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The Efficient Markets Hypothesis (EMH), News and Cointegration: Theory and evidence

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Abstract— **This paper revisits the impact of news on the determination of exchange rates. In fact we will be presenting an analysis and discussions for testing the Efficient Markets Hypothesis (EMH) using a news format and using Cointegration methodology. However, before presenting the results some useful points should be considered in order to carry out the analysis of this study. Accordingly, section 2 of this paper gives some restrictions of cointegration techniques when it is used for models that have more than two variables. The variables that we will be using in this analysis are defined in section 3. Section 4 provides the source and period of database used. The test results are given in section 5. The implications of including cointegrated variables will be discussed in section 6, mainly the issues of purchasing power parity, covered and uncovered interest parities. Finally some concluding remarks are drawn up.**

Index Terms— **Efficient Markets Hypothesis- Covered Interest Parity- Cointegration- ECM-**

I. INTRODUCTION

Unanticipated events "news" play a predominant role in affecting real variables and asset yields. The 'news' view of the determination of foreign exchange rates would seem to have wide appeal. For example, the financial columns of the daily press abound with headlines such as 'unexpectedly good money supply figures result in an appreciation of the exchange rate' and 'an unexpected deterioration in the current accounted to exchange rate depreciation'. Thus, since the new information is important in foreign exchange markets, then it is more appropriate to implement exchange rate models such as the monetary an portfolio approaches, in a 'news' context rather than regressing the exchange rate on the levels of, for example, relative money supplies.

In a previous paper we have discussed the problem of how this "news" can be modelled in foreign exchange markets (Bouteldja & Benbouziane, 2006). Using the method of cointegration in exchange rate determination models, the variables that reflect the news term can be detected. These variables should be cointegrated with the exchange rates.

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II. LIMITATIONS OF THE STUDY

III. DEFINITION OF THE VARIABLES

The study will mainly concentrate on testing the monetary and Portfolio Balance models of exchange rate determination. Also the news approach is concerned with using the models as the news term in the context of Efficient Markets Hypothesis. Where the spot and forward rates are defined previously, we now define the variables entering in exchange rate models:

3.1. Monetary Exchange rate model

Here, the general monetary model of exchange rate determination is considered. It will be tested for four countries, namely: Germany, United Kingdom, Switzerland and France. Variables of this model are as follows:

$$S_t = (m-m^*) - \phi\ (\bar{y}-\bar{y}^*) + \mu\ (i-i^*) + \lambda\ (\Pi- \Pi^*) \quad (1)$$

Where,

S_t = the log of the spot exchange rate.

m-m^* = changes in log of quantities of money (M1) at home and abroad.

y-y^* = changes in the log of income at home and abroad.

i - i^* = short term interest differential between home and abroad.

π-π^*= expected inflation differential at home and abroad, poxied by long-term government bond differential.

3.2. Portfolio Balance Model

In this context, we will be using the "Uniform Preference Model" as in the following equation . It will be tested for the case of Germany.

$$s = a_0 + \gamma (i - i^*) + b - f \quad (2)$$

Where,

S_t = log of spot exchange rate.

$(i$-$i^*)$ = short term interest differential at home and abroad.

b = log of the stock of domestic bonds denominated in home currency.

f = log of the stock of foreign bonds denominated in foreign currency.

IV. DATABASE

The analysis is based on quarterly data for all the variables in both the monetary and Portfolio balance models for the cases of Germany, United Kingdom, Switzerland, and France.

As far as the monetary model is concerned the data is collected for all four countries, whereas in the Portfolio Model, the study is limited to the case of Germany.

As far as the exchange rates are concerned, they are all Dollar bilateral exchange rates. Both the spot and forward rates of each country are taken. The spot rate being the end of month observation whereas the forward rate is the 90 days forward. The main source of these data is DATASTREAM, but other sources have also been used such as the IMF and EC annual reports. Data from DATASTREAM are spot and forward rates, Money (M1), Industrial production, short term interest rates and long-term government bond which is used as a proxy for inflation differential. Some of the data that enter in the calculation of domestic and foreign denominated bonds are collected from the IMF and OCED annual reports.
These data cover the period from 73 Q1 to 98Q4 (***Just before the EURO emergence***). There are 108 observations of each variable, so that the critical values reported by Fuller (1976), Engle and Granger (1987) and Engel and Yoo are appropriate.

V. Test Results

Before proceeding to an analysis of the results, we first show how the tests are conducted. First, the statistical and stability tests are considered for the General Monetary and Portfolio balance models. Then, we proceed to test the order of integrability of the variables since it is a necessary condition before proceeding to any cointegration test. The latter is considered eventually for both models, and it is also used for testing unit roots in the residuals when using these models (i.e. Monetary and Portfolio models) as the news term in the EMH framework. Finally, the variables that are cointegrated with the spot and forward rates are considered as a "news" term. Considerations are first given to statistical and stability tests for the monetary and Portfolio Balance Models.

5.1. Statistical and Stability Tests.

5.1.1. The General Monetary Model

A number of empirical studies tended to support the implementations of the monetary approach, but such studies have produced different results. For example, the evidence from the dollar/pound data by Bilson (1978) supported the flexible price model, Hodrick (1979) claimed support for the sticky price version while the results of Frankel (1979) were really encouraging for the real interest differential version.
As far as our data is concerned, the following equation is tested for Germany, UK, Switzerland, and France over the period 73Q1 – 98Q4.

$$S-\bar{S}=-\frac{1}{\theta}\left[(i-\Pi)-(i_{*}-\Pi_{*})\right]$$

(3)

Using ordinary Least Squares, Table (2) reports estimates of the four exchange rates. Except for the case of Germany, the coefficients of the interest differential are of the negative sign as implied by the sticky price model (Dornbush, 1976). In the case of Germany however, it is rather the Frenkel model that is supported since the coefficient of interest rate is significantly different from zero (Frenkel , 1981). But the overall results do not appear to support the monetary approach due to the presence of wrong signs on the other variables and the weakness of levels of significance.
As regards the stability lest, we conducted a (CUSUM) test proposed by Brown et al (1975). This test is particularly now useful for detecting changes in the systematic regression coefficients. Figures (1 to 4 in appendix1) show that exchange rates have been very volatile and difficult to be explained by variations in the underlying economic conditions. This volatility has led to many questions concerning the validity of these models. The plot of (CUSUM) tests in figures (5 to 8 in appendix1) suggests that the departure from the horizontal axis means, either the models is mis-specified or there is a structural break which occurred from time to time during 73Q1 - 98Q4. The figures, however, show that the stability test cannot be rejected at the 5% significance level for Germany, UK and Switzerland, whereas in the case of France, it is seen from figure (8 in appendix1) that the critical bonds at 5% level, and therefore the stability hypothesis is rejected in this model.

<u>5.1.2. The Portfolio Balance Model</u>

In this test we limit ourselves to the "uniform Preference" model represented in the section as in equation (2). Under this assumption, wealth redistribution via current account becomes irrelevant, all that matters are the supplies of bonds. From equation (2) it is expected that the sign of domestic denominated bonds coefficient will be positive, whereas the coefficient of foreign denominated bonds is expected to be negative. Thus an increase in the supply of foreign bonds (*F*) will lower their price *S*, while one in the supply of domestic bonds (*B*) does the opposite.

Table 1
Testing for Unit Roots in variables of exchange rate models.

Variable	Germany		United Kingdom		Switzerland		France	
	DF	ADF	DF	ADF	DF	ADF	DF	ADF
Δ(m-m*)	-1.21	-2.08	0.78	0.71	-0.90	-0.78	-2.17	-2.41
Δ(y -y*)	-0.89	-0.60	-1.37	-1.45	-1.82	-1.60	-0.68	-0.63
Δ(i – i*)	-2.80	-2.22	-2.67	-2.82	-2.68	-2.49	-3.50*	-3.60*
Δ(π-π*)	-1.47	-1.85	-1.06	-0.88	-1.42	-1.48	-1.53	-1.43

B	-0.64	-0.95	-	-	-	-	-	-
F	-2.34	-1.69	-	-	-	-	-	-

The null hypothesis is that the series in question are I(1).

** indicates rejection of the I(1) hypothesis. In fact this variable is an I(2) series. Approximate critical value at the 5% level is –2.89, with rejection rejoin{ θ|θ < -2.89}. DF and ADF stand for the Dickey Fuller and Augmented Dickey Fuller tests respectively.*

Table 5-2

Estimation of the General Monetary Exchange Rate, as in equation (1).

Dependent variable is Log US $/MAJOR Industrial currencies. Sample period 1973Q1- 98Q4

Country	a_0	m-m*	y-y*	i- i*	π-π*	R^2	s.e	DW
Germany	0.1845 (0.241)	1.07 (0.352)	-1.57 (0.615)	0.001 (0.015)	0.028 (0.017)	0.68	0.15	0.23
United Kingdom	-2.14 (0.625)	0.036 (0.142)	-0.039 (0.466)	-0.017 (0. 009)	-0.024 (0.012)	0.65	0.134	0.205
SwitZerland	-1.96 (1.26)	-0.59 (0.261)	-0.87 (0.435)	-0.06 (0.021)	-0.034 (0.019)	0.72	0.164	0.43
France	1.40 (0.086)	-0.62 (0.139)	0.195 (0.654)	-0.085 (0.013)	0.081 (0.029)	0.74	0.15	0.58

Note: Standard errors are in parentheses. Technique used is OLS.

Variables are:

m – m = log of (country) M_1 / USM_1*

y – y = log of (country) production / US production*

i - i = short term country- US interest differential.*

π -π = Expected country-US inflation differential, proxied by long term government bond differential.*

As stated previously, only the case of Germany is considered, because exchange and capital markets are free from extensive government intervention in this country. The test covers the period 73Q1 - 98Q4. Table (5) presents estimates for "Uniform Preference” model. While the German bond supply (F) is highly significant with the correct sign, the US bond supply is significant at the 95% level but with the incorrect sign. The R^2 and DW at .42 show that the regression discourage the Portfolio Balance model. Again we have used the (CUSUM) test for testing the stability of the regression and we found that it cannot be rejected at the 95% significance level.

5.2. The Order of Integration of the Variables

Before proceeding to test the set of variables for cointegration, it is sensible to establish the properties of the individual time series. To test the order of integration in the variables in question, we use a test based on the work of Fuller (1976) and Dickey and Fuller (1981). Table (1) indicates that the variables are I(1) series, except in the case of France where the interest rate differential is found to be I(2). In the bivariate case, a postulated long-run relationship with dependant and independent variables being (say) I(0) and I(1) respectively, may not make much sense. However, as shown in section 1 of this chapter, in the multivariate case, there may exist a subset of independent variables that are cointegrated, thereby rendering some linear of those variables to be of a lower order of integrability. An example of this can be seen in Leon (1987) when he tested the cointegrability of the demand for money. He found that the variables are cointegrated even if they are of different order of integrability. So it does not matter if one of our variables is I(2), provided when combined with other variables, they will produce an I(1) series.

5.3. Cointegration tests of Monetary and Portfolio Models

5.3.1. Cointegration tests of the Monetary Model

After looking at the order of integrability of the variables, we now proceed to test for cointegration, and see if residuals from equation (1) appear to be I(0).

The tests we will be using are those reported by Engle and Granger (1987), namely: the CRDW, DF and ADF tests. Table (3) gives the DF, ADF tests, whereas the CRDW tests are given in Table (4). For all four countries, the equation with the interest differential (i-i*) as the dependant variable, obtains stationary residuals. Indeed this hypothesis cannot be rejected at any level for France and Switzerland in all the three tests (i.e CRDW, DF and ADF tests). For the UK, the DF rejects the stationarity hypothesis even at the 10% level, whereas the CRDW and ADF tests accept it at the 5% level. In Germany, however, the I(0) hypothesis of the residuals is accepted at the 5% level by CRDW, and at the 10% level by the DF test. It is rejected when using the ADF test.

The overall test results show that equation (1) (i.e. the General monetary model) is an interest rate differential determining equation. This finding suggests that this term (i.e. *(i-i*)*) should be endogenously determined in the simultaneous equation.

Table 3

Testing for Unit Roots in the cointegrating residuals.

The General Monetary Model Equation (1) DF and ADF tests

Dependent Variable [a]	Germany		United Kingdom		Switzerland		France	
	DF	ADF	DF	ADF	DF	ADF	DF	ADF
S_t	-1.61	-1.55	-1.38	-1.84	-2.50	-2.0	-3.06	-2.60
m- m*	-3.38	-2.16	-1.70	-1.74	-4.47	-3.38	-3.65	-6.20
y- y*	-3.29	-2.14	-2.79	-3.34	-2.57	-2.15	-3.78	-3.35
i– i *	-4.02	-2.93	-3.92	-4.38	-5.98	-5.32	-5.10	-5.52
π -π*	-2.96	-3.54	-3.81	-3.17	-4.27	-3.51	-4.65	-3.96

[a] indicates that the variable in question is the dependent variable of this equation :
$S_t = a_0 + (m\text{-}m^*) - \phi(y\text{-}y^*) + \alpha(i\text{-} i^*) + \beta(\pi\text{-}\pi^*)$, The 1%, 5% and 10% critical values for these statistics are sa follows : DF , 4.94, 4.35 and 4.02 ; ADF, -4.80, -4.15 and –3.85 (see Engle and Yoo (1997)).

Table 4:

Testing for Unit Roots in the cointegrating residuals:
The General Monetry model (1) : CRDW tests.

Dependent Variable	Germany	UK	SwitZerland	France
S_t	0.23	0.205	0.43	0.58
m- m*	0.65	0.32	0.99	0.61
y- y*	0.63	0.44	0.39	0.83
I– i *	0.86	0.81	1.47	1.24
π -π*	0.52	0.62	0.92	1.07

See table 3 for notes:
Critical values for CRDW are ; 1.00, 0.78, and 0.69 for 1%, 5% and 10% respectively.

Furthermore, in the case of Switzerland, not only the interest differential determining equation obtains stationary residuals, but it is also obtained that the money differentials and long-term government bond differentials are used as the dependant variable.

One complication from the above results is that the residuals are I(0) series when the *(i-i*)* variable is used as the dependant variable, and we know that in the case of France this variable is an I(2) series. The interpretation is not logical if the dependant variable is I(2) and all the independent variables are I(1), because no linear combination of I(1) series can be I(2).

5.3.2. Cointegration tests for the Portfolio Model

This test proceeds at the same manner as the above test for the monetary model. Table (6) gives the CRDW, DF and ADF tests of the cointegrating residuals in the US Dollar / German Mark exchange rates. Again, the residuals that are obtained from making *(i-i*)* as the dependant variable, are stationary. The DF test and CRDW test cannot be rejected at the 5% level, whereas the ADF test is only accepted at the 10% level. The results show that the Portfolio Balance Model, as represented by the "Uniform Preference" approach, is an interest differential determining equation.

The conclusion that can be made from the monetary and Portfolio Balance models regarding cointegration tests is that there exists a long-run equilibrium relationship.

The problem, however, is that exchange rate models should be best expressed as interest differential, *(i-i*)*, determining model. Thus, *(i-i*)* should be endogenously determined in the simultaneous equation system.

Table 5

Estimation of the Portfolio Balance Model as in equation (2)for Germany. Dependent Variable is Log US$ / Dutch Mark . Sample period 73Q1- 98Q4.

Dependent Variable	a_0	*i – i**	*b*	*f*	*s.e*	R^2	DW
Germany	11.14 (1.76)	-0.027[a] (0.01)	-0.155 (0.048)	-0.763[a] (0.133)	0.13	0.42	0.42

[a] Significant at the 95% level and of the correct sign.

Technique used is OLS.
i – i= Short term German US interest differential ,*
b , f are domestic and foreign bonds respectively.

Table 6:

Testing for Unit Roots in the cointegrating residuals.
The Portfolio Balance Model (Germany).

Dependent Variable	CRDW	DF	ADF
S_t^*	0.42	-2.94	-2.62
(I– i*) *	0.68	-3.48	-3.38
b*	0.26	-1.56	-0.68
f*	0.84	-3.96	-3.28

** indicates that the variable in question in the dependent variable in this equation*

$$S_t = a_0 + \gamma(i\text{-}i^*) + b - f .$$

Approximate critical values for CRDW are 0.511, 0.386 and 0.322. For the DF critical values are –4.46, -3.37 and –3.03. For the ADF critical values are –4.46, -3.75 and –3.36. Test size for the three tests are for the 1% , 5% and 10% respectively, see Engle and Yoo(1987).

5.4. The EMH, 'News' and Cointegration tests

5.4.1. The Monetary Model "News" Approach

As far as this section is concerned, the general monetary model of exchange rate determination is analysed. This model is used as the news term in the following form equation:

$$\text{Ln } S_t = a + b \ln F_{t-1} + \text{"News"} + W_t$$

In fact, the equation that is tested is of the form:

$$Ln\,St = a + b\,Ln\,Ft\text{-}1 + \lambda(m\text{-}m^*) - \phi(y\text{-}y^*) + \alpha(i\text{-} i^*) + \beta(\pi - \pi^*) + Wt$$

The EMH suggests that Wt will be white noise error term, whereas cointegration suggests that W_t will be stationary.

To see how the "news" plays predominant role in exchange rate, a comparison is made between the simple EMH framework (i.e. relationship between spot and forward rates only) and the EMH when introducing the news term. Table (12) shows the first case, whereas the second is presented in tables (7), (9) and (10). Table (12) indicates that the DW is low, suggesting evidence of autocorrelation. However, when using the monetary model as the news term, Table (7) shows that the DW is improved, except in the case of UK.

As regards cointegration tests, Table (12) shows that the spot and forward rates are cointegrated, which is consistent with the EMH. Moreover, when introducing the news term, Table (9) shows that the DF and ADF were much improved compared to Table (12), suggesting cointegration between the spot rate and the other variables.

Normalising on St, Ft-1, (m-m*), (y-y*), (i-i*) and (π -π*), tables (9) and (10) show that again in all cases when the interest differentials are endogenous, the residuals are I(0) series. The CRDW test is accepted at the 5% level for all four countries. Except in the case of UK, the DF test is accepted at the 5% level. When the ADF test is used, however, the I(0) hypothesis is only accepted at the 10% level for the US Dollar/ German Mark exchange rate, and accepted at the 5% level for the remaining exchange rates.

The simple EMH framework suggests that there are two cointegrating vectors, depending whether the normalisation is on the spot or the forward rate. However, the above results of interest differentials indicates that there exists a third cointegrating vector. Furtheremore, in some cases such as Switzerland, normalizing on all the variables, except (y-y*), the residuals stationarity hypothesis cannot be rejected at the 10% level for all the three tests (i.e., CRDW, DF and ADF tests). This finding clearly support the cointegration test results of the monetary model (section 5.3.1).

Figures (9 to 12) plot this test for Germany, UK, Switzerland and France respectively. Clearly, the stability test cannot be rejected at the 5% level

5.4.2. The Portfolio Balance Model "news" approach

The same above procedures are applied to this model. Clearly the equation to be tested is:

$$Ln\,St = a + bLnF_{t-1} + \alpha(i\,\text{-}i^*) + b - f + W_t$$

Table (8) shows that the DW is 1.70 compared to 1.47 in table (12). Indeed, when adding the news term, the DW is improved, but the joint hypothesis of a = 0 and b = 1 is rejected.

Normalising for St, Ft-1, (i-i*), b and f, table (11) indicates that the DF and ADF tests, for St as the dependant variable, are improved compared to those reported in table (12), suggesting a necessity of the news term in this relationship. Looking to the other variables, we found that the residuals W_t, when *(i-i*)* is the dependant variable, are stationary. This is confirmed at the 5% for CRDW and DF tests, and at the 10% level for the ADF test.

The general conclusion that can be drawn from the above analysis for both monetary and Portfolio Balance "news" approach models is that the equation can be best expressed as an interest differential-determining equation. It was found that this variable is cointegrated with all other variables in all cases. Thus, this finding suggests that this variable should be incorporated in any news approach. Consequently, the next section will concentrate only on this variable, and using it as the news term in the EMH framework. The stability test of the EMH news approach is also conducted using the (CUSUM) test.

Table (7)

Testing for the EMH using the "monetary Model" as the news term.

Country	a_0	F_{t-1}	m-m*	y-y*	i- i*	π-π*	s.e	DW
Germany	-0.067	.99	0.06	-0.098	0.013	-0.0023	0.033	1.90
	(0.051)	(0.029)	(0.080)	(0.137)	(0.003)	(0.003)		
United Kingdom	-0.153	0.79	-0.012	0.133	-0.0032	0.0096	0.063	1.27
	(0.329)	(0.056)	(0.072)	(0.222)	(0.0047)	(0.0058)		
SwitZerland	0.182	1.01	0.05	-0.092	0.015	0.0003	0.039	2.05
	(0.31)	(0.033)	(0.065)	(0.103)	(0.0057)	(0.0048)		
France	0.023	0.99	-0.014	0.099	0.0072	-0.013	0.033	1.59
	(0.049)	(0.0314)	(0.038)	(0.149)	(0.0042)	(0.0074)		

Standard errors are in parentheses.

See table 6.2 for notes. F_{t-1} is the lagged forward rate. Technique used is OLS.

Table (8)

The EMH using the "portfolio balance model" as the news term.

Country	a_0	F_{t-1}	i- i*	B	f	s.e	DW
Germany	1.47	0.95	0.0084	-0.038	-0.094	0.03	1.70
	(0.518)	(0.031)	(0.0025)	(0.012)	(0.037)		

Standard errors are in parentheses.

See table 6.5 for notes. F_{t-1} is the lagged forward rate. Technique used is OLS.

Table (9)

Testing for unit roots in the cointegrating residual.

The General Monetary Model (1) as the news term in the EMH framework.

DF and ADF tests.

Dependent Variable [a]	Germany		United Kingdom		Switzerland		France	
	DF	ADF	DF	ADF	DF	ADF	DF	ADF
S_t	-7.25	-3.81	-5.19	-4.50	-7.84	-5.32	-6.17	-4.47
F_{t-1}	-7.43	-3.97	-5.55	-4.76	-7.93	-5.27	-6.42	-4.45
m-m*	-3.4	-2.35	-1.45	-2.12	-4.62	-3.34	-3.71	-2.94
y-y*	-3.22	-2.89	-2.84	-3.13	-2.59	-2.25	-3.86	-3.40
i- i*	-4.90	-3.91	-3.85	-4.39	-6.09	-4.78	-5.60	-4.84
π-π*	-3.07	-3.77	-3.73	-3.44	-4.27	-3.41	-5.09	-4.15

[a] *indicates that the variable in question is the dependent variable in this equation*
$S_t = a_0 + F_{t-1} + (m-m^*) - \phi(y-y^*) + \alpha(i-i^*) + \beta(\pi-\pi^*)$ *, and then normalizing on* S_t , F_{t-1} , *m-m*, y-y*, i- i* and π-π*.*
See table (6.3) for critical values.

Table (10)

Testing for unit roots in cointegrating residuals.
The General Monetary Model as the " news" term in the EMH framework.
CRDW tests

Dependent Variable	Germany	United Kingdom	Switzerland	France
S_t	1.90	1.23	2.05	1.59
F_{t-1}	1.95	1.37	2.06	1.65
m-m*	0.65	0.30	1.06	0.61
y-y*	0.61	0.46	0.41	0.86
i- i*	1.17	0.82	1.55	1.35
π-π*	0.51	0.66	0.96	1.24

See table (4) for notes.

Table (11)
Testing for Unit Roots in the cointegrating residuals.
The portfolio balance model as the news term in the EMH framework. The case of Germany.

Dependent Variable	CRDW	DF	ADF
S_t	1.70	-6.46	-4.37
F_{t-1}	1.85	-7.04	-5.04
i- i*	0.98	-4.40	-3.49
B	0.28	-1.21	-0.32
F	0.74	-3.37	-3.04

See table (6) for details.

5.5. The Effects of Including the Cointegrated Variables.
Table (12) indicates that the inclusion of the variables that are cointegrated with the spot and forward rates, improve the EMH which implies that $a = 0, b = 1$ and the error term will a white noise. Thus *(i-i*)* is the concerned variable for all four countries taken, and we think that this is the variable that reflects the news immediately. Therefore, it should implement the EMH model. As seen from table (12), the individual hypothesis that $a = 0$ *and* $b = 1$, are improved when including the news term. The value of these coefficients in some cases, is almost identical to their hypotheses. Moreover the joint hypothesis of market efficiency cannot be rejected at any level in all the cases. This is confirmed by the F and DW statistics reported in table (12). The implication of the above is that this term (i.e. the interest differential) is the variable that reflects the news immediately, and should implement the EMH framework.

Furthermore, in cases such as Switzerland and France, the inclusion of inflation differentials has improved the statistical properties of EMH, but we are more concerned with the general case rather than special ones.

6 Some Implications of Cointegration Tests

The last point of the earlier analysis suggests that the interest rate differential should implement the EMH framework as a news term. This is, by no means, a new relationship in exchange rate behaviour. In fact, as seen from table (12), it is an indirect test for the Uncovered Interest Parity (UIP), since by definition the UIP implies that the expected depreciation of the exchange rate will be equal to the interest differential at home and abroad.
In this section, it is shown how UIP condition is linked the EMH. The section also provides the implication of Purchasing Power Parity Using Cointegration tests.

Table (12)
The effects of incorporating the variables that are cointegrated in the EMH framework.

Country	a_0	F_{t-1}	i- i*	π-π*	DW	DF	ADF	F
German	0.032	0.969	-	-	1.47	-5.81	-4.34	74.6
Spot	(0.024)	(0.029)						
Rate	-0.025	1.0001	0.009	-	1.78	-6.79	-4.86	47.66

	(0.0268)	(0.0273)	(0.0024)					
UK	-0.055	0.91	-	-	1.23	-5.18	-4.15	23.13
Spot	(0.0264)	(0.042)						
Rate	-0.04	0.92	0.005	-	1.31	-5.45	-4.35	72.29
	(0.028)	(0.041)	(0.0037)					
Swiss	-0.048	0.95	-	-	1.66	-6.39	-4.85	89.8
Spot	(0.0195)	(0.0253)						
Rate	-0.054	1.012	0.0127	-	2.007	-7.66	-5.09	87.3
	(0.28)	(0.025)	(0.0028)					
	-0.058	1.016	0.0123	0.001	2.02	-7.73	-5.19	64.42
	(0.0315)	(0.0283)	(0.003)	(0.002)				
French	0.44	0.97	-	-	1.38	-5.55	-4.16	0.62
Spot	(0.024)	(0.025)						
Rate	-0.034	1.017	0.0084	-0.01	1.57	-6.15	-4.32	2.62
	(0.045)	(0.0234)	(0.0037)	(0.0048)				

Standard errors are in paretheses.
The F-statistic test the hypothesqis that $a_0 = 0$, $F_{t-1} = 1$ and $i - i^* = 0$. Sample period 73Q1 – 98Q4

Table13

Tests for a unit root in relative prices

Country	DF	ADF
Germany	0.97	0.198
United Kingdom	-1.59	-1.24
SwitZerland	-1.65	-1.32
France	-1.49	-1.57

The null hypothesis is that the series in question is I(1).
Approximate critical value at the 5% level –2.89,with rejection region { $\theta \mid \theta < -2.89$ }.

6.1. Uncovered Interest Parity

It was stated in the previous chapter that the Covered Interest Parity (*CIP*) can be expressed as:

$(1 + i_d) = S(1 + i_f) / f$

The Uncovered Interest Parity (UIP) however suggests that agents do not use the forward rate for cover. They use the expected spot rate instead. The above equation will then be:

$(1 + i_d) = S(1 + i_f) / S^e$

The EMH implies that the expected value of S_t is simply equal to the forward rate at time t-1 (i.e. the forward rate is an unbiased predictor to the spot rate):

$$E(S_t \mid I_t) = f^t_{t-1}$$

Replacing S^e by F_{t-1}, we obtain

$(1 + i_d) = S(1 + i_f) / F_{t-1}$

$$\frac{(1+i_d)}{(1+i_f)} = \frac{S_t}{F_{t-1}}$$

Using logarithm transformation, we obtain

$Ln(1 + i_d) - Ln(1 + i_f) = Ln\, S_t - Ln\, F_{t-1}$

$Ln(1 + i_d) - Ln(1 + i_f)$ is approximately equal to $i_d - i_f$ which implies that:

$Ln\, S_t = Ln\, F_{t-1} - (i_d - i_f)$

Combining the assumptions of EMH and UIP, the above model can be rewritten as:

$Ln\, S_t = a + b\, Ln\, F_{t-1} - \alpha(i_d - i_f) + U_t$

The EMH suggests that $a = 0, b = 1, \alpha = 0$ and the error term U_t should be white noise. Table (12) tests this assumption and gives evidence and support of the EMH. Cointegration tests also show that the relationship is at long-run equilibrium. Thus the UIP condition does hold in the long-run.

The results support what has been drawn in the literature review, saying that provided the CIP holds, market efficiency implies the validity of UIP. Table (12) shows that since the EMH cannot be rejected when using cointegration tests, the UIP is also accepted using the same test.

Tronzano (1992) rejected the market efficiency hypothesis in the Lira/Dollar case; therefore, as far as the UIP is concerned, it was found that this hypothesis is not supported by the empirical evidence.

Our results draw opposite conclusions of Tronzano, and support those results obtained by Frankel (1982). In fact, the UIP is a valid long-run relationship as proved by cointegration tests in table (12).

6.5. Purchasing Power Parity (PPP)

The best statistical test to verify the hypothesis of long-run purchasing power parity is to test whether exchange rates and prices are cointegrated.

Cointegration tests regarding the PPP, was first introduced by Taylor (1988) who examined this relationship for the UK, Germany, France, Canada and Japan all against the US Dollar over the period June 73- December 1985. He found that exchange rates and their corresponding price ratio cannot be cointegrated. KARFAKIS and MOSCHOS (1989) also tested this hypothesis (i.e. long-run PPP) for six Greek Drachma bilateral exchange rates. They drew results similar to those reported by Taylor (1988). There is no cointegration in any of cases considered.

Our tests, however, consider the four aforementioned countries over the period 73Q1 - 98Q4. The index chosen for the prices is the consumer price index.

It was found previously that exchange rates are integrated of order 1. Consequently, table (13) gives the order of integration of relative prices only. The hypothesis that the log of relative prices are I(1) series cannot be rejected.

We then proceed for cointegration tests by normalising on both exchange rates and relative prices. Table (14) shows that the CRDW, DF and ADF tests reject the cointegration of exchange rates and relative prices in either cases (i.e., when normalising on St or on Ln (P_t/P_t^*)). For all the four countries, the CRDW, DF and ADF tests suggest that the residuals are I(1) series. Since the series are not cointegrated in either cases of normalisation, there is no need to test for causality and to see which causes which.

The main conclusion is that there is no evidence of stable, long run proportionality between nominal exchange rates and prices. In fact they tend to drift apart without bound. This finding requires more work on the causes and consequences of this phenomenon.

Table 14

Cointegration regressions and tests for cointegration (PPP).

	Dependent Variable	Constant	S_t	P_t	DW	DF	ADF
Germany	S_t	5.36	-	-1.42	0.103	-1.20	-1.39
	P_t	1.79	-0.33	-	0.07	-1.46	-1.48
United Kingdom	S_t	-0.42	-	-0.87	0.14	-1.41	-1.59
	P_t	-0.13	-0.56	-	0.087	-1.55	-1.36
SwitZerland	S_t	0.60	-	-1.01	0.124	-1.66	-1.90
	P_t	0.23	-0.49	-	0.063	-0.98	-1.46
France	S_t	1.25	--	-1.89	0.123	-1.49	-1.89
	P_t	0.36	-0.35	-	0.08	-1.50	-1.49

Approximate critical values for DF, ADF and DW are: -3.37, -3.17; 0.386 respectively, at the 5% level. The null hypothesis is that the residuals are I (1).

CONCLUSION

The work in hand, essentially examined the role of news in foreign exchange markets. We argued that one can use the monetary or Portfolio Balance models as the news term in the EMH framework. The tests regarding the validity of these models suggest that the equation of exchange rate determination is an interest rate differential-determining equation. Thus this term (i.e. *(i-i*)*) should be endogenously determined within the simultaneous equation. The results also suggest that when the EMH model incorporates the news term, whether it is the monetary or Portfolio model, cointegration tests are improved. In all the cases the interest rate differentials are found to be cointegrated with the spot and forward rates (by normalising either on S_t, F_{t-1} or *(i-i*)*). Using *(i-i*)* as the news term that is immediately rejected in the EMH framework, it was found that the joint hypothesis of efficiency cannot be rejected.

In fact, the above finding is a confirmation of the validity of uncovered interest parity (UIP). The results in table (12) stated states that the UIP condition does hold in the long run (i.e the interest rate differentials are cointegrated with the expected change of exchange rates).

Finally, it is found that the PPP does not hold in the long run. The exchange rate and prices are not cointegrated. This suggests that more work is required for the causes and consequences of this failure.

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