EFFICIENCY AND NEWS IN EXCHANGE RATE MARKET: THE EURO/DOLLAR CASE

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Abstract

The aim of the paper is twofold: the first one is to examine the theoretical points that constitute literature on exchange rate market efficiency. We give a quick look to the long run, in which high or low efficiency results from the adjustment velocity of prices and production in goods market. We then go to examine literature conclusions about the short run. The second aim is to test the efficiency for the US dollar against the Euro foreign exchange market with a `news' exchange rate model using daily data over a period of 19 months. In the model we use, as proxies of 'news', variables generated by the residuals from a VAR model. Our results are consistent with the hypothesis that the forward exchange rate is not an unbiased predictor of the future spot rate. That is, we reject the hypothesis of efficiency and we show the importance of the 'news' in determining short-run movements in the exchange rate markets. The general conclusion we reach is that the euro dollar exchange rate market, from its birth to august 2000, is not efficient because expectations could not be rational, i.e. operators cannot predict risks coming from stock exchange and from uncertainty on future values of economic variables.

Keywords: Exchange rate; Efficiency Market Hypothesis; Risk premia; Vector Auto-Regression;

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1. Introduction

The exchange rate market efficiency is one of the most central topic international economist deal with because it is related to the nature of expectations and to the operators capacity to anticipate the exchange rate movements.

Using a very broad definition, a market is considered to be efficient if absolute price movements do not alter relative ones and if all markets are in equilibrium at current values. In other words, under efficiency conditions, monetary variables do not affect real ones and the economic system is dichotomic. Relating in particular to international markets, we have to introduce the money price of a currency in terms of another one, i.e. the nominal exchange rate, and explain why and how its movements influence the international markets efficiency. We can refer to the long run or to the short run: in the first case we consider international goods market, in which supply and demand offset through the purchasing power parity law; in the second case we consider a) the international Fisher effect and b) the unbiased forward rate theory.

The aim of this paper is twofold: the first one is to examine the theoretical points that constitute literature on exchange rate market efficiency. We quickly examine the long run, in which high or low efficiency results from the adjustment velocity of prices and production in goods market (section 2). We then consider literature conclusions about the short run: economists generally agree about the fact that international markets are efficient if operators are able to perfectly predict the exchange rate future value in order to cover themselves from the risk of capital losses (section 3). The second aim is to test the efficiency of the euro-dollar exchange rate market. Following the theory and using the VAR technique (presented in section 4) we test the presence of news in equations determining a) the spot exchange rate, b) the forward exchange rate and c) the interest rates variation through time (section 5). It emerges that in case a) and b) news variables are relevant, but in case c) they seems to be not. Empirical results show that the covered interest parity is not verified (section 5.1): in our opinion this means that the difference between forward and future spot exchange rate already contains the unpredicted events we were looking for.

The VAR methodology has not been used frequently in testing the market efficiency (see Bailey 1984), the dominant approach being that one of Frenkel (1981) and Dornbush (1982). This point of view was criticised because of the circular way they use.

The general conclusion (section 6) can be summarised as follows: the euro dollar exchange rate market, from its birth to august 2000, is not efficient because expectations could not be rational, i.e. operators cannot predict risks coming from stock exchange and from uncertainty on future values of economic variables of each country or, at a minimum, they

reveal the fragile nature of expectations[1]

2. Exchange rate market efficiency in the long run

In the long run a market is considered to be efficient if the purchasing power parity law or one price law is verified. According to this law the value of a good bought inside the country has to have the same price, if expressed in the same unit of measure, of the same good bought abroad (costs of transport obviously are not considered).

This condition is known as the strong version of the PPP or one price law:

$P = P^* S$ [1]

where P is the home price, P* is the foreign price and S is the nominal exchange rate. It can be expressed also in terms of the real exchange rate:

$R = SP^*/P = 1$

Since equation [1] has too strong hypotheses, it has been used a weak version of the PPP that can be expressed as follows:

$\delta P = \delta S + \delta P^*$ [2]

It states that the home price variation is equal to the variation of the exchange rate plus the variation of external price level. The adjustment mechanism works as follows: if output is at its full employment level and goods have the same qualitative features, consumers buy goods sold at lowest price. Because of rational expectations a demand increase causes just a price increase, and/or - under flexible exchange rate regime - a corresponding movement of currency relative prices.

The movement goes on until the PPP law is verified again.

However, there are, as data clearly show, long fluctuations in real exchange rates, that seem to allow for the failure of the one price law (cfr. Engel 1999).

The orthodox literature explains the movements through shocks originated in the real sector, which the market has not absorbed yet, because the international allocation of resources cannot happen quickly. These shocks can be due to 1) a change in the proportion between tradable and non-tradable goods. Fluctuations in prices in non-tradable goods causes higher inflation even if there is a strict control of the quantity of money; 2) a permanent change in the relative growth of productivity. If one country experiences a permanent increase in the rate of productivity prices permanently become lower and there will be a permanent increase of the real exchange rate; 3) a change in international consumer preferences.

However, according to the orthodox theory, the law of competition in the *very* long run would cause a reallocation of resources until the real exchange rate is again equal to one

[1] A support to this hypothesis comes from the sudden stock market crashed in 1987 and 1997.

and the international market efficiency confirms that relative goods prices are determined in the real sector.

3. Exchange rate market efficiency in the short run

In the short run the market efficiency is linked to the international Fisher effect and to the unbiased forward rate theory.

The international Fisher effect can be expressed in two ways the a) uncovered interest parity and b) the covered interest parity, in which risk is considered.

The UIP can be expressed as follows:

$$E_tS_{t+1}(1+i_t^*) = S_t\,(1+i_t) \qquad [3]$$

The value of the expected nominal exchange rate (E_tS_{t+1}) plus a certain rate of interest gained on foreign markets ($1+i^*$) is equal to the spot exchange rate (S_t) plus the rate of interest gained in home markets.

It can be also approximately expressed in log terms as follows:

$$E_ts_{t+1} - s_t \approx i_t - i_t^* \qquad [4]$$

known as uncovered interest parity condition of arbitrage, because operators do not take care of risks and rearrange their bonds investments every time there is the possibility of gaining on interest rates or on future value of currencies.

Because of the fact that monetary variables are involved in UIP (see Isard 2000) and prices are sticky, economists often accept short run disequilibrium in the exchange rate market. This phenomenon is known as overshooting or undershooting (Dornbush 1976 and 1988), according to which exchange rates increase or decrease more then proportionally because of low velocity price adjustments.

Theory however has "invented" another instrument to avoid the over or undershooting phenomena, introducing the possibility of covering from unexpected variation of prices.

The covered interest parity suggests that, if operators take care of risks to estimate the future value of the exchange rate, they take into account this condition of arbitrage:

$$F_t(1+i_t^*) = S_t\,(1+i_t) \qquad [5]$$

Where F_t is the present forward exchange rate. It can be rewritten in terms of logs:

$$f_t - s_t \approx r_t - r_t^* \qquad [6]$$

Comparing the [4] and the [6] we get

$$E_ts_{t+1} \approx f_t \qquad [7]$$

This means that the expected spot exchange rate almost equals the forward exchange rate because operators both take into account market risks and exploitable profits.

From the [7] it results that if

$E_t s_{t+1} = s_{t+1}$

i.e. expectations are correctly formulated and we are following the rational expectations hypothesis, then

$f_t \approx s_{t+1}$ [8]

This condition represent the unbiased forward exchange rate theory according to which the present forward exchange rate is the best predictor of the future spot exchange rate. If this condition is verified it means that operators have rational expectations and that the exchange rate market works under conditions of efficiency.

The empirical evidence about the efficiency hypothesis does not bring to a unique conclusion. In fact, there are many works that rejects the efficiency hypothesis [2] and, by contrast, other studies that confirm the efficiency hypothesis [3]. The rejection of the efficiency hypothesis implies, however, the presence of unexploited profit opportunities in market and the failure of agent's expectations. Moreover, the recent empirical analyses – in which can be included our study on euro/dollar exchange rate market - is that the forward exchange rate is not an unbiased predictor of the future spot and a time-varying risk premia is present in the exchange rate market.

Many authors (see for example Dornbush (1980 and 1988b) and Frenkel (1980 and 1981)) concluded that the best way to estimate the exchange rate market efficiency is to presume that the behaviour is due to interest rate differentials and any difference between forward and spot exchange rates at time t+1 results from the arrival of new information which agents have not predicted (see equation 4).

To test the efficiency of the exchange rate market (see Frenkel 1981) residuals from an auxiliary regression was used as a proxy for news and them as an auxiliary regressor, justifying in this way the difference between present forward exchange rate and future spot exchange rate. This result allowed concluding that the market is not efficient because of the presence of news.

But these conclusions have some problems. Pagan (1984), for example, has considered the limiting distribution of such an estimator and shown that the subsequent estimate of the disturbance variance is generally downward biased. In other words it is not correct to use the residuals of a regression - true for hypotheses and not verified - to estimate a variable - the difference between s_t and s_{t+1} - which is obviously correlated with it.

[2] Hakkio, 1981; MacDonald 1983, Hodrick and Srivastava, 1984; Domowitz and Hakkio, 1984; Fama, 1984; Taylor, 1988; Corbae *et a*l., 1992,

[3] Frenkel 1980, Longworth 1981, Hakkio and Rush, 1989; Baillie and Bollerslev, 1989; Lai and Lai, 1991; Masih and Masih, 1995

To estimate the presence of news we use a different approach following Baillie (1987) that uses a "specification of a complete multivariate time-series model, rather than [a] single equation estimation"[4].

In fact we first try to understand the variable determining interest rate differentials and the residuals coming out of the regressions are considered as news proving the inefficiency of the market.

4. METHODOLOGY

The starting point of our analysis is to use as proxy for 'news' variables the residuals from a vector autoregressive (VAR) model, the same utilized by Baillie (1987). A VAR model in a standard form can be written as follows:

$X_t = A_0 + A_1 X_{t-1} + u_t$ [9]

or a multivariate generalisation of [9]:

$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + \ldots + A_p X_{t-p} + u_t$ [9.1]

where

X_t = (n×1) vector containing each of n variables included in the VAR

A_0= (n×1) vector of intercept terms

A_i= (n×n) matrices of coefficients

u_t= (n×1) vector of error terms

"A VAR model is a better technique than any structural equation model, since macroeconometric models are not usually based on sound economic theories and loose models, such as the VAR model, should be employed, which do not impose rigid a priori restrictions on the data generation process (Lutkepohl, 1993). In other words, the user of a VAR model imposes few restrictions and usually employs OLS estimation. A VAR model is largely free of the spurious specification assumptions and errors associated with traditional macroeconometric procedures, so it can capture certain dynamic relationships among any economic variables better than the standard macroeconometric models. Nevertheless, considerable controversy has dealt with certain limitations of the VAR approach (Cooley and Leroy, 1985; Leamer, 1985). This controversy has mainly focused on the specific causal ordering of the variables involved in the VAR model. It is generally believed that, for results to be considered conclusive, they must be robust to ordering"[5].

[4] Baillie and Mcmahon (1989).

[5] Apergis and Eleftheriou (1997), p. 112.

In order to obtain a relationship between interest rate differential 'news' and exchange rate surprises, it is useful to decompose the general model presented in equation [9.1] into a more specific one. We use a simple VAR model with X_t vector containing three variables: Δi_t (interest rate differential), s_t (spot exchange rate) and F_t (forward exchange rate). We focus our attention on a number of different regression relationships already represented in a general form in equation [9.1]:

$$\Delta i_t = a1 + \sum_{i=1}^{v1} b1_i \Delta i_{t-i} + \sum_{i=1}^{v2} c1_i F_{t-i} + \sum_{i=1}^{v3} d1_i s_{t-i} + e1_t \qquad [10]$$

$$\Delta s_t = a2 + \sum_{i=1}^{v4} b2_i \Delta i_{t-i} + \sum_{i=1}^{v5} c2_i F_{t-i} + \sum_{i=1}^{v6} d2_i s_{t-i} + e1_t \qquad [11]$$

$$F_t = a3 + \sum_{i=1}^{v7} b3_i \Delta i_{t-i} + \sum_{i=1}^{v8} c3_i F_{t-i} + \sum_{i=1}^{v9} d3_i s_{t-i} + e3_t \qquad [12]$$

These three equations assume for hypothesis, following VAR methodology, that the present interest rates differentials, the present spot exchange rate and the present forward exchange rate depend on a parameter "a", past interest rates differentials, past forward exchange rates and past spot exchange rates, plus an error e_1 $e_{2,}$ e_3 which represent the residuals of the VAR model. The residuals of the equations [10], [11] e [12] are used to test the efficiency hypothesis. In fact we take the equation

$$s_{t+j} - s_t = \alpha + \beta(E_t s_{t+j} - s_t) + \gamma news_{t+j} + \mu_{t+j} \qquad [13]$$

following the 'news' model proposed by Frenkel (1980, 1981) and modified by Apergis and Eleftheriou (1997) into the equation [14][6]:

$$(s_{t+i} - s_t) = \alpha + \beta(F_t - s_t) + \gamma news_{t+i} + \mu_{t+i} \qquad [14]$$

We then use the residuals coming from equations [10], [11] and [12] and use them as Δinews, Δs_tnews and Δf_tnews respectively, in order to estimate the relevance of news effects on the three variables considered, testing the value of parameters a, ß and ?. In particular the hypothesis are H_0: $\alpha = 0$, $\beta = 1$ and $\gamma = 0$ versus H_1: $\alpha \neq 0$ $\beta \neq 1$ and $\gamma \neq 0$.

"According to equation [15], changes in the spot exchange rate occur because of new information which has not been anticipated in the previous period. News is a function of j -1 innovations that occur in the prediction interval from period t + j to t + 1. In other words, $E(news_{t+j}\ news_{t+j+k}) = 0$ for k >1.... As regards the significance of coefficient γ in equation

[6] Apergis and Eleftheriou,(1997).

[14], a statistically insignificant γ indicates that exchange rate fluctuations do not react to new information, thus indicating that this piece of new information has already been incorporated to exchange rate movements, i.e. the exchange rate market is efficient"[7]. Because Es_{t+j} is not available on international data and can be estimated just through direct interviews it can be substituted with F_t. In fact it can be considered the best predictor of the expected exchange rate.

5. ECONOMETRIC ANALYSIS

The data are daily (five days a week) covering the period from January 4th 1999 to August 11 2000 and are obtained from DATASTREAM. The choice of the sample was based on the need to analyse the behaviour of the US dollar exchange rates against the Euro. Using these variables we assume that the exchange rate value is not strongly influenced by monetary authorities intervention. For the estimation of the equations used in this work, the variables considered were[8]: the closing spot rate US dollar/euro (luseu); one month forward rate US dollar/euro (luseu1f); USA interest rate (usint); Euro-11 interest rate (euint).

A first step in testing the efficiency hypothesis and 'news' in the exchange rate market is related to the long-run relationship between spot and forward exchange rates, that is, to test if the variables involved in the analysis are cointegrated in the long-run. But, cointegration refers to a stationary relationship between integrated time series. This concept has played an important role in the theories of stochastic process and time series analysis. In fact, nonstationarity in a time series may be due to either a deterministic time trend or to a unit root. As pointed out by Hamilton (1994), for any unit root (i.e. difference -stationary) process there exists a stationary process that will be impossible to distinguish from the unit root representation for any given sample size T. The converse is also true. Interestingly, however, we can arrive at a testable hypothesis if we are willing to restrict further the class of processes to be considered. For example, if we use a first order autoregressive process, i.e. AR(1):

$$X_t = \beta X_{t-1} + \mu_t \qquad [15]$$

[7] Apergis and Eleftheriou, (1997),pag 112.

[8] In order to avoid Siegel's paradox (which arises because the expectation on an inverse does not, in general, equal over the expectation of the original variable), spot and forward exchange rate are in logarithms, thereby ensuring that results are independent of whether exchange rates are expressed in unit of home or foreign currency.

where "β" is a real number and μ_t is a sequence of independent normal-zero mean random variable with variance σ^2, so that $\mu_t \sim In(0,\sigma^2)$, then the restriction $H_O: \beta=1$ is testable. To test for stationarity, the unit root test is implemented, the Augmented Dickey-Fuller tests (Dickey and Fuller, 1979). This test is applied to all data we use in this work.

According to the Augmented Dickey-Fuller test[9], the results strongly suggest that all the variables are integrated of order one I(1); that is, we cannot reject the null hypothesis of non stationarity. Since we cannot reject the null hypothesis, then we have to consider the first difference process (DSP). A process is said to be DSP if it is not covariance stationary, but can be transformed into a covariance stationary process by differencing. If the model became stationary after the first difference, we say that it is integrated of order one, $X_t \sim I(1)$. The results of the ADF test compared with the critical value allow us to reject the null hypothesis. In other words, all the variables are integrated to the same order, that is, they are integrated of order one.

Cointegration analysis

The previous paragraph showed that all the variables relevant to the exchange rate determination can be better described as being non stationary, implying that random shocks to these series will have persistent effects in the distant future. Now, assuming that all the variables are ~I(1), the next step concerns the concept of cointegration. This refers to a stationary relationship between integrated time series. To simplify the discussion, we assume that the long–run relationship between spot, forward and interest rate differential is represented by the following equation:

$$s_t = \alpha + \beta F_{t-1} + \gamma \Delta i_{t-1} + \mu_t \qquad [16]$$

In order for s_t, F_t and ?¡ to be cointegrated, then two condition must be satisfied:

1) the three series have to be cointegrated to the same order;
2) a linear combination of the three series has to exist and it should be integrated to a lower order than the single series. That is, if cointegration is present, then these variables will move together in the long run.

In eq. [16], if μ_t is a white noise consequently μ_t is integrated of order zero $\mu_t \sim I(0)$. The results of cointegration test are reported in Table 1.

TABLE 1 Cointegration Test

[9] Dickey and Fuller, (1979), pp. 427-431.

Equation $s_t = \alpha + \beta F_{t-1} + \gamma \Delta i_{t-1} + \mu_t$						
	a	b	g	**R^2**	**ADF 5%**	**Wald test**
Coefficient	-0.066	0.8012	-0.1030	0.83	-13.75 crit. val. (-2.57)	1951.6**
t-stat	(-9.027)	(36.062)	(-70735)			
No. obs 399 Sample: 01/02/99 to 11/08/00						

The results recommend the presence of a cointegrated relationship among the variables concerned in the full sample. Under the null hypothesis of no cointegration, the ADF result from equation [16] is greater, in absolute value, than the ADF critical value at 5% of significance and we can reject the null hypothesis. Hence, the variables are cointegrated. The implication of the cointegration tests is that the VAR model is estimated in its levels. Once the VAR model was estimated (equation [10], [11] and [12]), the residuals from each equation were extracted and they have been used as "news proxies" for testing the efficiency hypothesis.

The efficiency 'news' model was estimated over the all sample.

The results of the estimations of equation [15] are reported in the following table. They provide mixed support for the efficiency hypothesis using 'news' residuals from a VAR model as proxies. "The residuals from the VAR model are considered to be the unanticipated parts of certain macroeconomic variables that seem to play a substantial role in the US dollar/euro exchange market"[10]. The results of the estimation of equation [15] along with the associated restriction, i.e. $H_0 : \alpha = 0$, $\beta = 1$ and $\gamma = 0$, are reported in table 2

Table 2 **Efficiency test with a 'news' proxy $(s_{t+i}-s_t) = a + b(F_t-s_t) + g news_{t+i} + m_{t+i}$**						
	a	b	g	**R^2**	**RSS**	**F-test**
newsDi coefficient t-stat.	**-0.0088** (-6.388)**	**-1.0525** (-6.105)**	**-0.04499 (-0.426)**	**0.08**	**0.269**	**18.643 [0.00]**
newss coefficient t-stat.	**-0.0095** (-6.896)**	**-0.77** (-4.104)**	**0.69* (3.209)**	**0.10**	**0.262**	**24.18 [0.07]**
newsf coefficient t-stat.	**-0.009** (-6.617)**	**-0.98** (-5.826)**	**0.83** (3.784)**	**0.11**	**0.260**	**26.337 [0.05]**
Sample: 04/02/99 to 11/08/00						
No. observations: 396						

[10] Apergis and Eleftheriou, (1997), pag. 114.

The variables 'newsΔi' 'newss', and 'newsf' are the residual of the equations [10], [11] and [12] respectively. The first represents unanticipated changes in exchange rate; the second depicts unanticipated changes in interest rates; the third, represents unanticipated changes in forward exchange market.

It emerges that 'news' is relevant in determining s_t and F_t. Following the mainstream theory, 'news' on the interest rate differential is not a very important variable in determining exchange rate movement from its expected path. It can be intended that interest rates are now fully affected by expectations concerning inflation and currency parities, as well as by changes in interest rates in foreign money and capital markets. It seems that economic agents are able to capture all the information embodied in the interest rate differential. But this interpretation would be in contrast with results coming out equation [11] and [12] where news variables are relevant. That's why our opinion is, on the contrary, that equation [10] already contains the news effect present in both the forward rates and the spot rates (third and fourth term). This circumstance is confirmed by the fact that the CIP is not verified. This result is shown in the next paragraph.

5. 1 THE COVERED INTEREST RATE PARITY (CIP)

From table 2 emerges that the variable "newsΔi" is not relevant. In our opinion this result is due to the fact that CIP could not be verified.

We estimate equation [6] in the following form:

$$f_t - s_t = \alpha + \beta (i - i^*)_t + \mu_t \qquad [17]$$

The above equation was estimated for the US dollar-Euro foreign exchange market where all home and foreign variables are comparable in terms of maturity.

The results of CIP are summarised in table 3.

Table 3	Equation: $f_t - s_t = \alpha + \beta\ (i - i^*)_t + \mu_t$		US dollar-Euro			
Dep.var. $f_t - s_t$	a ^	b ^	**R^2**	**DW**	**F(1,397)**	**RSS**
	0.0432	0.52314	0.68	0.011	15.704	0.0293
t-stat	(5.76)	(3.96)				
No. obs 399						
Sample: 01/02/99 to 11/08/00						

Equation [17] was estimated under the condition that $\beta^{\wedge} = 1$ and μ_t is a white noise. The result suggests that, under the period of investigation (01/02/99 – 11/08/00), the CIP was not verified. In fact, the ß coefficient is statistically significance at 5% but different from 1.

According to the above results, in the US dollar -euro exchange rate market there could be more opportunities of extra profits from the arbitrage. Hence, as suggested by Koedijk and Wolff (1996) " our evidence suggests that the interest differentials do not capture time-varying risk premia but likely reflect a peso problem, learning about a policy regime, a market inefficiency or a combination of these factors"[11]

6. CONCLUSIONS

In this paper the efficiency for the US dollar against the Euro foreign exchange market has been tested with a `news' exchange rate model using daily data. In the model we use, as proxies of 'news', variables generated by the residuals from a VAR model. We examined the efficiency and the 'news' hypothesis in the Euro-Dollar exchange rate market using daily data over a period of 19 months. Our results are consistent with the hypothesis that the forward exchange rate is not an unbiased predictor of the future spot rate. That is, we reject the hypothesis of efficiency and we show the importance of the 'news' in determining short-run movements in the exchange rate markets. One interpretation of this systematic expectation failure could be that the unexpected change in the future spot rate is triggered by 'news' which, for expectations between "t" and "t+1", become known only after time "t". These 'news' could take the form of unexpected policy changes, new statistical information or other unknown events, which have some exchange rate implication.

In other words the presence of new information, not included in the appraisal of the future spot exchange rate, bring economists to conclude that either a) that the market is not efficient or b) economic policy authorities *intentionally* deceive operators. Conclusion b) is very improbable because the theoretical paradigm the European Central Bank relies on (Kydland and Prescott 1977, Barro and Gordon 1983 etc.) In conclusion expectations are not rational and monetary variables are able to offset real ones.

Levich, analysing the links between spot, forward and interest variables argues that "the nature of the forward exchange rate - its determinants and relationship to the future spot rate - is an important empirical issue that is currently unresolved. While the forward rate may approximate the market's expectation of the future spot rate, it has been demonstrated clearly that the forward premium is a poor predictor of the future change in the spot exchange rate." [12].

[11] Koedilk , Wolff (1996) pag. 133.
[12] Levich , (????), chapter 19.

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