The Euro exchange rate efficiency and risk premium: an ecm model

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ABSTRACT

The purpose of this work is to investigate the efficiency of the current Euro spot and current forward exchange rates. Within the past three decades there have been large movements in the exchange rate markets and often these movements were not related with the changes in the "fundamentals" of the economy. On the other hand, the exchange rate market efficiency implies that, if the market is efficient, there is no remaining ex ante opportunities for making profits through speculation. Hence, testing for efficiency involves the joint hypothesis of a specific risk premium and rationality. We analysed the relationship between spot and forward rates of the Euro against the British pound and the US dollar. For one of the two exchange rates (EU/UK), we reject the hypothesis of efficiency and a further analysis on the presence of a risk premium shows that it is consistent and time varying.

Keywords: Exchange rate; Efficiency Market Hypothesis; Risk Premia; Error Correction Model;

JEL classification: F30, F31

1 Introduction

Since the end of the Bretton Woods system the exchange rate market has been characterized by strong fluctuations. These unpredictable movements in exchange rates raise the question whether the foreign exchange market is efficient. The theoretical debate started in 1970 with the famous Fama definition of market efficiency. According to this definition, the forward rate should be the best predictor of future spot rate. Moreover, the exchange market might be judged not efficient either because period- to-period movements in exchange rates are serially correlated, or because forward exchange rates are not unbiased predictors of future spot exchange rates. The latter is strictly related with the presence of a risk premium. Given this, much of the recent evidence on asset market efficiency has been difficult to interpret. In particular, there is a large literature showing that the forward exchange rate is a biased predictor of future spot rates. This could mean either that exchange rates are inefficient, in the sense of the asset market approach, or that there is an unspecified risk premium influencing exchange rate movements.

2 Methodology

We consider the efficiency of the forward exchange rate. In general, an investor can sign a forward contract at time "t" to purchase foreign currency at time t+J at a price

$$f_{t,j}= s_t + (i_{t,j} - i_{t,j}^*) \quad [1]$$

where $i_{t,j}$ and $i_{t,j}^*$ are, respectively, the j-period ahead home and foreign interest rate. In theory, the "rational " investor will sign the contract if he expects that

$$E(s_{t+j} \mid I_t) \geq s_t + (i_{t,j} - i_{t,j}^*) \quad [2]$$

Moreover, if the forward market is efficient, then expected forward market profits should be zero, that is,

$$E(s_{t+j} \mid I_t) - f_{t,j} = 0 \quad [3]$$

Past researches on this topic - Cornell (1977), Levich (1978), Frankel (1980), Macdonald (1983), Cifarelli (1992), Apergis and Eleftheriou .(1997) and others - found positive results and supported the unbiased efficient hypothesis. On the other hand, Bilson (1980), Cumby and Obstfield (1984), Fama (1984) Goodhart (1988) Frankel and Froot (1988) and others, tend to reject the unbiased efficiency hypothesis.

However, forward market efficiency does not preclude the existence of a risk premium, defined as the excess expected return demanded by investor for assuming the risk of future changes in exchange rates. If this is correct, the relevant market equilibrium condition should include an additional term:

$$E(s_{t+j} \mid I_t) - f_{t,j} - RP_{t,j} = 0 \qquad [4]$$

where $RP_{t,j}$ is the risk premium.

The difference between the forward exchange rate and the spot exchange rate has always been used as the measure of the risk premium that the marginal investor would pay to reduce his exposure to exchange risk. Tests on forward markets, therefore, involve the joint hypothesis of a specific risk/return relationship and rationality. Most of the empirical studies on the measure of exchange risk premium undertaken in the eighties and early nineties have led the conclusion that the measured risk premium is not statistically significant. The inference from this conclusion could be that the foreign exchange market should be efficient.

In the exchange rate market the simple way to get a profit is concerned with the arbitrage. Since it does not involve any sort of risk, it seems clear that in equilibrium, the expected return should be zero (Eq.[4]). In other words, the forward exchange rate should be an unbiased predictor of future spot rate. Moreover, interest rate parity implied perfect substitution between domestic and foreign financial assets and the absence of foreign exchange controls. One important element of perfect substitution concerns risk neutrality with respect to exchange rate risk. If individuals are risk averse, they will not consider the return on foreign assets as comparable with the risk less return on domestic assets. In absence of transaction costs, the market is efficient if the covered interest rate parity is verified. It can be shown as

$$f_t - s_t = \alpha + \beta(i - i^*) + \mu_t \qquad [5]$$

It must be noted that a test for covered interest parity (CIP) is a necessary condition for efficiency but it is not a sufficient one.

3 Empirical results

The choice of the sample 1997 -2002 using monthly observation was essentially based on the need of analysing the behaviour of the Euro exchange rate against two important currencies (US dollar and British pound)[i]. Using these two exchange rates we assumed that their values are not strongly influenced by monetary authorities' intervention[ii].

A first step to test the efficiency hypothesis of exchange rate market is related to the test for the CPI. Table 1 and 2 show the results of the estimations of equation [5] for the covered interest rate parity test for the EU/US dollar and EU/UK pound under the condition that $\hat{\beta} = 1$ and μ_t is a white noise.

These results could suggest that, under the period of investigation (1997-2002), the covered interest rate parity was verified so that there were no more opportunities of extra profits from the arbitrage.

Once we have analysed the CIP for the two exchange rate market, next step in testing the efficiency of forward exchange rate is to test empirically the following equation:

$$s_t = \alpha + \beta f_{t-j} + \mu_t \qquad [6]$$

where the efficiency hypothesis holds if $\hat{\alpha}=0$, $\hat{\beta}=1$ and μ_t is an error term with zero mean and variance (σ^2) [iii]. In order to avoid the problem of nonstationarity of the time series eq.[6] has been estimated using a form "in which exchange rate changes are explained by the forward premium of the previous period"[iv] that is,

$$(s_t - s_{t-1}) = \alpha + \beta(f_t - f_{t-1}) + \varepsilon_t \qquad [7]$$

A second step to test the efficiency hypothesis of exchange rate market is related to the long-run relationship between spot and forward exchange rate, that is, to test if the variables involved in the analysis are cointegrated in the long run. To simplify the discussion, we assume that the long run relationship between spot and forward exchange rates[v] is represented by the following equation:

$$S_t = \alpha + \beta f_{t-1} + \mu_{5t} \qquad [8]$$

Under the null hypothesis of no cointegration the results for the eq.[8] of the two exchange rates, presented in Tab.2, show that the variables are cointegrated.

Eq. [8] represents the long run relationship between spot and forward exchange rate. "S_t and f_{t-1} follow a common trend, they may drift apart in the short run, but in the long run market forces will bring them together. If $\alpha^{\wedge} = 0$, $\beta^{\wedge} = 1$ and μ_t is white noise, then the forward exchange rate could well be seen - always in the long run - as an unbiased and efficient predictor of the future spot rate"[vi]. In other words, whenever S_t turns out to differ from f_{t-1}, some sort of adjustment must occur to restore the equilibrium in subsequent periods. To catch the adjustment process the following equation was implemented:

$$\Delta s_t = \alpha + \Sigma\beta\Delta s_{t-1} + \Sigma\delta\Delta f_{t-1} + \Sigma\omega s_{t-1} + \Sigma\psi f_{t-1} + \gamma\, \mu_{5t-1} + \varepsilon_t \qquad [9]$$

This dynamic error correction model shows the movement of the variables in any period is related to the previous period's gap from long run equilibrium. Table 3 presents the dynamic model for the two exchange rates.

Tables 2 and 3 show very controversial econometric results from estimating equations [8] and [9]. The cointegration regression confirms the efficiency hypothesis for the exchange rate EU/US but reject the same hypothesis for the EU/UK exchange rate that is $\alpha^{\wedge} \neq 0$, $\beta^{\wedge} \neq 1$. Moreover, in table 3 the estimates of the error correction models show that the lagged equilibrium error ($\gamma\, \mu_{5t-1}$) plays a relevant role in determining short run exchange rate behaviour and, according to Baillie and Bollersley (1989), it can be attributed to a systematic expectational error and/or to a time varying risk premium. Another problem arises from the results of eq.[9]. The coefficient of the lagged equilibrium error ($\gamma\, \mu_{5t-1}$) for one the two equations is positive, in particular the EU/US exchange rate. This would suggest, following J.A. Frankel and K.A. Froot (1987)[vii], "….a destabilising behaviour of economic agents and has to be attributed to the short run nature of the exchange rate forecasts involved in the estimates"[viii]. A way to solve these controversial results is to estimate the error correction model in the following form:

$$\Delta s_t = - d\, (s_{t-1} - s^{\wedge}_{t-1}) = - d\mu_{5t-1} \qquad [10]$$

In estimating eq.[10] if "$d^{\wedge}$" is positive, that is, -d is negative, the spot rate will converge to its equilibrium value, given by the cointegrating regression. On the other side, if "$d^{\wedge}$" is negative and, consequently, -d is positive the exchange rate will tend to diverge from its equilibrium value. Table 4 presents the results of the estimations of eq.[10] for the two exchange rates. The results confirm that there is no convergence for the EU/UK exchange rate as it was shown that the efficiency hypothesis was strongly rejected (table 2). The EU/US convergence coefficient is positive but almost equal zero indicating a very slow convergence to its equilibrium value. Finally, despite the positive value of the coefficient of the lagged equilibrium error for EU/US, the positive value of the convergence coefficient for the same exchange rate seems to confirm the efficiency hypothesis tested in eq. [8] and also indicates a convergence path to its long run equilibrium[ix].

The above controversial results force us to investigate the presence of the risk premium into the EU/UK exchange rate. While we test the efficiency hypothesis of the exchange rate market, we test the joint hypothesis of unbiasedness, that is, the rationality of economic agents; and also assume that agents are risk neutral. But if agents are risk averse they consider both the expected value and the degree of the uncertaincy on their return on speculation, and find speculation less attractive the greater the uncertainty. This point appears to be extremely relevant to the recent exchange rate experience (e.g. June-September 1992 EMS crisis, Mexican pesos' crisis in 1994 and Asian crisis in 1997). To test the presence of risk premium in the EU/UK exchange rate market we follow the work of Chiang and Hindeland (1988)[x]. Starting from eq. [4] they assumed that the expected value of s_t could be equal to a weighted average of s_t and f_t, where the sum of β_1 and β_2 is equal one, that is,

$$E(s_{t+j} \mid I_t) = \beta_1 s_t + \beta_2 f_{t,j} \qquad [11]$$

Substituting eq.[11] into eq.[4] they obtained the following equation:

$$RP_{t,j} = (1-\beta_2)\ (f_{t,j} - s_t) \qquad [12]$$

Using eq.[12] it is possible to directly test the risk premium[xi]. Figure 1 shows the behaviour of the risk premium over those years and table 5 gives some examples of risk premium's value during the period 2000:4-2002:1. The results are consistent with the hypothesis of the existence of a time-varying risk premium and with the results obtained by Chiang and Hindeland (1988).

The results that we obtained from estimating the efficiency market of these two exchange rates allow us to reject the joint hypothesis in one of the two markets examined. Nevertheless, remains unclear whether this rejection shows expectations to be biased and inefficient, or whether it reflects the existence of a time varying risk premium, or whether this is a result of both combined.

4 Conclusion

In investigating the efficient market hypothesis for the Euro exchange rate and the presence of a risk premium, we found that the spot and forward exchange rates are nonstationary and cointegrated. For one exchange rate (EU/UK), we reject the hypothesis of efficiency and the further analysis on the presence of a risk premium shows that it is consistent and time varying. One possible interpretation of this systematic expectation failure is that the unexpected change in the future spot rates could be triggered by "news". We cannot conclude from this, however, that agents are inefficient or irrational in their behaviour. Furthermore, the risk premium drives a wedge between the expected value of the future spot rate and the present forward rate. This point appears to be particularly relevant to recent exchange rate experience, and the difficulties it causes for testing market efficiency are confirmed by the fact that the risk premium, as we found in our empirical analysis, changes over time.

Finally, it is worth pointing out the nature and role of monetary policy implication: if the efficiency hypothesis is not verified the monetary policy is not perfectly effective as a stabilization instrument.

Table 1					
Test for Covered Interest Rate Parity EU/UK					
Equation: $f_t - s_t = \alpha + \beta(i - i^*) + \mu_t$					
variable	$\hat{\alpha}$	$\hat{\beta}$	R^2	**DW**	**t-stat. for ρ**
leuuk	**.00823 (.407064)**	**1.01793 (25.8979)**	**0.94**	**1.995**	**4.45**
Test for Covered Interest Rate Parity EU/US					
leuus	**-0.00236 (-0.8929)**	**0.9734 (36.149)**	**0.97**	**1.73**	**4.68**
The above equations were estimated using AR1 procedure					
sample 97:1 02:2; obs=62 **i,i* 1 month interest rate differential;** **$f_t - s_t$ = leuuk, leuus;** **i - i* = lintduk, lintdus.**					

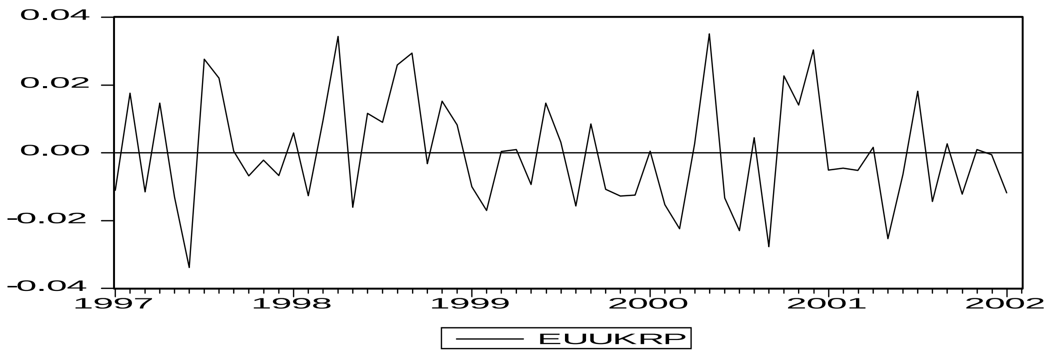
Table 2							
Test for cointegration							
Equation $S_t = \alpha + \beta f_{t-1} + \mu_{5t}$							
Exchange rate	$\hat{\alpha}$	$\hat{\beta}$	R^2	**ADF**	**Phillips Perron test**	**Johansen procedure**	
						Eidgenvalue	**Likelihood Ratio**
EU/UK pound	**-0.0331 (-1.9695)**	**0.6320 (7.85084)**	**0.90**	**-4.31**	**-7.88**	**0.2277**	**18.62**
EU/US dollar	**-0.00215 (-0.7581)**	**1.0248 (8.48934)**	**0.96**	**-4.59**	**-7.06**	**0.2313**	**16.11**
sample 1997:2 2002:2 **t-stat. in brackets are computed with heteroskedasticity consistent standard error** **ADF crit. val. (5 %) -2.91** **Johansen procedure crit. val. (5 %) 15.41**							

Table 3						
Short run exchange rate dynamics model						
General equation $\Delta s_t = \alpha + \Sigma\beta\Delta s_{t-1} + \Sigma\delta\Delta f_{t-1} + \Sigma\omega s_{t-1} + \Sigma\psi f_{t-1} + \gamma\mu_{5t-1} + \varepsilon_t$						
Exchange rate EU/UK: $\Delta s_t = \alpha + \beta\Delta s_{t-1} + \delta s_{t-1} + \gamma\mu_{5t-1} + \varepsilon_t$ **Sample 1997:3 2002:2 obs. 60**						
α^	β^	δ^	γ^	R^2	**DW**	**F-test**
0.051 (2.3016)	**0.6688 (2.9602)**	**0.1188 (2.3715)**	**-0.5561 (-2.977)**	**0.16**	**1.93**	**3.46**
Exchange rate EU/US: $\Delta s_t = \alpha + \beta\Delta s_{t-1} + \delta s_{t-1} + \gamma\mu_{5t-1} + \varepsilon_t$ **Sample 1997:3 2002:2 obs. 60**						
α^	β^	δ^	γ^	R^2	**DW**	**F-test**
-0.006 (-2.236)	**-0.405 (-3.054)**	**-0.054 (-2.005)**	**0.664 (4.081)**	**0.24**	**1.54**	**5.84**

Table 4	
Short run convergence	
Equation: $\Delta s_t = -d(s_{t-1} - \hat{s}_{t-1}) = -d\mu_{5t-1}$	
exchange rate	d
EU/UK	-0.0397
EU/US	0.0752

Table 5	
Some $Rp_{t,j}$ estimation from eq.[12]	
2001:04	0.001592
2001:05	-0.025404
2001:06	-0.006389
2001:07	0.018191
2001:08	-0.014377
2001:09	0.002630
2001:10	-0.012206
2001:11	0.000938
2001:12	-0.000551
2002:01	-0.011845

Figure 1



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[i] Data source: Datastream, IMF - Financial Statistics and European Central Bank Statistics.
[ii] For the estimation of the equations used in this work, the variables considered were:
a) the closing spot rate Euro/US dollar (EUUS) and Euro/British pound (EUUK);
b) one month forward rate Euro/US dollar (EU1US) and Euro/British pound (EU1UK);
c) one month Euro interest rate differential with US and UK one month interest rates.

[iii] To avoid the overlapping data, f_{t-j} should be chosen in order to exactly match the maturity of the forward contract.
[iv] G. Cifarelli, op. cit. pag. 198.
[v] In order to avoid Siegel`s paradox spot and forward exchange rates are in logarithms.
[vi] Cifarelli, [1992] op. cit. pag. 201.
[vii] J.A. Frankel and K.A. Froot, Short term and long term expectations of the Yen/Dollar exchange rate: evidence from survey data, Journal of the Japanese and International Economies, no. 1 Sept. , 1987.
[viii] Cifarelli, [1992] op. cit. pag. 203.

[ix] Cifarelli [1992] suggests that “ in the first case an unexpected appreciation brings about a depreciation in the following period as investors expect the currency to depreciate back to the equilibrium value given by the cointegrating regression. In the second case there is a bandwagon effect: an appreciation generates expectations of a further future appreciation of the currency of interest”. op. cit. pag. 203.
[x] T.C. Chiang and T.J. Hindelang, Forward rate, spot rate and risk premium: an empirical analysis, Weltwirtschaftliches Archiv, no. 194, pp. 74-87, 1988.
[xi] These tests may be classified as weak tests since the information set used by economic agents is assumed to include only the past history of the exchange rate.