (7) and (8) (Table 3) taken together suggest that the forward rate contains risk premia which vary in an autocorrelated way.

Since the risk premium varies in an autocorrelated way and the changes in spot rate (observed on ex-post basis) move randomly, we can measure the premium content in (F_t-S_t) by estimating the ARIMA model for (F_t-S_t); the predicted series being the risk premium and the error term (expected to be zero on ex-ante basis) being the observed changes in spot rate which do not need to have any serial dependence. Table 4 summarises the results of the ARIMA estimation.

Different degrees of serial dependence are observed across the currencies. The ARIMA model is able to decompose the (F_t-S_t) into risk premium and expected changes in spot rates. In the cases of the Canadian dollar, the Japanese yen, the Dutch guilder and the Swedish krone only a small portion of (F_t-S_t) is explained by the risk premium and most of it is caused by observed changes in their exchange rates. In six of the currencies under study a considerable portion of (F_t-S_t) is explained by the risk premium.

A summary of the results for the examination of the stability and significance of the mean of the difference between forward rate and current spot rate (F_t-S_t) and forward rate and future spot rate (F_t-S_{t+1}) is presented in Table 5. The mean for the differences between forward rate and current spot rate (F_t-S_t) is statistically significant in all the cases except for the US dollar, and it varies over the period (as explained by the T-test for $Mean_1 = Mean_2$ vs $Mean_1 \# Mean_2$) except in the cases of the Japanese yen and Swedish krone. However, the mean of the forward error ((F_t-S_{t+1}) is statistically insignificant in all the cases. This supports the closeness of the forward rate to the observed future spot rate. The mean of the forecast error (F_t-S_{t+1}) is stable across the sub-sample except in the case of the Canadian dollar. It is positive (though statistically insignificant) in all the cases, ranging from 0.175 (Canadian dollar) to 0.797 (US dollar). A consistent positive mean of the forecast error suggests the existence of the forward premium. The variation in the risk premia across the currencies could be the result of the differences in the risk associated with the currencies. Therefore, in brief, the second null hypothesis that "The forward rate is the sum of the expected future spot rate and a risk premium and it (risk premium) varies in an autocorrelated way" cannot be rejected.

The poor performance of the forward rate in predicting the future spot rate is well documented in recent studies, e.g. Murfin and Ormerod (1984), Peel and Pope (1987a) and the references cited therein. They reported that the forward rate cannot do better than the current spot rate in predicting the future spot rate. To test the hypothesis (H_{03}) that "The current spot rate is a better predictor of the future spot rate than the forward rate" a simple correlation coefficient between the future spot rate (S_{t+1}) and the current forward rate (F_t) is firstly calculated and compared with that between the future spot (S_{t+1}) and the current spot rate (S_t) (Table 6). The correlation of the future spot rate (S_{t+1}) with the current spot rate (S_t) is found to be marginally higher than with the forward rate (F_t) for seven out of the ten currencies under study. The correlations with the forward rate were marginally higher for the Austrian schilling and the German mark while they were equal in the case of the Japanese yen. Thus this supports the proposition that the forward rate is not a better predictor of the future spot rate than the current spot rate.

Secondly, the standard deviation of the difference between the future spot rate and the forward rate, (S_{t+1}-F_t), is found to be higher than that of the difference between the future spot rate and the current spot rate (S_{t+1}-S_t), in eight out of the ten cases while it is smaller in the case of the Austrian schilling and equal for the German mark. In brief, this also supports the hypothesis that the current spot rate performs better as a predictor of the future spot rate than does the corresponding forward rate. However, both tests suggest that the forward rate is marginally better than the current spot rate in predicting the future spot rate of the Austrian schilling.

Though both comparisons of the correlation coefficients and the standard deviations suggest that the current spot rate is a better predictor of the future spot rate than the corresponding forward rate, they do not specify the predictive ability of the current spot rate. The current spot rate could be the best predictor of the future spot rate if monthly changes in the exchange rates (our sample consists of monthly data) move randomly. Out of the various methods of testing the randomness of a time series [discussed and estimated in Poudyal (1990) for different financial time series], we are using the Exponential Smoothing technique for the present purpose, mainly due to its simplicity and accuracy [see Gardner (1985) for a detailed discussion on the merits of the Exponential Smoothing technique]. The results for the Exponential Smoothing technique suggest that the current spot rate is the best predictor of the future spot rate, especially in the cases of the Belgian franc, French franc, Italian lire and Swedish krone as the Alpha were 1.00 (Table: .6). For the rest of the currencies, the best fitted Alpha is 0.90 which suggests that the current spot rate is a good predictor of the future spot rate. Past exchange rates can add very little predictive power. The model seems able to capture the movements in exchange rates as the Box-Ljung statistics suggest no serial correlation in the error term (residuals from the Exponential Smoothing) for all currencies. Thus, in brief, the current spot rate is the best predictor of the future spot rate, and monthly exchange rates move randomly. It can make better predictions than the corresponding forward rate. Therefore, the null hypothesis (H_{03}) that "The current spot rate is a better predictor of future spot rate than the forward rate" cannot be rejected for the currencies in the sample.

In summary, in most of the cases the evidence is consistent with the Efficient Market hypothesis and the findings of the earlier research papers. The tests based on Peel and Pope (1987b) model suggest that the forward rate is an unbiased predictor of the future spot rate. Since (F_t) is not only $E(S_{t+1})$, rather a sum of the $E(S_{t+1})$ and (P), the deviation of $E(S_{t+1})$ from (F_t) cannot be regarded as an evidence against the market efficiency hypothesis. Any differences noticed between the future spot rate (S_{t+1}) and the forward rate (F_t) (ex-post observed) are expected to be the effect of the news arriving between time period t and t+1 and the forward premium. Further, assuming the validity of the the Rational Expectation hypothesis, the ex-ante premium in the forward rate is found to vary in an autocorrelated way. Finally, the current spot rate is found to be a better predictor of the future spot rate than the forward rate, which is not inconsistent with the Market Efficiency hypothesis since the current spot rate (S_t) and the forward rate (F_t) are both expected to incorporate all the information available up to that point of time.

IV. Nepalese Context

The forward exchange rate system in Nepal is at its rudimentary stage of development. Nepal Rastra Bank, the central bank of the country, implemented the policy of forward exchange cover for export under the letter of credit since August, 17, 1983, covering transactions in the US dollar only. When there arose a fluctuation in the exchange rate of the dollar vis-a-vis the Nepalese currency, the Bank would then fix the forward rate for the ensuing nine months. Under the arrangement, exchange rate would be fixed in terms of US $ per Rs 100 and $ 0.0040 added to the amount every month till nine months. The profit/loss arising from such contract would be in the account of this Bank There was a condition of requiring the contract to be entered for a period not exceeding six months from the date of the despatch of the goods. There was no limit of amount under this provision. However, no single export transaction has taken place till date under the forward exchange cover. The probable reason behind this phenomenon has been the depreciating rate of Nepalese currency against the foreign currencies.

Nepal Rastra Bank also implemented, under the experimental basis, the system of forward cover for import transactions under the letter of credit with effect from February 18, 1989. The period of the contract was one month in minimum and six months in maximum, with the amount ranging from US $ 10,000 in minimum to US $ 100,000 in maximum. The foreign currencies eligible for such contract were US dollar, Pound sterling, Japanese yen, Deutsch mark and Swiss franc. While entering into contract with the importers under the scheme, the concerned commercial bank would be permitted to add/deduct some percentage, on the basis of the exchange rate daily fixed by the Nepal Rastra Bank. All the foreign exchange risk, profit or loss arising from the contracts entered into under this scheme would have to be borne by the commercial bank itself. Nepal Rastra Bank would bear no financial or foreign exchange liability under such transactions. Some transactions took place under this arrangement.

With the partial convertibility of the Nepalese currency introduced since March 4, 1992 for-reaching implications have taken place in the exchange and trade regime of the country. The provisions of the export and import cover as noted above need, therefore, be recast in the new lines. Accordingly, the system of forward cover under the changed circumstances is being worked out and would be brought out shortly. Only when the forward market grows and develops sophistication would the exercise relating to the prediction of the future spot rate be more realistic in Nepal and the releance of current spot rate or the forward rate in such prediction could be better understood.

Table 1

OLS REGRESSION ESTIMATION

(January 1981 to October 1986)

$(\ln S_{t+1} - \ln F_t) = a_0$ .... (3)

$(\ln S_{t+1} - \ln S_t) = a_1$ .... (4)

COUNTRY	$(\ln S_{t+1} - \ln F_t)$	$(\ln S_{t+1} - S_t)$
AUSTRIA	-0.003 (-0.96)	-0.007 (-1.88)
BELGIUM	-0.005 (-1.22)	-0.003 (-0.88)
CANADA	-0.007 (-1.77)	-0.005 (-1.42)
FRANCE	-0.005 (-1.26)	-0.002 (-0.51)
GERMANY	-0.003 (-0.83)	-0.007 (-1.83)
ITALY	-0.007 (-1.80)	-0.002 (-0.39)
JAPAN	-0.007 (-1.53)	-0.011 (-2.44)
NETHERLANDS	-0.003 (-0.84)	-0.006 (-1.75)
SWEDEN	-0.002 (-0.64)	-0.001 (-0.23)
USA	-0.006 (1.04)	0.005 (0.75)

T - Statistics are given in parentheses.

* Indicates significant 5% level.

Table 2

AUTOCORRELATIONS

Country	r_1	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9	r_{10}
					$S_{t+1}-S_t$					
Austria	0.04	-0.03	0.04	-0.11	-0.21	-0.11	0.19	-0.10	-0.03	0.04
Belgium	0.08	0.02	0.09	-0.07	-0.22	-0.11	0.15	-0.10	-0.07	-0.01
Canada	0.05	0.25	0.03	0.24	0.03	-0.05	0.04	-0.09	-0.01	-0.07
France	0.08	0.01	-0.03	-0.18	-0.21	-0.17	0.18	-0.07	0.03	0.12
Germany	0.00	-0.01	0.06	-0.13	-0.21	-0.08	0.18	-0.09	-0.03	0.05
Italy	0.03	0.06	-0.02	-0.08	-0.13	-0.14	0.11	-0.02	-0.03	0.05
Japan	-0.03	0.07	0.00	-0.04	-0.08	-0.24	0.12	-0.16	-0.01	0.08
Nether.	0.03	0.01	0.05	-0.14	-0.18	-0.08	0.14	-0.10	-0.03	0.03
Sweden	-0.03	-0.01	-0.15	0.03	-0.11	-0.01	0.07	-0.11	0.05	0.02
USA	-0.02	0.19	0.00	0.14	0.04	-0.11	0.05	-0.01	0.00	-0.06
					F_t-S_{t+1}					
Austria	0.07	-0.02	0.04	-0.12	-0.21	-0.13	0.18	-0.11	-0.04	0.18
Belgium	0.06	0.04	0.07	-0.08	-0.23	-0.15	0.12	-0.14	-0.09	-0.05
Canada	0.15	0.24	0.05	0.30	0.07	0.00	0.07	-0.09	-0.01	-0.06
France	0.11	0.01	-0.05	-0.20	-0.24	-0.20	0.15	-0.10	0.13	0.09
Germany	0.01	-0.02	0.06	-0.13	-0.21	-0.09	0.18	-0.10	-0.04	0.04
Italy	0.06	0.08	-0.04	-0.09	-0.15	-0.16	0.10	-0.05	-0.04	0.03
Japan	0.01	0.11	-0.02	-0.05	-0.08	-0.24	0.11	-0.16	-0.01	0.07
Nether.	0.05	0.02	0.03	-0.14	-7.16	-0.09	0.12	-0.12	-0.04	0.02
Sweden	-0.03	-0.01	-0.13	0.02	-0.12	0.00	0.07	-0.12	0.03	0.03
USA	0.09	0.24	0.06	0.17	0.03	-0.11	0.08	0.01	0.04	-0.02
					F_t-S_t					
Austria	0.43	0.42	0.37	0.26	0.17	0.17	0.07	0.00	-0.09	-0.04
Belgium	0.48	0.67	0.37	0.45	0.44	0.20	0.32	0.09	0.29	0.12
Canada	0.05	0.06	0.07	0.06	0.14	0.07	0.07	0.05	0.04	0.07
France	0.48	0.47	0.34	0.22	0.08	0.19	0.29	0.27	0.33	0.19
Germany	0.72	0.72	0.63	0.52	0.44	0.44	0.35	0.30	0.23	0.22
Italy	0.61	0.51	0.36	0.27	0.18	0.12	0.25	0.26	0.33	0.23
Japan	0.22	0.16	0.16	0.16	0.09	0.08	0.04	0.04	0.02	-0.01
Nether.	0.25	0.11	0.11	0.26	0.07	0.07	0.08	0.12	0.03	0.06
Sweden	0.18	0.05	0.16	-0.02	-0.14	-0.13	-0.05	-0.03	-0.20	-0.20
USA	0.21	0.18	0.19	0.14	-0.01	0.06	0.04	0.06	0.08	0.06

The Critical Value of Standard Error = 0.12

Table 3

$$\ln F_t - \ln S_{t+1} = a_1 + b_1 (\ln F_t - \ln S_t) + e_{1,t+1} \qquad (7)$$
$$\ln S_{t+1} - \ln S_t = a_2 + b_2 (\ln F_t - \ln S_t) + e_{2,t+1} \qquad (8)$$

(January 1981 to October 1986)

OLS Estimation:

Country	a_1	b_1	a_2	b_2	SE(a)	SE(b)	R_1^2	R_2^2	DW
Austria	0.007	1.089	-0.007	-0.089	0.007	1.871	0.00	0.00	1.82
Belgium	0.002	1.873*	-0.002	-0.873	0.004	0.811	0.05	0.00	1.73
Canada	0.004	1.749*	-0.004	-0.749	0.004	0.547	0.12	0.01	2.05
France	0.002	1.060	-0.002	-0.060	0.004	0.731	0.02	0.00	1.76
Germany	0.006	0.816	-0.006	0.184	0.008	2.013	0.00	0.00	1.90
Italy	-0.007	2.551*	0.007	-1.551*	0.006	0.749	0.13	0.05	1.87
Japan	0.019*	3.120*	-0.019*	-2.120	0.007	1.380	0.06	0.02	2.16
Nether.	0.013*	3.131	-0.013*	-2.131	0.006	1.619	0.04	0.01	1.92
Sweden	-0.001	2.151	-0.001	-1.151	0.004	1.579	0.01	0.00	1.86
USA	0.007	1.808*	-0.007	-0.808	0.007	0.570	0.02	0.01	2.21

ZSURE Estimation:

Country	a_1	b_1	a_2	b_2	SE(a)	SE(b)	R_1^2	R_2^2	DW
Austria	0.006	0.788*	-0.006	0.212	0.004	0.296	0.02	0.01	1.81
Belgium	0.033	0.907*	-0.003	0.093	0.004	0.322	0.08	0.03	1.79
Canada	0.005	1.305*	-0.005	-0.305	0.004	0.207	0.14	0.04	1.95
France	0.004	0.141	-0.004	0.859*	0.004	0.257	0.04	0.01	1.71
Germany	0.006	0.799*	-0.006	0.201	0.004	0.286	0.02	0.01	1.90
Italy	0.002	0.843*	-0.002	0.157	0.004	0.291	0.16	0.07	1.86
Japan	0.011*	1.089	-0.011*	-0.085	0.006	0.907	0.08	0.05	2.04
Nether.	0.009*	1.832*	-0.009*	-0.832*	0.004	0.310	0.07	0.04	1.87
Sweden	0.002	0.034	-0.002	0.966	0.004	1.089	0.04	0.02	2.05
USA	0.008	1.109*	-0.008	-0.109	0.004	0.211	0.14	0.04	2.06

* Indicates significant at 5% level.

Table 4

BEST FITTED ARIMA MODELS FOR (F_t-S_t)

(January 1981 to October 1986)

COUNTRY	MODEL	CONSTANT	R^2
AUSTRIA	(1 0 1)	No	0.34
BELGIUM	(5 0 2)	No	0.71
CANADA	(0 1 1)	No	0.07
FRANCE	(0 0 4)	Yes	0.49
GERMANY	(1 0 1)	No	0.55
ITALY	(1 0 1)	Yes	0.41
JAPAN	(1 0 1)	Yes	0.15
NETHERLANDS	(0 0 4)	Yes	0.09
SWEDEN	(2 1 0)	No	0.10
USA	(3 1 3)	No	0.41

Table 5

TESTS FOR FORECAST ERROR

(January 1981 to October 1986)

	MEAN		T-Value ($Mean_1$ Vs $Mean_2$)[1]	
COUNTRY	(F_t-S_{t+1})	(F_t-S_t)	(F_t-S_{t+1})	(F_t-S_t)
AUSTRIA	0.349 (0.96)	-0.335** (-14.20)	-0.44	2.75*
BELGIUM	0.452 (1.22)	0.132* (2.65)	-0.90	4.43**
CANADA	0.175 (1.77)	0.174* (2.09)	2.50*	2.93*
FRANCE	0.489 (1.26)	0.292** (4.59)	-0.63	4.91**
GERMANY	0.309 (0.83)	-0.372** (-16.57)	-0.33	5.73**
ITALY	0.727 (1.80)	0.576** (9.55)	-0.26	5.41**
JAPAN	0.686 (1.53)	-0.386** (-10.16)	-0.10	0.19
NETHERLANDS	0.304 (0.84)	-0.320** (-12.13)	-0.53	3.20**
SWEDEN	0.234 (0.64)	0.152** (5.46)	-1.01	0.58
USA	0.797 (1.78)	0.034 (0.39)	1.97	2.67*

T - Statistics for mean are given in parentheses.
1 The mean of sample 1 compared with the mean of sample 2.
* Indicates significant at 5% level.
** Indicates significant at 1% level.

Table 6

SPOT RATE vs FORWARD RATE IN PREDICTING THE FUTURE SPOT RATE

Country	Correlation (S_{t+1}, S_t)	Correlation (S_{t+1}, F_t)	Std. dev. $(S_{t+1}-S_t)$	Std. dev. $(S_{t+1}-F_t)$	Best Fitted Alpha
1. Austria	0.961	0.962	0.857	0.858	0.90
2. Belgium	0.899	0.893	2.313	2.246	1.00
3. Canada	0.977	0.975	0.067	0.063	0.90
4. France	0.848	0.842	0.362	0.356	1.00
5. Germany	0.959	0.960	0.124	0.124	0.90
6. Italy	0.816	0.794	78.012	74.163	1.00
7. Japan	0.982	0.982	13.709	13.463	0.90
8. Netherlands	0.958	0.957	0.134	0.132	0.90
9. Sweden	0.853	0.851	0.342	0.339	1.00
10. USA	0.983	0.981	0.060	0.055	0.90

Selected References

Agmon, T and Amihud (1981), The forward Exchange Rate and the Prediction of the Future Spot Rate, **Journal of Banking and Finance**, 5, pp 425-437.

Edwards, S (1983), Floating Exchange Rates, Expectations and New Information, **Journal of Monetary Economics**, 11, pp 321-336.

Fama, E F (1984), Forward and Spot Rates, **Journal of Monetary Economics**, 14, November, pp 319-338.

Frenkel, J A (1976), A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence, **Scandinavian Journal of Economics**, May, pp 200-224.

Frenkel, J A (1978), Purchasing Power Parity Doctorinal Perspective and Evidence from the 1920's, **Journal of International Economics**, 8, pp 169-191.

FRENKEL, J A (1981), Flexible Exchange Rates, Prices and the Role of "News": Lessons from the 1970s', **Journal of Political Economy**, August, pp 665-705.

Giddy, I H and G Dufey (1975), The Random Behaviour of Flexible Exchange Rates, **Journal of International Business Studies**, 6(1), pp 1-32.

Giddy, I H (1977), **Term Structure and Expectations in the Money and Foreign Exchange Markets**, Columbia University, Graduate School of Business Working Paper, cited in Levich (1979).

Hansen, L P and R J Hodric (1983), Risk Averse Speculation in the Forward Exchange Market: An Econometric Analysis of Linear Models, in J A Frenkel (ed), **Exchange Rates and International Economics**, University of Chicago Press, Chicago.

Levich, R (1979), On the Efficiency of Markets for Foreign Exchange, in R Dornbusch and J Frenkel (eds), **International Economic Policy Theory and Evidence**, John Hopkins Press, pp 246-267.

Murfin, A and P Ormerod (1984), The Forward Rate for the US Dollar and the Efficient Markets Hypothesis, 1978- 1983, **Manchester School**, Vol. 52, pp 292-299.

Ott, M and P T W M Veugelers (1986), Forward Exchange Rates in Efficient Markets: The Effects of News and Changes in Moneatry Policy Regimes, **Review**, Federal Reserve Bank of St. Louis, June/July, pp 5-15.

Peel, D and P F Pope (1987a), On Testing the Relationship Between Exchange Rate Movements and Monetary Surprises: A Comment on Smith and Goodhart, **The Manchester School**, June, pp 197-202.

Peel, D and P F Pope (1987b), Forecasting Foreign Exchange Rates: Can We Do Better ? **University** of Strathclyde, Memio

Porter, M G (1971), A Theoretical and Empirical Framework for Analysing the Term Structure of Exchange Rate Expectations, **Staff Papers**, pp 613-645.

Wolff, CCP (1987), Forward Foreign Exchange Rates, Expected Spot Rates, and Premia: Signal Extraction Approach, **Journal of Finance**, June, pp 395-406.