THE EFFICIENCY OF THE FOREIGN EXCHANGE MARKETS

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INTRODUCTION

The trading of currencies takes place in foreign exchange markets whose major functions, is to facilitate international trade and investment. Foreign exchange markets, however, are shrouded in mystery. One reason for it is that a considerable amount of foreign exchange market activity does not appear to be related directly to the needs of international trade and investment. Highlighting the range of activities that take part in a foreign exchange market, we may say that speculation explains a vast amount of foreign exchange transactions available through organised markets. Speculation is the kind of activity of making profis by outguessing other market participants as to what future exchange rates will be. In this paper 1 shall assess the efficiency of the foreigh exchange markets, namely, whether the current prices reflect all the available information and there are no unexploited opportunities for certain profits.

In the first part Γ 11 both examine the underlying theory which prevails for the determination of the exchange rate and discuss the efficiency of the foreign exchange markets hypothesis. In the second part Γ 11 conduct empirical tests of the efficiency hypothesis by using the exchange rates of U.S. dollar/pound, U.S. dollar/French Franc, U.S. dollar/Swiss Franc. Finally in the third part are included conclusions and arguments which are brought in favour of or against the hypothesis under consideration.

I. EXCHANGE RATE DETERMINATION

In recent years the theoretical literature on the «asset - market» view of exchange rates has been greatly expanded. The popularity of this view may be attributed to the compelling realism in today's world of both its distinguishing theoretical assumption and its distinquishing empirical implication. The theoretical assumption, known as perfect capital mobility, refers to the absence of substantial transactions costs, capital controls, or other impediments to the flow of capital between countries. Under this assumption the exchange rate adjust instantaneously to equilibrate the international demand for stocks of national assets, while in the traditional flow view it was supposed to adjusting to equilibrate demand for flows of national goods. The empirical implication is that floating exchange rates will exhibit high variability, that exceeds what one might regard as that of their underlying determinants. Bearing in mind the classification based on whether or not domestic and foreign bonds are assumed to be perfect substitutes in asset holders' portfolios, we must define what is meant by perfect capital mobility as the term is used here, and also substitutability.

By perfect capital mobility between countries is denoted that actual portfolio composition adjusts instantaneously to desired portfolio composition. Perfect substitutability between domestic and foreign bonds is the much stronger assumption that asset holders are indifferent as to the composition of their bond portfolios as long as the expected rate of return in the two countries' bonds is the same when expressed in any common nummeraire. Thus the interest rate on a domestic bond is equal to the interest rate on a foreign bond plus the expected rate of appreciation of foreign currency. The implication of this is that bond supplies then become irrelevant. Given that, the determination of the exchange rate, rests on the money markets. Models which focus on the demand for and the supply of money belong to a certain category called the «monetary approach» to exchange **rates.**

I.1. The flexible — price (Monetarist) Monetary Model

As also described above, the main features of the model are: lack of any transactions costs, or capital controls which hinder the integation of capital markets as well as perfect substitutability between domestic and foreign bonds. In that sense there is only one bond in the world. Similarly applying the same prin-

ciples to the goods markets we obtain analogous results. In other worlds we end up with only one good in the world. The implication of this assumption is that of purchasing power parity. The domestic price level equals the foreign price level times the exchange rate.

Setting out the monetary approach model we may write a conventional demand for money function as follows :

(1) $m = p + \Phi y - \lambda_i$ where :

$m =$ log of the domestic money stock

$p =$ log of the domestic price level

$\Phi =$ money demand elasticity with respect to income (positive)

$y =$ log of domestic real income

$\lambda =$ money demand semielasticity with respect to interest rate (negative)

$i =$ the domestic short - term interest rate.

By assuming a similar demand for money function for a foreign country :

(2) $m^* = p^* + \Phi y - \lambda_i^*$

Substracting (2) from (1) we get a relative money demand function :

(3) $(m - m^*) = (p - p^*) + \Phi (y - y^*) - \lambda (i - i^*)$

Recalling the assumption about the one bond in the world, the uncovered interest parity is given by :

(4) $i - i^* = \varepsilon\ (\Delta e)$

Where $\varepsilon\ (\Delta\varepsilon)$ = expected depreciation of domestic currency

Combining (3) & (4) and solving for the relative price level

(5) $(p - p^*) = (m - m^*) - \Phi\ (y - y^*) + \lambda\varepsilon\ (\Delta e)$

The purchasing power parity which is one of the characteristics of the model may be written as :

(6) $e = p - p^*$

Where e = log of the spot exchange rate defined as the price of foreign currency in terms of domestic.

As a consequence :

(7) $\varepsilon\ (\Delta e) = \varepsilon\ (\Delta p) - \varepsilon\ (\Delta p^*)$

By combining (5), (6) & (7) we obtain the monetarist equation of exchange rate determination .

(8) $e = (m - m^*) - \Phi\ (y - y^*) + \lambda\ (\varepsilon\Delta p - \varepsilon\Delta p^*)$

Equation (8) says that the exchange rate, defined as the relative price of currency is determined by the demand for and supply of money stock. An increase in the money supply will bring about a proportionate depreciation whereas an

increase in domestic income raises the demand for money and thus causing an appreciation.

Before modifing equation (8) into the next equation, it is necessary to refer to the Rational Expectations Hypothesis. The centrepiece of this hypothesis is that people are rational in their behaviour and they base their decisions on the basis of the best available information. The implication of this is that people are not trying any more to catch up with current prices but by exploiting all past information they are in line with the current level of prices. Any asystematic errors should be conceived and incorporated in their expectations. The significance of the Rational Expectations Hypothesis is that markets adjust quickly to «news» and policy makers cannot use economic policy to affect unemployment and output.

Now we turn again into our model and by assuming that expectations are rational and quite as well that income growth is exogenous we may write $y - y^* = \bar{y} - \bar{y^*}$. The above outlined Rational Expectations Hypothesis allows us to express the expected inflation in terms of the rationally expected monetary growth rate and write equation :

$$(9)\quad e = (m - m^*) - \Phi (y - y^*) + \lambda (\pi - \pi^*)$$

That equation is the basis for econometric estimation.

Furthermore we examine the existence and presentation of the expected inflation according to the specification of the money supply.

If we specify that changes of money supply follow a random walk then the future relative monetary growth rate and thus the last term in equation (8) is simply the current relative monetary growth rate, which will be represented by $\pi - \pi^*$.

If on the other hand we specify the level of the money supply to be a random walk it follows that the expected relative rate of monetary growth $\pi - \pi^*$ is zero. However the existence of inflation in today's world and it's effect on money demand cannot be ingnored.

Π. THE EFFICIENCY OF THE FOREIGN EXCHANGE MARKETS

In this second part I shall raise the issue of the efficiency of the foreign exchange markets and examine their ability to obtain good estimates of the parameters of their underlying theories.

Imagine a world in which (1) all traders have access to currently available information about the future (2) all are good analysts and (3) all pay close attention to market rates and adjust their holdings appropriately.

Is there any reason why well - functioning markets might rule out persistent excess profits? According to the theory of efficient markets the answer is, Yes. The theory of efficient markets holds that market prices already contain all available information. It is not possible to make profits by looking at old information or at patterns of past price changes. The efficient market view provides another way of looking at the pattern of exchange rate movements in organised market. Under the «efficiency» regime exchange rate movements should look highly erratic like a random walk when plotted over a period of time. But how this randomness can be justified and accepted as rational in an efficient market ? The answer to this question is given by the fundamental idea of the efficient - market theory. Rates respond to surprises, to news which by definition is unpredictable events causing them to move in any direction. Any other than random events should be conceived by people who will adjust their expectations about the future movements of the exchange rates accordingly.

Another issue related to the efficiency of the foreign exchange markets is that of risk premium.

The risk premium issue in foreign exchange markets really challenge the allegedly efficiency of the latter and the issue of the joint hypothesis of market efficiency and no risk premium, has created a lot of controversy among the researchers. But first it is important to be clear about what is meant by the term risk premium.

By rejecting the joint hypothesis, is as if rejecting the equality of expected future spot rates E (S_{t+1}) and forward rates (F_t^1) :

$$E = [S_{t+1}] - F_t^1 = 0.$$

In empirical tests the expectations of the future spot rate are assumed to be rational so that it's expected value is equal to it' s actual value plus some random forecasting error. Whenever the value of $S_{t+i} - F_t^1$ is predictably different from zero, there is evidence of the existence of a risk premium, market inefficiency or both. The risk premium values can take both positive and negative prices. Borrowing from the financial theory the way of measuring a security's risk, we apply it here in the foreign exchange markets. Thus, an asset' s (currency) risk is considered according to its contriobution to an investor's overall portfolio of assets. Then if follows that a negative risk premium should be paid whenever an asset's return covaries negatively with overall portfolio returns as stated earlier. Digging deeper into the notion of risk premium we try to specify theoretical determinants of the risk premium or else what would cause a currency's returns to covary with overall portfolio returns. There are two groups of models which allow the existence of risk premium: those which require the presence of outside assets to explain the existence of a risk premium and those that do not.

According to the former group of models, domestic and foreign bonds are considered to be imperfect substitutes. In this case, investors must be paid a premium in order to be induced to hold a greater share of the riskier bonds. Because of the imperfect substitutability between domestic and foreign bonds, determinate demands for the respective bonds and real yield differentials are risen. This might be the justification of using an asset demand equation in empirical tests, leaving $S_{t+1} - F_t^1$ a noisy measure of the risk premium on left side of the equation.

The second type of models which allow for the existence of a risk premium does not require the existence of outside assets. In these models there is perfect substitutability between domestic and foreign bonds. This means that asset holders are indifferent as to the composition of their bond portfolios as long as the expected rate of return on the two countries' bonds is the same when expressed in any common numeraire. Then it follows that a risk premium will exist, whenever changes in the exchange rate come from changes in the real exchange rate.

Most of the empirical work on the existence of risk premium has focused on the first type of models, whereas empirical tests based on the latter type of models are less common. Loopesko (1984) in over half the cases considered found lagged spot rates and uncovered interest parity deviations significant. She also found that lagged intervention helped explain deviations from uncovered interest parity in about the same number of cases. These results might be considered as evidence for the market inefficiency in the absence of a link from these

variables to risk premiums. These findings serve as a reminder that the efficiency of foreign markets theory and risk premiums are not mutually exclusive alternatives.

In one of his papers Frankel (1986) showed that under some certain assumptions the empirically risk premiums would be too small to account for the rejection of the joint hypothesis of efficiency and no risk premium. Thus, under Frankel's assumptions the conclusion would be market inefficiency.

Domowitz and Hakkio (1985) found that there is little evidence that the conditional variance of the exchange rate itself is the sole determinant of the risk premium.

Having examined risk premium from both it's theoretical and empirical aspect what conclusion can be drawn from this literature? Unfortunately the answer is not very much. Thus, although the vast majority of empirical works do not support the existence of risk premium it can hardly be argued that some findings are in favour of the risk premium existence.

Despite its lack of empirical support the issue of risk premium will continue to be prominent in the efficient-market theory literature.

II. 1. A test of the efficiency hypothesis

Now I shall examine the efficiency hypothesis by presenting a test conducted by me. This test involves the exchange rates of U.S. dollar/English pound, U.S. dollar/Swiss Franc and U.S. dollar/French Franc. The theoretical framework for this test is provided by the monetary approach to the exchange rate determination, outlined in the first part. The key feature of this approach is that if exchange rates are derermined in way similar to that of other assets, then it follows that all available information should be reflected in the current level of prices. The equation that expresses the monetary approach and which was also used by J. Frenkel in one of his papers is the following :

$$(1)\quad \ln S_t = \alpha + b \ln F_{t-1} + u_t$$

Γ m going to use this very same formula in order to carry out my own test. Thus, I first regress the current spot rate, l_nSt, on the logarithm of the forward exchange rate prevailing at the previous month, l_nFt-i. If foreign exchange markets are efficient, then the residuals, Ut, would be serially uncorrelated. Furthermore if the forward exchange rate is an unbiased predictor of the future spot exchange rate, then it tollows that the constant term in equation (1) should not differ significantly from zero and the slope coefficient should not differ significantly from unity. I examine the efficiency hypothesis by using monthly data seasonally adjusted for the period January 1979 - December 1984. The spot rates are end -of- month rates obtained from the IMF tape. The forward exchange rates arc end - of- month, for one - month maturity obtained also from the IMF tape. The obtained results are reported in table (1).

The test statistics for testing the joint hypothesis are reported in the column headed by F.

Figure 1 represents plots of actual and fitted values of the dollar/pound exchange rate regression. As may be seen, the Joint hypothesis that the constant coefficient is zero and that the slope coefficient is unity, cannot be rejected for all three exchange rates. Moreover the hypothesis that the constant term does not differ significantly from zero is not rejected in all three exchange rates. Nevertheless the hypothesis that the slope coefficient does not differ significantly from unity is rejected for both U.S. dollar/Swiss Franc &U.S. dollar/French Franc exchange rates. The same hypothesis cannot be rejected for the U.S. dollar/Pound exchange rate.

So far I have been assessing whether the forward rate is an unbiased forecast of the future spot rate, by using the $l_nS_t = \alpha + bl_nF_{t-1} + u_t$ regression, in all three exchange rates. The used technique was the OLSQ method. Now we turn next to the question of efficiency. One of the main features of the market efficiency definition as discussed earlier is that prices reflect all available information. Thus, expectations concerning future exchange rates are reflected in forward rates and spot exchange rates reflect all currently available information. Then it follows that if forward rates prevailing at period $t-1$ summarize all relevant information available at that period they should contain also information available at period $t-2$.

Looking at the tables we see that the inclusion of lagged values of the forward rates (l_nF_{t-2}) in equation (1) neither improve the goodness of fit nor the coefficients yield estimates that differ significantly from zero. These results are

TABLE 1

Efficiency of foreign exchange markets (standard errors in parantheses) [1]

Dependent variable I_nS_t	Estimation method	Constant	I_nF_{t-1}	I_nF_{t-2}	R^2	s.e	D.W	F
	OLS	—0,022 (0,012)	1,024 (0,019)		0,98	0,03	1,69	1,86
dollar/ pound	OLS	—0,019 (0,013)	1,119 (0,137)	—0,099 (0,141)	0,98	0,03	1,89	
	IV	—0,022 (0,012)	1,023 (0020)		0,98	0,03	1,71	
	OLS	—0,042 (0,022)	0,975 (0,032)		0,93	0,03	1,79	1,90
dollar/ Swiss Franc	OLS	—0,045 (0,022)	—1,027 (0,133)	—0,057 (0,136)	0,93	0,03	1,89	
	IV	—0,044 (0,022)	—0,973 (0,033)		0,93	0,03	1,79	
	OLS	—0,027 (0,024)	0,991 (0,013)		0,99	0,03	1,87	0,49
dollar/ French Franc	OLS	—0,028 (0,025)	—1,030 (0,130)	—0,039 (0,131)	0,99	0,03	1,94	
	IV	—0,027 (0,024)	—0,991 (0,013)		0,99	0,03	1,87	

1. s.e is the standard error of the equation

R^2 is the coefficient of determination.

The F- statistic, tests the joint restriction. The test statistic is distributed as F (2,70). Critical values for F (2,70) are 3,13 (at 95 percent level of significance) and 4,92 (at 99 percent). The table values for the Durbin - Watson significance points are $d_L = 1.58$, $d_U = 1.64$

consistent with the above mentioned market efficiency hypothesis. Continuing the examination of the tables a striking result comes up. The Durbin-Watson statistics signifies the absence of autocorrelation, in other words, it is consistent with the hypothesis made about the non-correlated residuals.

Worth noting here is that one of the Durbin-Watson statistic drawbacks is that it is inappropriate test for testing autocorrelation if among the explanatory variables there are lagged values of the endogenous variable. Then since l_nF_{t-1} is highly correlated with l_nF_{tt-2} the D — W statistic may not be appropriate because equation (1) is similar to a regression of l_nS_t on its own lagged value. However, Durbin's h—statistic reveals that the residuals are serially uncorrelated at conventional confidence levels.

As it is khown, for OLSQ technique to be the best estimation method (B.L.U.E.) it is needed to fulfil all the assumptions concerning the randomness of the error term. One of them holds that the error term should be uncorrelated with the explanatory variable. Thus, in our case it must hold true that cov (u_t, $l_nF_{t-1}=0$) .

In order to examine whether the OLSQ estimates may be subject to **the** errors in variables bias I perform a specification test by using the **Instrumental** Variables technique. By this test I assess the likelihood of misspecification of the b_0 coefficient. Therefore, I have to test the null hypothesis that b_0 is **an** unbiased coefficient against the alternative one which holds that b_0 is biased **and** an unbiased coefficient b1 may be obtained by applying the **Instrumental Variables** estimation procedure.

As it can seen, in all three exchange rates both the constant and the slope coefficients obtained by the Instrumental Variables technique are almost identical to those obtained by the OLSQ procedure. For example, for the Dollar/Swiss Franc exchange rate the constants are 0.042 and 0.044 and the slopes are 0.975 and 0.973, not to mention the Dollar/French Franc exchange rate where both the constants and the slopes are exactly the same. Consequently we may conclude that the use of the forward exchange rate as a proxy, for expectations does not introduce significant errors in variables bias and thus the use at the **OLSQ** estimation procedure seems to be an appropriate one.

III. CONCLUSIONS

We may say that the findings of the test described above, justify the use of the forward rate as an unbiased predictor of the future spot exchange rate. Also we may conclude that the behaviour of the foreign exchange markets has been broadly consistent with the general motion of the efficient market hypothesis.

Although the empirical evidence supports the efficiency hypothesis however there are several issues which must be taken into account before a definite answer is given such as ;

— the term «efficiency» has been used here in its narrow meaning rather than the broad concept of the word.

— the risk premium issue plays a significant role in the rejection or not of the foreign markets efficiency.

— the construction of a model which would generate the time series of the xpected prices is vital. Market efficiency is determided in relation to this standard.

— the constraution of a model unich would examine the relationship between speculative returns and excange risk is very important.

Surely the incoming literature about these questions will shed light in the still ambiquous foreign exchange markets efficiency.

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