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Université ABOU-Bekr Belkaid Tlemcen
Faculté des Sciences Économiques et de Gestion

Thèse présentée pour l'obtention du diplôme de Doctorat d'État en
Sciences Économiques
Option : Finance

**Cointegration and Efficiency in
the
Foreign Exchange Market**

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Abstract

In this thesis, I address some of the major outstanding questions in the empirical study of Efficient Markets Hypothesis (EMH) in the foreign exchange markets using cointegration techniques.

The EMH argues that the forward rate "fully reflects" available information about the exchange rate expectations. One view of market efficiency states that the current price fully reflect all available information. When this is implied to the foreign exchange market, it implies that 'economic agents' expectations about future values of exchange rate determinants are fully reflected in the forward rates.

The goal of our research, is to investigate the efficiency of the foreign exchange market and the role of the news in determining the short-term deviations of the exchange rate from its long run equilibrium. Although, many tests have been used in the literature to test the validity of the EMH, we will be using the cointegration methodology and giving a new way of testing different aspects of market efficiency for exchange rates.

An other aspect of the study is to look for the efficiency hypothesis of exchange rates in developing countries. However, and due to the absence of forward rates in the majority of these countries, we will simply asses the policy implications of these rates, and in particular, the Algerian exchange rate.

After introducing the work in hand (chapter 1), the second chapter examines the existing literature and the empirical evidence concerning cointegration methodology. The third chapter is an extensive assessment of The efficient markets hypothesis and its implications for exchange rates. The fourth chapter gives analyses and discussions of the results concerning the use of cointegration for testing different aspects of exchange market efficiency. Chapter 5 considers the role of news in exchange rate markets an give theoretical models on how to test for market efficiency using a news format . Chapter 6 is simply the test results of the aforementioned questions in the previous chapter. Exchange rate policies for developing countries are discussed in chapter 7. chapter 8 is a particular case. In fact , it examines the Algerian exchange rate policy using a cointegration analysis. Concluding remarks, recommendations and considerations for further work are given in chapter 9.

CHAPTER 1

Introductory Chapter

1.1 Introduction

The advent of flexible exchange rates in 1973 has led to a great amount of empirical research concerning the relation between the spot and forward exchange rates. The important issue here is whether or not the foreign exchange market can be regarded as an efficient market. In an efficient market, prices fully reflect all available information and it should not be possible for a market operator to make abnormal profits. Assuming rational expectations and risk neutrality on the part of the agents in the foreign exchange market, it can be shown that the forward rate is an unbiased predictor of the future spot rate. The Efficient Market Hypothesis (EMH) is very important for the construction of macroeconomic models and for testing monetarist theories concerning the asset approach to the exchange rate.

In the past two decades there have been many empirical studies both in support of and opposing the unbiased forward (UFH). The UFH argues that the forward rate "fully reflects" available information about the exchange rate expectations (Chiang, 1988). One view of market efficiency states that the current price fully reflects all available information. When this is implied to the foreign exchange market, it implies that 'economic agents' expectations about future values of exchange rate determinants are fully reflected in the forward rates (Chiang, 1988). To test this hypothesis, the conventional method uses an Ordinary Least Squares (OLS) regression, with the spot rate as the dependent variable, while the one-period lagged forward rate as the independent variable. To support the UFH, the constant term would not differ from zero, the coefficient of the one-period lagged forward rate would not significantly differ from one, and the error term would not exhibit any serial correlation.

It is also useful to point out that a central concern for macroeconomic analysis, particularly from the viewpoints of policy prescription, is to understand and analyze the relationships that might exist among variables displaying non-stationarity over time. The co-integration methodology is generally used to capture and measure long run equilibrium relationships among these variables. Current

economic literature is abundant with empirical works (Engle and Granger, (1987), Corbae *et al* (1992), Sephton, and Larsen, (1991), Napolitano (1998)) employing such co-integration methodology.

In the long run, the exchange rate is influenced by relative inflation, growth and interest rates and trade and investment flows between countries. Foreign exchange dealers therefore closely monitor announcements of new economic statistics on the major world economies. When economic releases are out of line with forecasts, dealers alter the rates they are quoting to reflect the implied change in their assessment of the currency's value.

Since changes within and between different governments often lead to changes in economic and financial policies, political developments can also affect the foreign exchange market. The market may therefore react to changes in public opinion polls or other 'news' items which have implications for future political developments. But expected news, whether economic or political, rarely moves exchange rates – the effect will already have been anticipated or "discounted". Unexpected news, such as a country changing the regime it favours for managing its currency, or unanticipated problems in a nation's economy, however, can lead to sudden and sharp exchange rate movements.

The goal of our research, and according to what have been said above, is to investigate the efficiency of the foreign exchange market and the role of the news in determining the short-term deviations of the exchange rate from its long run equilibrium. Although, many tests have been used in the literature to test the validity of the EMH, we will be using the cointegration methodology and giving a new way of testing different aspects of market efficiency for exchange rates.

Another aspect of the study is to look for the efficiency hypothesis of exchange rates in developing countries. However, and due to the absence of forward rates in the majority of these countries, we will simply assess the policy implications of these rates, and in particular, the Algerian exchange rate.

Considerations are first given to a background that summarises the basic elements of our thesis.

1.2 Research background

Under the presence of efficiency in the foreign exchange market, the forward exchange rate should be an unbiased predictor for the future spot rate. There is, however, considerable empirical evidence which rejects the hypothesis of efficiency (Hakkio, 1981; MacDonald, 1983; Hodrick and Srivastava, 1984; Domowitz and Hakkio, 1984; Fama, 1984; Taylor, 1987; Sephton and Larsen, 1991; Corbae *et al.*, 1992). By contrast, other studies have provided evidence in support of the hypothesis of efficiency (Frenkel 1981, Longworth 1981, Hakkio and Rush, 1989; Baillie and Bollerslev, 1989; Lai and Lai, 1991; Tronzano, 1992; Masih and Masih, 1995,).

Many other studies such as, Hai, Mark and Yu (1997), Norrbin and Reffett (1996), Newbold, *et al.* (1996), Clarida and Taylor (1997), Barnhart, McNown and Wallace (1998) and Luintel and Paudyal (1998) have focused on the relationship between cointegration and tests of the Forward Rate Unbiasedness Hypothesis. The results of these studies are mixed and depend on how cointegration is modeled.

The rejection of the efficiency hypothesis implies the presence of unexploited profit opportunities for those who participate in exchange rate transactions. In other words, the general conclusion emerging from the extensive empirical analysis is that the forward exchange rate could not be an unbiased predictor of the future spot and the presence of a risk premium is apparent (Hodrick and Srivastava, 1984; Domowitz and Hakkio, 1984).

In order that the efficiency hypothesis is valid, two necessary conditions must hold: (i) spot and forward prices must move closely together; departures from equilibrium must be only temporary and (ii) the lagged forward rate must be an unbiased predictor of the present spot rate (Lewis, 1989). Dornbush (1980) and Frenkel (1981) have suggested that the correct way to model exchange rate movements is to presume that the foreign exchange market is efficient. In this case, movements in exchange rates will be due to the arrival of new information. In doing that, they built two different models for 'news'. Despite these differences, the basic

assumption is that any difference between the forward and the future spot rate must be (in an efficient market) due to the 'news'.

The majority of the Efficient Market Hypothesis have concentrated on econometrically estimating an equation of the following form:

$$\ln S_t = a + b \ln F_{t,1} + U_t \quad (1-1)$$

Where $\ln S_t$ is the logarithm of the spot exchange rate and $\ln F_{t,1}$ is the logarithm of the forward rate at t-1.

If the forward market is efficient, it is expected that (a) will be statistically significant, (b) will differ significantly from unity, and the error term to be serially uncorrelated.

For instance, using the OLS (Ordinary Least Square) to estimate this equation, Levich, (1979) found that the joint hypothesis cannot be rejected and the residuals fall within the conventional level for the United Kingdom and France. Using the Instrumental Variables (IV) method to account for the risk aversion, Frankel (1979) tested the efficiency of six currencies. He found that, except in two of these currencies (UK pound and Swiss Franc), the hypothesis cannot be rejected. Frenkel (1981) has also used the IV method to test the efficiency of France, the United Kingdom, and West Germany. He concluded that the joint hypothesis cannot be rejected.

Although equation (1.1) has proved to be the most popular way of testing the EMH for the foreign exchange market, researchers have argued that the stochastic process generating S_t and $F_{t,1}$ in the above equation may be non-stationary and therefore forward market efficiency should be tested using rates of change (Hansen and Hodrick, 1980, and Meese and Rogoff, 1984). Thus, we regress the rate of depreciation of the spot rate on the forward premium as follows:

$$S_t - S_{t-1} = a + b (f^t - s)_{t-1} + U_t \quad (1-2)$$

where again, it is expected that (a) = 0, (b) = 1 and U_t to be a white noise process and orthogonal to the information set. Bilson (1981) reports estimates of

equation (1-2) for a selection of nine currencies. He rejects the unbiasedness proposition for only two of these currencies. The results indicates also significant autocorrelation in three cases. Furthermore, the results show that the slope coefficients are close to -1 rather than 1.

Our research, however and as mentioned above will use a different method for testing the efficiency of the foreign exchange market. In fact, the proposed test is based on cointegration methodology (Granger, 1986, and Engle and Granger, 1987). The main implications of cointegration for market efficiency is that two spot prices in an efficient market cannot be cointegrated, and secondly the spot and forward rates of an exchange rate are cointegrated since they move closely together in the long run.

1.3 Implication of cointegration for spot prices

Following a review of basic concepts and models, Granger (1986) draws six implications of cointegration, which relate that concept to short and long run forecasts, control, Granger causality, and speculative markets. In the latter implication, cointegration suggests that if two spot prices S^a_t , S^b_t are a pair of series from a jointly efficient market, speculative market, they would not be cointegrated. If they would, this follows that there exists an error-correction model for them, and one can be used to forecast the other even when taking into account lagged values of the forecasted rate. We know, however, that if the market is efficient, the price at any time should contain all available information. Thus, given past prices, no other information should be in use in predicting future prices. Clearly, there is a contradiction between the error -correcting models and the EMH.

This is the basis of our test. If the spot prices are efficient they could not be cointegrated. The first attempt to test the above implication is by MacDonald and Taylor (1989). The implication was tested for ten (10) Dollar bilateral exchange rates over the period June 1973 December 1985. They found strong evidence of cointegration for any of the exchange rate series examined. The findings are consistent with the Efficient Markets hypothesis.

1.4 Implication of cointegration for the spot-forward relationship

Every major newspaper, such as the Wall Street Journal or the Financial Times, prints everyday a list of exchange rates. For major currencies, two different prices are quoted. One is the « spot price ». The other is the « forward price ». The spot exchange rate is the domestic currency price of a unit of foreign exchange for immediate delivery (two working days in the interbank market). The forward rate for each currency is the price one have to pay when you sign a contract today to buy that currency on a specific future date (30, 90 or 180 days forward).

Following the asset approach to the exchange rate, one important implication of this is that expectations about future exchange rate will be important in the determination of the current exchange rate. Since money is durable, expectations will affect the future exchange rate. Therefore, if agents are revise their expected future spot rate then the current spot rate must change by a similar amount, otherwise there will be large unexploited expected returns.

The simple monetary approach provides an explanation to the close correlation between actual and expected spot exchange rates. First, and assuming perfect capital mobility, but that arbitrageurs are risk neutral so that they do not use the forward market for cover, there exists the *uncovered interest parity* which must hold at any moment in time. Arbitrageurs use the expected spot rate in place of the forward rate of the currency..

As mentioned earlier the concept of the forward rate is synonymous with the market's expected future spot rate. It follows that the spot and forward rate should be closely tied together. We conclude that the forward rate can be used to predict the actual spot rate since they move closely together. This is the main idea of efficiency. Moreover , following Engle and Granger (1987), if some individual time series move closely together in the long-run, it follows that they should be cointegrated.

Engle and Granger (1987) point out that "an individual variable, viewed as a time series, can wander extensively and yet some pairs of series may be expected to move so that they do not drift too far apart". Clearly , the spot and forward rate

correspond well with the kind of series that do not drift too far apart. In fact, they are always tied together. It follows that, $S_t - bF_{t-1} = U_t$ is stationary (i.e. S_t and F_{t-1} are cointegrated).

Comparing the tests that have been used for market efficiency and the recent technique of cointegration, some useful points can be drawn. First, the EMH suggest that the slope coefficient in (1.1) should equal 1, for the forward rate to be an unbiased predictor, whereas, in cointegration it is not necessary for the cointegration vector to be 1. On the other hand, the EMH seeks the error term U_t (like in equation 1.1) to be white noise, whereas cointegration suggests that U_t should be stationary.

1.5 The following chapters

Chapter (2)

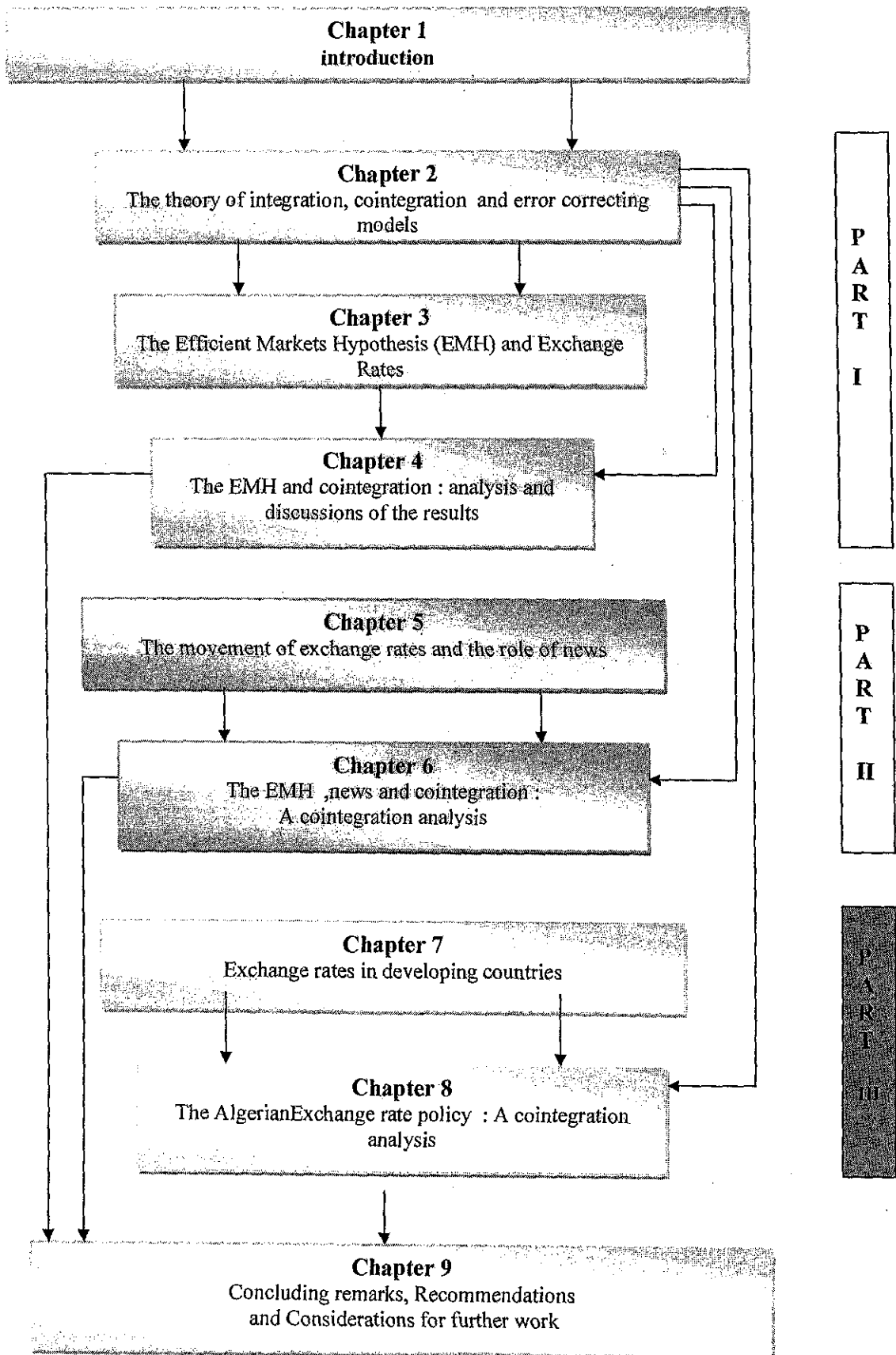
First we will introduce the theory of Integration, Cointegration and Error Correction Models. The first section of this chapter provides a literature review on cointegration methodology and some other related work on this issue. Definitions of integration, cointegration and error correction models are given in section 2. Section 3 considers the testing and implications of cointegration, whereas section 4 gives some problems associated with using cointegration in macroeconomic models. Some examples of cointegrated variables are given in the concluding remarks.

Chapter 3

This chapter deals with the Efficient Markets Hypothesis (EMH) and its implications for exchange rates. In section 1, a theoretical background and basic exchange rate concepts are given. Secondly, the theory of Efficiency hypothesis is discussed deeply. The empirical evidence and other issues raised by different studies are provided in section 3.

Chapter 4

This chapter deals with the implications of cointegration for the Efficient Markets hypothesis. Although many tests have been used in the literature to test the validity of the EMH, we will be using the cointegration methodology and giving a



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CHAPTER 2

The Theory of Integration, Cointegration and Error Correction Models

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2.0 Abstract

This chapter deals with the theoretical foundations and characteristics of the cointegration techniques and its implications on exchange rates. Section 1 provides a literature review on cointegration methodology and some other related work on this issue. Definitions of integration, cointegration and error correction models are given in section 2. Section 3 considers the testing and implications of cointegration, whereas section 4 gives some problems associated with using cointegration in macroeconomic models. Some examples of cointegrated variables are given in section 5 followed by some concluding remarks.

2.1 - Introduction

It is believed that certain pairs of economic variables should not diverge from each other too far apart, at least in the long-run. Thus such variables may drift apart in the short run or due to some new events, but economic forces will bring such series together if they continue to drift apart in the long-run. There exist many examples of these kinds of variables such as short and long term interest rates, income and consumption, households income and expenditure and the value of sales and production costs of an industry. Other possible examples would be prices and wages, imports and exports and spot and future prices of a commodity among others. Equilibrium relationships undergo the same concept that suggests close correlation in the long-run.

A condition for this long-run equilibrium to be true is called cointegration. This latter was introduced by Granger (1981) and Granger and Weiss (1983). The main idea of cointegration is to allow specification of the models that capture part of such belief. In fact, cointegration analysis provides a way of investigating the possible existence of equilibrium relationships and of estimating any such relationship if it exists. It also provides a computationally attractive way of incorporating long-run (levels) into dynamic models.

Section 1 provides a literature review on cointegration methodology and some other related work on this issue. Definitions of integration, cointegration and error correction models are given in section 2. Section 3 considers the testing and implications of cointegration, whereas section 4 gives some problems associated with using cointegration in macroeconomic models. Some examples of cointegrated variables are given in section 5 followed by some concluding remarks.

2-2. A Literature Review On Cointegration

The empirical evidence has shown that many macroeconomic time series are typically non stationary, as indicated by the high serial correlation between successive observations especially when the sample size is small. It is also an empirical fact that changes in the series are small compared to the levels. At the same time, though, casual observations tell us that some of these variables tend to trend together. The above considerations have been tested statistically inducing two different approaches.

On the one hand some econometricians have neglected the fact that there exist some spurious regressions, and run static models in levels. This practice has been criticised by many time series analysts because it is inconsistent with most data. Yule (1926), for example, used both analytical and experimental method to examine the correlation between two unrelated time series such that: (a) the series were white noise $I(0)$; (b) their first differences were white noise $I(1)$; (c) their second differences were white noise $I(2)$. Yule found that in cases (b), (c) correlation theory perform as if the series were related. He concluded that the R^2 of the regression in related, non-stationary series tends to unity nothing could be learned by examining that statistic in such environment. Granger and Newbold (1974) replicated the gist of Yule's findings and pointed out that the interest should concentrate on the Durbin-Watson statistic since the residuals are not $I(0)$ series. To discriminate against spurious regressions, Granger and Newbold suggested that R^2 should be greater than DW statistic.

The main idea of the above criticism is that if no bounded combination of the levels exists, then the error term must be non-stationary in the regression under the null hypothesis so that known distributional results do not apply.

On the other hand, however, in the possibility of likely spurious regressions, econometricians used the Box and Jenkins approach (1970), concerning differencing data to remove unit roots. Their models could be used to describe only relationships between changes in time series. By using this approach, all information about long

run relationships among the levels of economic variables is lost. Obviously this is not a good solution for spurious regressions.

To account for both problems, the Error Correcting Models (ECM) were introduced (Sargan, 1964). An ECM has the advantage of combining the dynamics of both short run (changes) and long run (levels). One necessary condition for an ECM is that all variables entering in this model should be $I(0)$ series, otherwise the t -values would not be valid.

Granger (1983) introduced the concept of cointegration and established a unified basis for the analysis of ECMs and of time series in which variables stochastically trend together. A more general idea of cointegration was developed by Granger and Weiss (1983). Granger and Engle (1985) proved that cointegrated series have an ECM representation, and conversely that ECMs generate cointegrated series, thus clarifying when levels information could be retained in econometric equations. Granger (1986) extended his research by presenting a way of testing and estimating cointegrated variables. He also draws six implications of cointegration, which relate that concept to short term and long run forecasts, control, Granger causality and efficient markets. Engle and Granger (1987) developed the theory further. Full details of this is given in the next section.

A related literature to cointegration is that concerned with the statistical properties of, and tests for time series data that have unit roots. This literature includes Fuller (1976), Dickey and Fuller (1979, 1981), Evans and Savin (1981), Nelson and Plosser (1982), Sargan and Bhargava (1983), Phillips (1985, 1987, 1988, 1992, 1995, 1997), Phillips and Xiao (1998), and Phillips and Peron (1988) among others. The above is just a review of the work concerning the theory of cointegration. More development of the implications, testing, problems and estimation is given in the following sections. Considerations are first given to the definition of integration, cointegration and ECMs.

2.3. The Definitions of Integration, Cointegration and ECMs

2.3.1 Integration

The theory of time series starts by examining the general characteristics of the individual series. That is by looking at the statistical properties of the series, especially the linear properties such as mean variance and autocorrelation function. When a time series has these linear properties, and is time invariant, it is a stationary series. Such a series is called an $I(0)$ series, denoting "integrated of order zero". Some series need to be differenced to achieve stationarity and this will be called $I(1)$, denoting "integrated of order one".

Generally speaking an integrated series of order d is a series that requires differencing d times before it becomes stationary. Formally, consider a series X_{it} , $t=1,2,\dots,T$. This series is integrated of order d , $X_{it} \sim I(d)$ if $(1-B)^d X_{it}$ has a stationary, invertible, non-deterministic ARMA representation (Engle and Granger, 1987).

The above definition considers the weaker concept of integration. Hylleberg *et al.* (1990) extended this concept to other frequencies rather than the long-term zero frequency. A series is said to contain a unit root of order d , i.e. to be integrated of order d at frequency θ , $Y_{it} \sim I_{\theta}(d)$ if its spectrum takes the form $f(w) = c(w - \theta)^{-2d}$ for w near θ . For $\theta = 0$ we obtain the $I(d)$ concept described earlier.

The simplest example of an $I(0)$ series is a white noise, U_t , so that $\rho_k = \text{cor}(U_t, U_{t-k}) = 0$ for all $k \neq 0$. Another example is a stationary AR(1) series, X_t generated by :

$$X_t = \alpha X_{t-1} + U_t$$

where $|\alpha| < 1$ and U_t is a white noise with zero mean.

A special example of an $I(1)$ series is a random walk, where X_t is generated by,

$$X_t = X_{t-1} + U_t + m$$

where again U_t is considered to be white noise. If m is not equal to zero, X_t is a random walk with a drift.

Many macroeconomic time series are found to follow a random walk, i.e. $I(1)$ series, as suggested by the analysis of Box and Jenkins (1970) techniques, or by direct testing as in Nelson and Plosser (1982).

In this chapter, the analysis concentrates mainly on $I(0)$ and $I(1)$ series, but the results extended to higher order integrated variables. Granger (1986) and Engle and Granger (1987) give differences between $I(0)$ and $I(1)$ series. This can be summarised in the table below.

Characteristics of X_t	$I(0)$ with zero mean	$I(1)$
1) variance of X_t	Finite	$\text{var} \rightarrow \infty$ when $t \rightarrow \infty$
2) An Innovation on the value of X_t	temporary effect	permanent effect
3) Spectrum of X_t , $f(w)$	$f(w)$ has property $0 < f(w) < \infty$	$F(w)$ has the approximate shape $f(w) \sim A w^{-2d}$
4) Expected time between crossings of $X = 0$	finite	Infinite
5) Autocorrelations ρ_{1h}	Decrease steadily in magnitude for large h , so their sum is finite.	$\rho_{1h} \rightarrow 1$ for all h as $t \rightarrow \infty$ (Granger and Newbold, 1974)

As can be seen from the above table, because of the important difference of relative sizes of variances, any linear combination of I(0) and I(1) variables will be an I(1) series, just as a deterministic trend will dominate stationary variable.

If the dependent variable is I(0), the explanatory variables must be collectively I(0), which means, for example, a deterministic trend and an I(0) variable would be jointly inappropriate regressors. If a misspecification of this type is made it will result in the disturbance term exhibiting I(1) behavior. Cases in which a linear combination of I(1) regressors is I(0) occur when the variables are cointegrated. This motivates the following definition of cointegration.

2.3.2 Cointegration

Generally speaking any linear combination of two I(0) series, say X_t , Y_t , having no drift or trend in mean, is also I(1). However, if there exists an equilibrium relationship between X_t and Y_t such that:

$$Z_t = X_t - AY_t \quad (2.1)$$

we would expect Z_t to be stationary, i.e. $Z_t \sim I(0)$, then X_t and Y_t will be said to be cointegrated, with the cointegrating vector A .

Cointegration theory was introduced by Granger (1983) and Granger and Weiss (1983). It was developed later by Granger and Engle (1985, 1999) and Granger (1986).

A more technical definition of cointegration is given in Engle and Granger (1987).

The components of the vector X_t are said to be cointegrated of order d , b denoted $X_t \sim CI(d,b)$ if

- (i) all components of X_t are I(d)

(ii) there exists a vector $\alpha (\neq 0)$ so that

$$Z_t = \alpha' X_t \sim I(d-b), b > 0 \quad (2.2)$$

The vector α is called the cointegrating vector.

Although the individual series wander extensively, there exists one or more linear combinations which do not. This linear combination can be interpreted as a representation of an equilibrium relationship that exists between these variables. To see this, we consider a two example both being $I(1)$. Suppose that the relationship between these two variables takes the form:

$$X_t = a + bY_t \quad a, b \text{ constant} \quad (2.3)$$

where in a stochastic environment such a relationship must be amended to :

$$X_t = a + bY_t + U_t \quad (2.4)$$

U_t being an error term and represents the deviations of the system from the hypothesised equilibrium in equation (2.3). If there exists an equilibrium relationship between X_t and Y_t , then we would expect U_t to be stationary, i.e for deviations from equilibrium to rarely drift far from zero if U_t have a fixed mean (of zero) and to exhibit complete persistence. Here U_t will measure the extent to which the relationship is out of equilibrium, and it is called the equilibrium error. Granger (1986) states that the equilibrium is not used to describe the behavior of certain economic agents but it rather shows a tendency of an economic system to move towards a particular region of the possible outcome space.

If U_t was non-stationary, i.e. $I(1)$, it would have no tendency at any point in time to be moving towards zero, so that the system is never tending towards the hypothesised equilibrium when it is out of it. In fact if U_t is non-stationary, then it can wander widely and zero crossings would be rare, suggesting that the notion of

an equilibrium relationship between X_t and Y_t becomes meaningless. Thus, for a pair of $I(1)$ series cointegration is necessary for the equilibrium relationship to hold.

Johansen (1995) has shown that it is not necessary that all components of X_t (as in equation 2.2) be of the same order of integrability. He suggests that if $X \sim I(1)$ then X and $\bar{y} = \sum_{j=0}^p y^{t-j}$ could be cointegrable. In general, X_t is cointegrable if there exists a cointegrating vector such that :

$$Z_t = \alpha'(L)X_t \sim I(d-b) \quad (2.5)$$

where $\alpha(L)$ is a vector of functions of the lag operator L . The cointegrating vector, α , however, may not be unique as there may be more than one, some of which may be linearly dependent.

One thing that should be noted is that a relationship of X_t being $I(0)$ and Y_t being $I(1)$, makes no sense as the independent and dependent variables have such vastly different properties. In the multivariate case, however, there may exist a subset of the independent variables that are cointegrable [in general, $CI(d,b)$], thereby rendering some linear combination of those variables to be of a lower order of integrability. In this case, cointegrability exists even if the variables are of different order of integrability.

2.3.3. Error Correction Models

Granger (1983) and Granger and Engle (1985) has proved that if X_t , Y_t are both $I(1)$ without trends in mean and are cointegrated, there exists a generating mechanism having what is called the 'error correcting' form :

$$\begin{aligned} \Delta x_t &= -\rho_1 z_{t-1} + \text{lagged}(\Delta x_t, \Delta y_t) + d(B)\epsilon_{1t} \\ \Delta y_t &= -\rho_2 z_{t-1} + \text{lagged}(\Delta x_t, \Delta y_t) + d(B)\epsilon_{2t} \end{aligned} \quad (2.6)$$

where Z_t is defined previously such that $Z_t = X_t - AY_t$.

$d(B)$ is a finite polynomial in the lag operator B , such that $B^k X_t = X_{t-k}$, and $\varepsilon_{1t}, \varepsilon_{2t}$ are joint white noise, and with $|\rho_1| + |\rho_2| \neq 0$.

Error Correction Models (ECM) are not new. Early versions are Lucas (1967) and his particular work on adjustment costs in the investment decision, Sargan (1964), and Phillips (1957). The main idea of these models is that a proportion of disequilibria in one period is corrected in the next period. Recently, ECM have seen great interest after an important series of papers, Hendry and Mison (1978), Davidson *et al.* (1978), Hendry and Von Ungern Sternberg (HUS) (1980), Currie (1981), and Salmon (1982). All these studies have looked for the dynamics of the error correcting models. The relationship between these models (i.e. ECMs) and cointegration was first pointed out by Granger (1983), Granger and Engle (1985), and Granger (1986). This relationship was further developed and generalised by Engle and Granger (1987). Latest studies includes Hylleberg *et al.* (1990), Hylleberg and Mison (1989), Granger *et al.* (1990), Granger and Engle (1999) among others. These studies consider some problems related to ECMs. These problems are discussed later in section (2.4).

Consider the simple error correction mechanism (ECM):

$$\Delta y_{t-1} = b \Delta x_{t-1} + c(y_{t-1} - ax_{t-1}) + \varepsilon_t \quad (2.7)$$

where $y_{t-1} - ax_{t-1}$ is the equilibrium error in t-1 which to be corrected. Thus, this formulation gives the equilibrium relationship directly. This has the usual interpretation: the change in Y_t is due to the immediate 'short-run' effect from the change in X_t to last period's error (based on the equilibrium regression), which represents the 'long-run' adjustment to past disequilibrium. Engle and Granger suggested a two-step estimation procedure for an ECM. First estimate the long-run parameter(s) a and then enter the lagged cointegrating regression residuals in the ECM, which is then estimated (by OLS). Note however that the two step method

can also be applied to cases where the r (the rank) is greater, provided it is known a priori that none of the cointegrating vectors (i.e. rows of α' in equation 2.2) involve precisely the same set of variables.

Therefore, it is seen that the conditions under which the Engle-Granger two-step estimator applies are very restrictive. Hylleberg and Mison (1989) state that even the required prior information is available the usual test statistics based on asymptotic normality are not appropriate, and the limiting distribution of the estimators is non standard.

One important feature of the ECM is that all terms included in these models are $I(0)$. The converse is also true: If X_t and Y_t are $I(1)$ and are generated by an error correction model, then X_t and Y_t are necessarily cointegrated. Furthermore, Engle and Granger (1987) noted that if X_t and Y_t are cointegrated, the generation process can always be written in the error correction form, so that the equilibrium concept has no impact.

Although the ECM has the advantage of separating long-run and short-run responses, it does however suffer from many problems. For instance, Wickens and Breusch (1988) state that there is no benefit for using the ECM model to obtain estimates of the equilibrium relationship. They suggest that other formulations might be used, and are just as suitable. The most likely problem to occur in ECMs is multicollinearity. Other problems may also be found in the ECM formulation such as autocorrelation and spurious regressions. Considerations of these problems are given in section (2.4)

2.4. Testing and Implications of Cointegration

A number of procedures have been suggested in the literature for testing whether a set of variables is cointegrated. Engle and Granger (1987) provide a detailed review and procedures. Since cointegration tests are occasionally used in further chapters, it will be sufficient to give in this section just a brief survey for

testing procedures for unit roots and cointegration. In this section, Considerations are also given to the implications of cointegration for macroeconomic models.

2.4.1 Testing for Unit Roots

Before proceeding to test a set of variables for cointegration, it is sensible to establish the properties of the individual series. Much of the theory of cointegration has been developed for the cases where all the series are I(1). It was shown, however, in the previous section that cointegration could exist even if the variables are of different order of integrability. Thus the order of integration of the variables must be determined.

A useful test for unit roots is based on the work of Fuller (1976) and Dickey and Fuller (1979, 1981). Other tests are provided by Sargan and Bhargava (1983), Nelson and Plosser (1982), Phillips (1985, 1987) and Phillips and Peron (1988).

To test for the I(1) hypothesis is to test whether :

$$H_0 : a=1 \text{ in } X_t = aX_{t-1} + \varepsilon_t$$

against

$$H_1 : a < 1$$

Consider the OLS estimator of a , \hat{a} , and its associated t -statistic, \hat{t} . Under H_0 , \hat{t} does not have a limiting normal distribution since X_t is non stationary implying a violation of classical assumptions. Critical values of t , however are given in Fuller (1976) (see appendices).

To account for a drift term in the above equation, Dickey and Fuller(1979) suggested a following equation:

$$\Delta X_t = \alpha_0 + \alpha_1 X_{t-1} + U_t \quad (2.8)$$

The test which has been used is the ratio of 1 to its calculated standard error that is obtained from equation (2.8), and it is called the Dickey-Fuller (DF) test. The null hypothesis is that:

$$H_0: X_t \sim I(1)$$

It is rejected if α_1 is negative and significantly different from zero. The Dickey-Fuller test does not have a t -distribution but table of significance level has been provided to test this hypothesis (Dickey and Fuller, 1979).

Another test is similar to the DF test in equation (2.8) but modified to:

$$\Delta x_t = \alpha_0 + \alpha_1 x_{t-1} + \sum_{i=1}^p b_i \Delta x_{t-i} + u_t \quad (2.9)$$

where p is selected large enough to ensure that the residuals U_t is an empirical white noise. This test is called the Augmented Dickey-Fuller (ADF) test, and it is the ratio of α_1 to its calculated standard error in equation (2.9). The OLS estimator of normalised α_1 and its calculated t -statistic have the same limiting distribution as for the DF (with drift) statistic. The DF critical values provide a small sample approximate test. Since in practice we do not know if extra lags appear in the true model we must allow for them, and the ADF is generally the recommended one as stated by Engle and Granger (1987).

Although the DF and ADF statistics are the most widely used in testing for unit roots, recent studies tend to prove that these tests are not very powerful. For instance, Schwert (1989) has raised a potentially important methodological objection to the use of Dickey-Fuller test upon which Nelson and Plosser (1982) rely. Specifically, the DF test (1979) for unit roots employs an autoregressive correction to account for the short-run dynamics of the process. Schwert (1989) has shown using Monte Carlo simulations that the DF (1979) testing procedure can lead to misleading inferences when moving average terms are present in the first differenced representation of the process, and the order of the autoregressive correction does not increase with the sample size.

Corbae and Ouliaris (1986) developed the test proposed in Phillips and Peron (1988) and found that this test has significant advantages over the Dickey-Fuller technique when there is weakly dependent and heterogeneously data.

2.4.2- Testing for Cointegration

There exist many methods to detect the presence of cointegration. The first test was introduced by Engle and Granger (1987). Others tests used, are those of Johansen (1991) and Philips and Hansen (1990). Moore and Copeland (1995) has compared the three tests. They show a slightly difference using these different tests. However they could not state which test could be best used.

Engle and Granger (1987) have proposed several tests for examining the hypothesis that a set of variables are cointegrated. In all their seven proposed tests, the null hypothesis is non-cointegration (against the alternative of cointegration). Therefore a large test statistic rejects non-cointegration, or in another way, a large test statistic accepts cointegration. These tests involve estimating the cointegrating regression of the form (as in the general case in equation 2.2):

$$\alpha'X_t = Z_t$$

Perhaps surprisingly, OLS is an ideal estimation procedure. The OLS estimator $\hat{\alpha}$ tends to its true value in large samples (T). This is in contrast to standard results (with $X I(0)$) $\hat{\alpha}$ tends to its true value at $T^{1/2}$. Thus $\hat{\alpha}$, for $X I(K)$, $K \geq 1$, has the desirable property of being super consistent. In substantial serial correlation, however, likely to be in the error term will render biased the estimates of the standard errors of the elements of $\hat{\alpha}$. Therefore, we cannot test for significance of individual variables by checking their t -statistics against the t -distribution. In fact the limiting distribution of $\hat{\alpha}$ under the null hypothesis of no-cointegration depends on nuisance parameters, which means that the conventional tests are not valid.

In fact, Engle and Granger (1987) has considered the testing procedures for the bivariate case only. The regression to be tested is of the form:

$$X_t = c + dY_t + U_t \quad (2.10)$$

where X_t and Y_t are the series being tested for cointegration. The first three tests proposed by Engle and Granger examine whether U_t is stationary; the remaining tests focus on whether X_t and Y_t obey an error correction process. Critical values of these tests are given in Engle and Granger (1987). Engle and Yoo (1987) extended the simulation results for these tests to the case of 3, 4, and 5 regressors.

The first test involves the Durbin Watson from the cointegration regression (CRDW). The CRDW tests for absence of serial correlation, returning $DW=2$ under this null. For positive serial correlation DW falls below 2, and in the limit as the residuals U_t become random walks we would find $DW=0$. Thus by examining if CRDW is significantly greater than zero we have potentially another test for cointegration (i.e. $U_t \sim I(0)$). However, the power of CRDW is very poor so it can only be used as an approximate quick result (Engle and Granger, 1987).

The second and third tests used slightly modified Dickey-Fuller type regressions (Dickey and Fuller, 1979, 1981) to test whether the residuals U_t have a unit root. If U_t is an $I(1)$ series, then X_t and Y_t are not cointegrated. The Dickey-Fuller is obtained as the t -statistic of $\hat{\rho}$ in the following regression formula:

$$\Delta \hat{U}_t = \hat{\rho} \hat{U}_{t-1} \quad (2.11)$$

where \hat{U}_t is the estimated residuals from equation (2.10). If $\hat{\rho}$ is positive and significantly different from zero, the residuals \hat{U}_t are stationary and the hypothesis of cointegration is accepted. The augmented Dickey-Fuller (ADF) test proceeds in a manner similar to the DF but additional lags of $\Delta \hat{U}_t$ are used to be sure that the residuals for the DF regression are white noise (serially uncorrelated). The ADF regression is as follows:

$$\Delta \hat{U}_t = \rho U_{t-1} + \sum_{i=1}^p \hat{\alpha}_i U_{t-i} + \varepsilon_t \quad (2.12)$$

The next four tests make use of the fact that cointegrated variables can always be written as an error correction model. The first of these four tests is called the restricted vector autoregression, or RVAR test. This test requires estimation of two equations :

$$\Delta X_t = \beta_1 \hat{U}_{t-1} + \varepsilon_{1t}$$

$$\Delta Y_t = \beta_2 \hat{U}_{t-1} + \theta \Delta y_t + \varepsilon_{2t}$$

The error correction model implies that β_1 and β_2 are jointly significant. The RVAR test is based on the sum of their squared t-statistics. If β_1 and β_2 are significantly different from zero, X_t and Y_t are cointegrated since they are represented as error correction model. The augmented RVAR, or ARVAR, test is the same as RVAR except that additional lags of ΔX_t and ΔY_t are used in the regressions.

The sixth test is called the unrestricted VAR, or UVAR, test. This test examine whether X_t and Y_t satisfy a vector autoregression (VAR) in the levels by estimating these two equations :

$$\Delta X_t = \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \varepsilon_{1t}$$

$$\Delta Y_t = \beta_3 Y_{t-1} + \beta_4 X_{t-1} + \theta \Delta X_t + \varepsilon_{2t}$$

The UVAR examines if the β 's are jointly significant. The UVAR test is to twice the sum of the F-statistics (the F-statistic test for the β 's equal to zero) in both equations. If the β 's are significantly different from zero, thus ΔX_t and ΔY_t depend on their levels and can be represented as an ECM. The last test presented by Engle and Granger (1987) is called the augmented UVAR, or AUVAR, test. It is similar to the UVAR except for p lags of ΔX_t and ΔY_t in each equation.

2.4.3- Implications of Cointegrated Variables

Granger (1986) draws six theoretical implications of cointegrated variables, which can be presented as follows.

i) If X_t , Y_t are cointegrated, so will be X_t with $bY_{t-k} + w_t$ for any value of k , but there may be a change in the cointegrating parameter. If has a unit root, i.e. $I(1)$, then it will be cointegrated with X_{t-k} for any value of k . Granger (1986) indicated that this implication, unlike in the case of cointegration when $I(1)$ series are combined, is not an important relationship since it is valid for any $I(1)$ series.

ii) Yoo, S. (1986) and Engle and Yoo (1987) proved that X_t is $I(1)$ and $f_{n,h}(J_n)$ is the optimal forecast of X_{n+h} , based on the information set J_n available at time n , then X_{t+h} , $f_{t,h}(J_t)$ are cointegrated if J_n is a proper information set, that is if it includes X_{n-j} , $j \geq 0$. If J_n is not a proper information set, and its optimum forecast are only cointegrated if X_t is cointegrated with variables in J_t .

iii) If X_{n+h} , Y_{n+h} are cointegrated series with parameter and they form an optimal forecast using the information set $J_n : X_{n-j}, Y_{n-j}, j \geq 0$, then the h -step forecast will be written as :

$$f_{n,h}^x = Af_{n,h}^y \quad \text{as } h \rightarrow \infty$$

This is proved by Yoo (1986) and Engle and Yoo (1987). Therefore, the long-run forecasts of cointegrated systems are tied together regardless to the fact that individual forecasts diverge to infinity. The cointegrating relationship will hold exactly in the long-run forecast.

iv) If X_t is an $I(1)$ controllable variable and T_t is an $I(1)$ variable, then they will be cointegrated if an optimum control is applied (Nickell, 1985).

v) Another implication in Granger (1986) is concerned with Granger causality. Since the error correcting forms of X_t and Y_t when cointegrated, indicate that one variable can help to forecast the other. Because of the condition that $|\rho_1| + |\rho_2| \neq 0$, and Z_{t-1} must occur in at least one equation, knowledge of Z_t must

improve the forecastability of at least one of X_t and Y_t , thus Granger causality must occur in at least one of them.

vi) A last implication is related to the Efficient Markets Hypothesis (EMH) and follows directly from the above implication. If X_t , Y_t are two prices, determined in an efficient speculative market they cannot be cointegrated. If they are, this implies that either X_t or Y_t can help to forecast the other. Clearly, this contradicts the concept of efficiency. If prices are efficient, all available information is reflected in the market and no other opportunities can be in use. Thus, for example MacDonald and Taylor (1988) found that prices of tin, lead, and zinc, which are determined in the London Metal Exchange (LME), are not cointegrated. The same authors also found that spot exchange rates cannot be cointegrated (MacDonald and Taylor, 1989, 1992).

In our research, the focus is mainly on the last two implications given above. The next chapter considers the Efficient Markets Hypothesis (EMH) in foreign exchange markets and shows in more details how these markets cannot be cointegrated. Granger causality will also be examined in some relationships such as the long-run Purchasing Power Parity (PPP).

2.5. Problems in Cointegration Methodology

The section draws some new problems pertinent to econometric modeling that are raised when using cointegration techniques. These problems are summarized below:

i) The first problem is concerned with the DF and ADF tests for unit roots. The application of these tests is complicated by the fact that when lags are present in the true relationship, the DF regression as in equation (2.11) is inappropriate and when lags are absent, the ADF regression in equation (2.12) is over parameterised. An added difficulty is that critical values for the ADF test are available only for the case of $p=1$ and $p=4$.

ii) The ADF test is the recommended one by Engle and Granger (1987), but when results conflict, say that the ADF is rejected, whereas the DF and CRDW are accepted, should it be always that the ADF is the deciding test. Drobny and Hall (1987) in a analysis of consumption, in which they show that the wealth to income and a tax differential variable need to be added to income in order to form a cointegrating set. Their regression was :

$$\ln \hat{c}_t = 0.962 \ln Y_t + 0.067 \ln(W/Y)_t + 0.244 \text{Tax}_t + 0.005 \text{Dummy}$$

66Q4-85Q4: CRDW =1.57, DF=-6.92, ADF=-3.35, R²=0.977

As seen from the above results cointegration in accepted by DF and CRDW tests, but it is rejected by the ADF test even at the 10% level. Drobny and Hall (1987)concluded, however that the variables are cointegrated.

iii) The critical values given in Engle and Granger (1987) have only been constructed for one sample size and only for the bivariate case. Engle and Yoo (1987) extended the simulations results for the DF and ADF statistics to the case of 3, 4, and 5 variables. Their results show that the inference becomes much less precise as the number of regressors increases. The ADF 5% critical value for 5 regressors at T=100 is equal to -4.36 compared -3.17 for 1 regressor. The question here is whether cointegration could applied in cases with more than five regressors.

iv) It has been recognized that one of the problems raised by serially correlated errors is that the usual tests of significance are invalid. In this case, Using OLS there is a possibility of obtaining a regression relating economic time series exhibiting typical behavior, with apparently high degree of fit, as measured by R², when in fact the independent variables have no explanatory power whatever, is examined. This is the problem of spurious regressions.

Consider now the model

$$Y_t = \beta X_t + U_t$$

where X_t, Y_t are considered to be I(1) series, and suppose that the null hypothesis is $\beta=0$ is true so that Y_t does not depend on the explanatory variable X_t at all. It is reasonable to ask whether, given the time series properties of X_t and Y_t , high value of R² is likely to obtain, leading to rejection of the null hypothesis through the F-

statistic, if OLS is applied to the above regression and the message of DW statistic is unheeded. This question is approached, largely through simulation, by Granger and Newbold (1974). First it should be noted that the usual F-statistic

$F = \frac{R_2}{1-R_2} \frac{n-k}{k-1}$ is only distributed as Fisher's F with k-1 and n-k degrees

of freedom under the null hypothesis if the error series U_t is white noise. But if the null hypothesis is true, then $U_t = X_t - \beta_1 X_t$, in which case the time series structure of U_t is the same as Y_t . Thus, if Y_t represents the level of economic variable, in which case its time series structure will be very far from that of white noise, the conventional test statistic cannot follow its assumed distribution under the null hypothesis, and hence the associated test is invalid. That is to say, high values of R^2 may well occur even if the null hypothesis is true, and one should observe a spurious regression.

Now differencing must reduce the order of integration by unity, so if ΔY_t is related to ΔX_t , then if X_t and Y_t are cointegrated ($Y_{t-1} - \hat{\beta} X_{t-1}$) is I(0) and can be included in a model as if $\hat{\beta}$ is known. Thus, the 'spurious regressions' is resurrected in a completely new guise and now to the benefit of economics (Hendry, 1986). To estimate $\hat{\beta}$, we start by regressing Y_t on X_t ; such an equation, as mentioned above, will have substantial residual autocorrelation so inference on β is invalid, but the ECM can be constructed such as ($Z_t = Y_t - \hat{\beta} X_t$). Note that all variables are I(0) and conventional t-tables are appropriate.

Phillips (1987) show that the limiting distribution results of cointegration theory confirm what have been said above, and show that inferential procedures should be directed towards the error term for evidence of an equilibrium, not individual coefficients.

v) The problem of multicollinearity is also raised in the context of cointegration. If a model involves I(0) and I(1) variables such that the latter are cointegrated, then there will be a near singularity in the second moment matrix, as most I(1) will be highly intercorrelated even if they are cointegrated (Hendry, 1986). This can be shown using the following example :

$$\Delta Y_t = a_0 + a_1 \Delta X_t + a_2 Y_{t-1} + a_3 X_{t-1} + U_t$$

In this model Y_{t-1} and X_{t-1} will be highly collinear, and neither have significant t-values despite being cointegrated, because of their I(1) nature. Moreover, if we drop either variables would complicate the problem since the other must now be insignificant if it is I(1), knowing that ΔY_t is I(0). Since Y_{t-1} and X_{t-1} are I(1), their second moments are huge compared to a_0 , ΔX_t , and $Z_{t-1} = (Y_{t-1} - \beta X_{t-1})$. Hendry (1986) states that when $(X'X)$ matrix for the above regression is inverted, the sub-matrix involving Y_{t-1} and X_{t-1} will have a near singularity corresponding to the cointegrating vector $(1: -\beta)$. Conversely, omitting any I(0) variable will be irrelevant to the estimate of β . Moreover, Z_t may be I(1) due to the omission of another I(1) variable, say w_t , such that $(Y_t - \beta X_t - \phi w_t)$ is I(0). In this case, neither a_2 or a_3 is significant when omitting w_t . Davidson *et al.* (1978) argued that adding a variable such as w_t will produce a significant ECM coefficient. Thus, one should be very careful when modeling I(1) variables, and should make general specifications to be sure that all variables in an ECM are I(0).

vi) Another problem which has been addressed in the literature of cointegration is that of choosing between alternative equilibrium specifications. For example, we have the following regressions :

$$Y = a_1 X_1 + a_2 X_2 + U_1 \quad (1)$$

$$Y = b_1 X_1 + b_2 X_3 + U_2 \quad (2)$$

and that both set of variables (Y, X_1, X_2) and (Y, X_1, X_3) are cointegrated. How do we choose between them? Drobny and Hall (1987) advocated a non-nested testing procedure in such kind of problems.

If both equations appear to be admissible cointegrating regressions, this suggests that they are two equations from the system because, for instance, there cannot

exist two different consumption functions in reality. So if they are equations from the system, this leads to the equation of why it is necessary to choose between them in the first place. On the other hand if they are both alternative specifications of a single equation, for example two different consumption functions, then under the null one must be false so that either U_1 or U_2 is non-stationary. This stationarity then invalids the second stage inference.

2.6 Recent work using cointegration methodology

It should be useful to give few examples of cointegrated variables. Engle and Granger (1987) in a series of examples found that income and consumption are cointegrated, wages and prices are not, short and long interest rates are, and nominal GNP is not cointegrated with M1, M3, or total liquid assets, although it is possibly with M2. The consumption-income relationship was also examined by Drobny and Hall (1987). Their results show that these variables are cointegrated. Leon (1986) and (1987) tested the long-run relationships for inflation and growth and the demand for money respectively. While the results show that inflation and growth are not cointegrated, the long-run demand for money is supported but it was found that this relationship should be best expressed as an inflation determining equation. As regards the implication of cointegration for market efficiency MacDonald and Taylor (1988) found that spot prices in the London Metal Exchange (LME) are not be cointegrated. Similarly the EMH was examined in the foreign exchange market by MacDonald and Taylor (1989), and Hakkio and Rush (1989). Their results are very much in favor of the EMH. That to say that the spot exchange rates are not cointegrated.

The long-run Purchasing Power Parity (PPP) was tested using cointegration by Taylor (1988) and Karfakis and Moschos (1989). They found no evidence of such long-run relationship. In fact the exchange rates and prices tend to drift apart without bounds. Phillips, McFairland and McMahon (1996) find cointegration between the forward rate and spot rate for four currencies. In one case they also find support for the EMH, where the forward rate is an unbiased predictor of the future spot rate and there is a zero mean risk premium.

Kawai, M. and Ohara, H., (1997) and using monthly data for the G7 countries in the post-Bretton Woods floating rate period, show that almost all bilateral real exchange rates have unit roots and, hence, are nonstationary. The paper, also, rejects simple PPP as a long-run relationship. It, also shows that many of these real exchange rates are cointegrated with other real economic variables such as relative labor productivity, terms-of-trade ratios, real trade balance ratios, and long-term real interest rate differentials.

Ghezali S. *et al* (1998), Tested the Unit root hypothesis for oil prices. They could not be rejected, and argued that oil prices follow a stochastic trend.

Subarna and Zadeh, (2001) examines the relation between the spot rates and forward Rates in the foreign exchange markets for five different countries: Canada, US, UK, Germany and Switzerland. Findings indicate that for Canada and UK asymmetric adjustment process exists between these two rates, while for Germany and Switzerland the process seems to be symmetric. It is also found that the positive phase of the adjustment process is more persistent than the negative phase for Canada and U.K. The optimal threshold level for the exchange rate differential for these countries is identified, but the threshold error correction models do not provide any additional meaningful information about this adjustment process. It confirms the idea that the adjustment process in the equilibrium relation between these two rates may not behave symmetrically. Napolitano O. (2002), in his article tested for the EMH in the current spot and the current forward exchange rates and the British Pound and the U.S Dollar. For one of the two exchange rates (EU/UK), He rejects the hypothesis of efficiency and a further analysis on the presence of a risk premium shows that it is consistent and time varying.

Okubo M. (2002) in his latest paper tested the long-run relationship between consumption and income in Japan using tests of the deterministic Cointegration restriction. In other words, he tested permanent income hypothesis using Japanese quarterly data. The main focus is on the relationship between stochastic and deterministic trends of consumption and income. It is found that the deterministic

cointegration restriction implied by the model is strongly rejected in Japan in contrast to the U.S. result, and the rejection depends on the existence of a trend break. Okubo's finding suggests that the postwar Japanese economy experienced the change in a steady state path considered by the neoclassical growth model.

Dufrénot and Mignon (2002), in their book entitled 'Recent Developments in Nonlinear Cointegration with Applications to Macroeconomics and Finance' provide new insights on nonlinear cointegration and error correction models (NECM). It seeks to bring together recent developments on the subject that are, up until today, scattered throughout the literature. The authors demonstrate the importance of NECM models for studying partial adjustment problems in macroeconomics and the efficient market hypothesis in finance.

Conclusion

This chapter provides a brief notes on cointegration methodology. It has shown that cointegration analysis provides of investigating the possible existence of equilibrium relationships and of estimating any such relationship if it exists. It also provides a computationally attractive way of incorporating long-run (levels) information into dynamic models. The testing, implications and problems were the main concern in the chapter in hand. The above list of examples using cointegration techniques is rather an illustrative but not exhaustive examples of cointegrated variables. Future research concerning long run relationships will be very fruitful using this new methodology.

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CHAPTER 3

The Efficient markets

Hypothesis and exchange rates

The Efficient markets Hypothesis and exchange rates

3.0. Abstract

This chapter deals with the theoretical foundations of the Efficient Markets Hypothesis (EMH) and its implication on spot and forward exchange rates. Section 1 provides a theoretical framework and basic concepts of exchange rates. The Theory of Efficient Markets Hypothesis (EMH) and the implications of the cointegration techniques are discussed in section 2. Section 3 considers the empirical evidence of exchange market efficiency and gives some issues raised empirically such as The existence of risk premium and the error orthogonality problem, the empirical regularities and some other econometric problems and techniques. Finally some concluding remarks are given in the last section.

3.1. Introduction

After more than three decades, there remains serious and fundamental disagreement about how well floating exchange rates have worked. Besides the general concern of whether the floating exchange rate system contributes to the level of uncertainty in the system, there also is the narrower question, addressed here, of whether the foreign exchange market is efficient in the sense that prices fully reflect available information. The objective of this chapter is to deal with the theoretical and empirical arguments that pertain to efficiency in the foreign exchange market.

3.2. A Theoretical Framework and Basic Concepts of Exchange rates

3.2.1 Exchange Rates as Asset Prices

It is argued that the exchange rate should be viewed as an asset price since it is by definition the price of a national money in terms of another (i.e., it is a relative price). Following Mussa (1979), and concerning the asset approach to the exchange rate, he argues that one should use tools normally used for the determination of asset prices (such as stock and share prices) to analyse the determinants of exchange rates rather than looking to the exchange rate in terms of flow demand and flow supplies.

For instance, the supply and the demand sides of normal good depend on many factors (e.g. ; demand is a function of tastes, incomes and relative prices whereas supply is a function of technology and factor prices). The price changes in this situation are caused by shifts in the demand and supply schedules.

On the other hand, however, the price of assets changes because the market as a whole changes its view of what the asset is worth. In this case buyers and sellers are confronted by the same factor. A new information, for example, can change the price of a sharp up or down.

The basic idea of the asset approach to the exchange rate is that the same theory of the determination of prices of common shares is relevant to the determination of the exchange rate (Mussa 1979).

Viewing the exchange rate as an asset price, a number of implications can be noted briefly and will be described in detail in the next section. First, expectations will be important in the determination of the current exchange rate. Since monies are durable, in the sense that they last for a number of periods, expectations about future exchange rates will affect the current exchange rate. Thus, if we assume that for some reasons agents change their future expectations of the exchange rate we would expect today's to exchange by a similar amount, otherwise there would be a large unexploited expected return available in the foreign exchange market.

Since the exchange rate is the relative price of monies one reason why agents should change their beliefs could be due to a change in the money supply expected to prevail in the future. The importance of expectations in foreign exchange markets should result in a close correspondence between actual exchange rates and the market's expected future exchange rates.

A second implication rises from the monetary approach to the balance of payments which implies that real factors can affect the exchange rate and the balance of payments, but only to the extent that they first affect the demand for money.

Thirdly, and since assets are stocks, equilibrium is defined as a situation where the stock demand for money is equal to the stock supply of money. Flows of assets across the foreign exchange can occur, but such flows are a reflection of disequilibria between money demand and money supply and must eventually cease.

The final and the most important implication of regarding the exchange rate as an asset price is that such prices are usually regarded as being determined in efficient markets.

An efficient market participant, following Fama (1970), is the one in which market participants exploit all profitable trading opportunities and force the current price to reflect all available formation. This implies that under certain circumstances, exchange rates should behave randomly. They should follow a random walk (Levich, 1979).

The implication of regarding the exchange market as an efficient market is that in such a market the forward exchange rate set today is usually taken to be the market's expectation of the spot rate in some future period. The difference between the forward rate set at time t , with maturity in $t+1$, and the actual spot rate at $t+1$ is the unexpected change in the exchange rate.

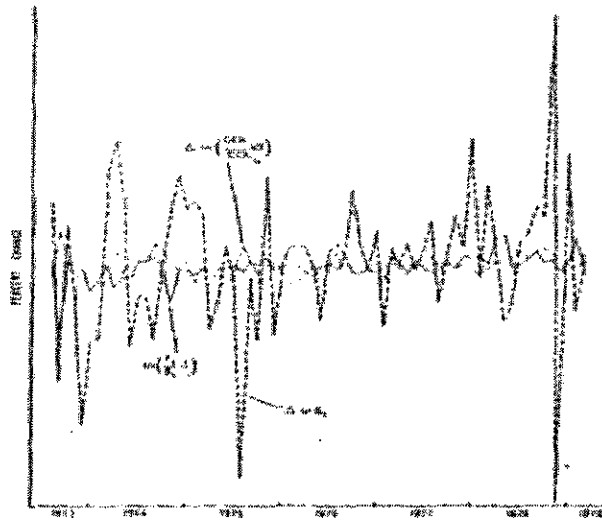
The evidence from the behaviour of spot and forward rates, as illustrated in Figure 3.1, which indicates that the bulk of exchange rate changes appear to be due to new information. The close correlation between movements of spot and forward rates, as shown in figure 3.2, indicates that this new information appears to alter views concerning current and expected future exchange rates by approximately the same amount. This close correlation between spot and forward rates is also evidence of the close link between current and expected exchange rates (this evidence will be discussed further in the next section).

Within the broad perspective of foreign markets as asset markets, there is the narrower technical question of "market efficiency". The theory of efficient markets hypothesis (EMH) is discussed in detail in the following section followed by a review of the empirical work in this area.

3-2-2 Some Regularities of the Spot and Forward markets

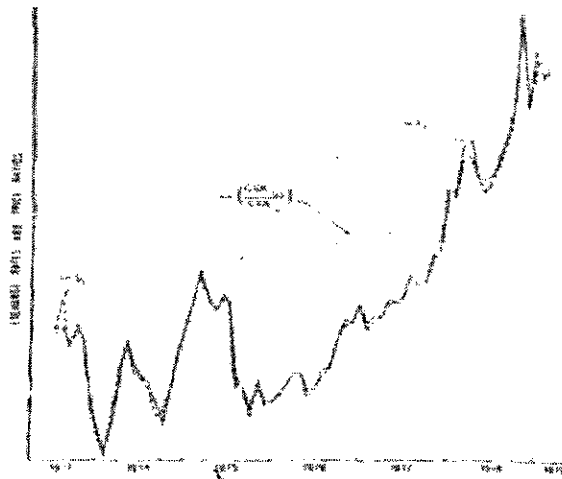
Every major newspaper, such as that Wall Street Journal and the Financial Times, print everyday a list of exchange rates. For major currencies two different prices will be quoted. One in the "spot" price. The other is the "forward" price.

The spot exchange rate is the domestic currency price of a unit of foreign exchange for immediate delivery (two working days in the interbank market). The forward rate for each currency is the price you have to pay when you sign a contract today to buy that currency on a specific future date (30, 90 or 180 days ahead).



Monthly Percentage Changes of the U.S./German Consumer Price Indices, of the \$/DM Exchange Rate and the Monthly Forward Premium.

Figure 3.1



Monthly Observations of the Dollar/DM Spot and Forward Exchange Rates and the Ratio of the U.S./German Cost of Living Indices (scaled to equal the spot exchange rate at the initial month) June 1923 - Feb 1979

Figure 3.2

As noted in the previous section, one implication of the asset approach to exchange rate is the expectation of the current exchange rate. Since money is durable, expectations about future exchange rates will affect current exchange rate. Thus if agent revise their expected future spot rate then the current spot rate must change by a similar amount otherwise there would be large unexploited returns.

The simple monetary approach provides an explanation to the close correlation between actual and expected spot exchange rates. First and assuming perfect capital mobility but that arbitrageurs are risk neutral, so that do not use the forward market for cover, there exist the uncovered interest parity, which must hold at any moment in time. Arbitrageurs use the expected spot rate in place of the forward rate of the currency. The uncovered interest parity implies that :

$$\dot{S}^e = (i - i^*) \quad (3.1)$$

where \dot{S}^e is the expected change in the spot rate .

Following the flex-price monetary approach reduced form , the exchange rate equation is:

$$S = m - \alpha_1 y + \alpha_2 i \quad (3.2)$$

where an x percent increase in the domestic money supply leads to an x percent increase in S (exchange rate depreciation). Where an increase in income leads to an exchange rate appreciation and an increase in the domestic rate of interest leads to an exchange rate depreciation .

If now we substitute the uncovered interest parity term of the FMAER (flexi-price monetary approach to exchange rate) reduced form , and by normalizing the foreign interest rate to have a value of zero we obtain

$$S = m - \alpha_1 y + \alpha_2 \dot{S}^e \quad (3.3)$$

Or , dating variables ,

$$S_t = m_t - \alpha_1 y_t + \alpha_2 [S_{t+1}^e - S_t] \quad (3.4)$$

Assuming rational expectations, agents will know the path of the exchange rate then:

$$S_{t+1}^e = E_t S_{t+1}$$

Thus the FMAER reduced form can be rewritten in the following way :

$$S_t = \frac{1}{1+\alpha_2} [m_t + \alpha_1 y_t + E_t S_{t+1}] \quad (3.5)$$

Using equation (3.5) we can find the expected value of the exchange rate in any future period $t+j$. The importance of this is that the factors that determine the exchange rate are what agents expect the money supply and income to be in the future. Thus the equation will be:

$$E_t S_{t+j} = \frac{1}{1+\alpha_2} [E_t (m - \alpha_1 y)_{t+j} + \alpha_2 E_t S_{t+j+1}] \quad (3.6)$$

From the above discussion, and as noted earlier, the close correlation between spot rate and expected future spot rate can be illustrated by using the FMAER reduced form (as in equation (3.6)). Where if (α_2) the coefficient on the expected change in the exchange rate, was large, the actual and expected exchange rate would have a correlation coefficient of close to unity. Figure 3.3 illustrates the relationship between the contemporaneous spot and forward exchange rate for German-Mark /US Dollar rates, as Ukpolo Victor (1997) estimated this relationship for the period 1980-1996. Indeed, as expected, the spot rate and forward rate are closely tied together, the correlation coefficient being 0.99.

Many studies have focused on how good a predictor of the future spot rate is the forward rate when used as a proxy of the market expectations? Figure 3.4 is simply figure 3.3 but with a three -period lagged forward rate , it shows that the predictive powers of the German Mark-Dollar forward rate are not very impressive , which means that the forward rate is a poor predictor of the future spot exchange rate.

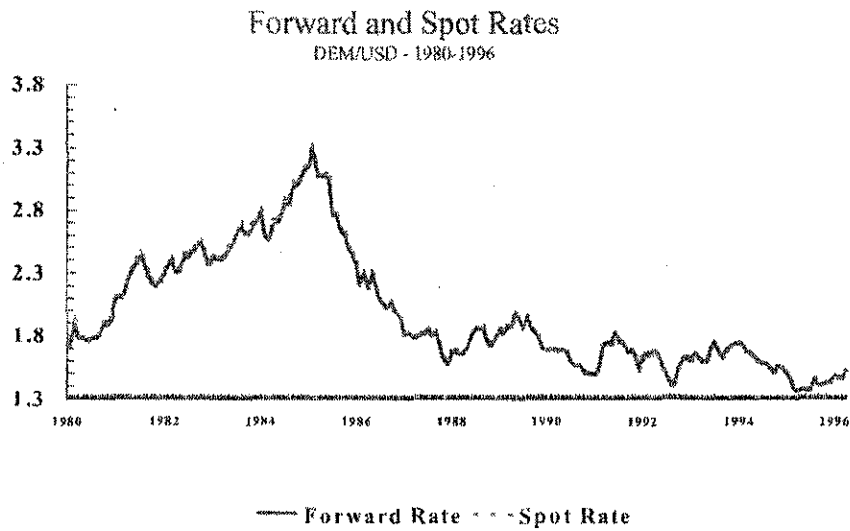


Figure 3.3 *Forward and Spot Rates (DEM/USD) 1980-1996*

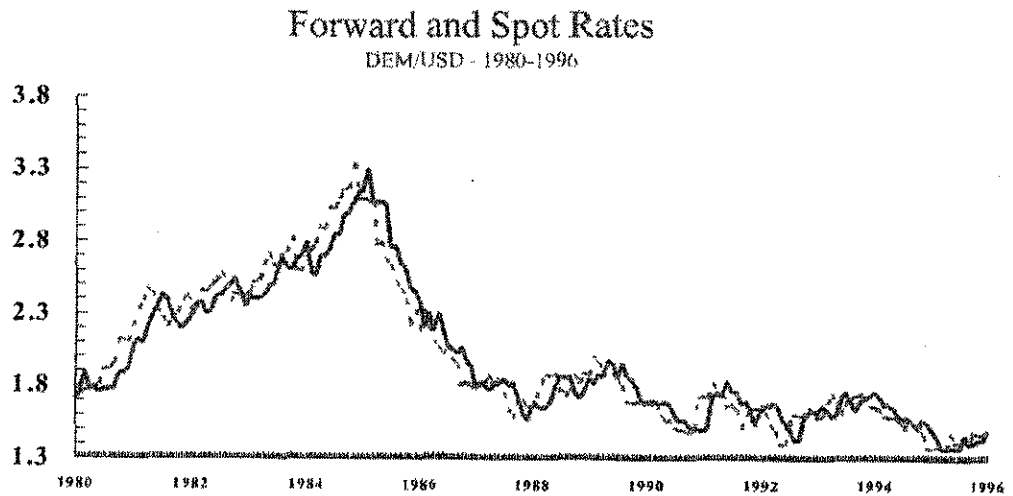


Figure 3.4 *Spot and Forward Rates (lagged three periods (DEM/USD) 1980-1996*

The results imply that there should be evidence of one of the following :

- i- the markets participants are irrational , or
 - ii- there is an evidence that a liquidity premium exists on forward exchange ,
- or

iii- there is evidence of market inefficiency .

In the following chapters we will give answers to the questions. Considerations are initially given to the theory of the Efficient Markets Hypothesis.

3.3 The Theory of Efficient Markets Hypothesis (EMH)

The pioneering work on efficient markets is attributed to Bachelier (1900). Samuelson (1965) provided a proof that properly anticipated prices fluctuate randomly. Thus if a market is "efficient", the current price is the "best" estimate of the next period price, and fluctuations should be random. Fama (1970) is responsible for the rigorous development of the concept into the related forms of weak, semi-strong, and strong efficiency.

Following Fama (1970), and as stated in the previous chapter efficient market is one which 'fully reflects' all relevant information instantly. Thus it should not be possible for a market operator to earn abnormal profits. This statement is so general that it is not generally testable. To make this concept testable, efficient markets theory uses "fair game" models of the following form, Levich (1979):

For a security the excess return \tilde{Z}_t is defined as

$$\tilde{Z}_t = \tilde{R}_t - R_t^* \quad (3.7)$$

Where:

\tilde{Z}_t = the excess market return (a random variable)

\tilde{R}_t = one period (from t-1 to t) nominal return from holding this security, including both capital gains and intermediate cash income.

R_t^* = expected R_t for the security arising from market equilibrium.

Then,

$$E(\tilde{Z}_t / Q_{t-1}) = 0 \quad (3.8)$$

Where,

Q_{t-1} = available information at time t-1.

Equations 3.7 and 3.8 assert that at today's price of this security the expected excess returns over the next period will be zero. Efficient markets theory implies that no unexploited profit opportunities will exist in securities market: at today's price, market participants cannot expect to earn higher than normal return (equilibrium expected return) by investing in that security.

Equation 3.8 is analogous to an arbitrage condition. Arbitrageurs who are willing to speculate may perceive unexploited profit opportunities and purchase or sell securities until the price is driven to the point where 3.8 holds approximately. Indeed, as pointed out by Grossman and Sliglitz (1976), if equation 3.8 held exactly, efficient markets theory would imply a paradox. If all information were fully reflected in a market according to 3.8, obtaining information would have zero return. Thus the market would not be able to reflect this information because it would be uncorrelated and hence unknown.

Several costs involved in speculating could drive a wedge between the left and right-hand sides of 3.8. Because the collection of information is not costless; arbitrageurs would have to be compensated for that cost and others incurred in their activities, as well as for the risk they bear.

Transaction and storage costs would also affect equation 3.8. Yet securities have the key feature of homogeneity, for they are merely paper claims to income on real assets. Transactions and holding costs should thus be negligible, while compensation to arbitrageurs and the cost of the information collection should be quite small relative to the total value of securities traded. Therefore, the efficient market theory of equation 3.8 is a close approximation to reality and could be extremely useful in macroeconomic analysis.

Equation 3.8 can be best expressed, in the following model (Levich, 1979):

$$Z_{i,t+1} = X_{i,t+1} - E(\tilde{X}_{i,t+1} | I_t) \quad (3.9)$$

Equation 3.9 is the same equation as equation 3.8 but with different notations, where:

$X_{i,t+1}$ = one period percentage return

I_t = the information set

\sim = denotes the equilibrium value

Z = the excess market return

If the market for asset i is efficient then the sequence $Z_{i,t}$ should be serially uncorrelated and orthogonal to the information set,

$$\text{(i.e. } E(Z_{j,t+1} | I_t) = 0 \text{)}$$

This example makes clear that the Efficient Market Hypothesis (EMH) is a joint hypothesis because:

1. It assumes that agents are rational in forming their expectations in period (t) because they do not make any systematic forecasting errors.
2. Agents also know the market equilibrium returns exactly. The joint hypothesis of the EMH has an important implication for any researcher. If someone finds that there is a rejection of the hypothesis he cannot discern if this is due to the irrationality of the agents or to the misspecification of the market equilibrium return.

With regard to the information set (in our notation I_t). Fama (1970) defines three types of efficiency each of which is based on a different notion of exactly what type of information is understood to be relevant in the phrase "all prices fully reflect all relevant information":

1. Weak-form efficiency

The weak-form of the EMH suggests that no investor can earn excess return by developing trading rules based on historical price or return information. In other words, the information of past prices or returns is not useful in achieving excess returns. This weak form of the EMH is popularly known as the "random walk" theory, and the models describing such efficiency in terms of the share's intrinsic value are known as the "fair game" models.

2. Semi-strong form efficiency

When the information set include publicly available information (i.e. information on money supplies, interest rates and income etc.), and it is not possible for any investor to earn excess returns, the market is said to be semi-strong efficient.

3. Strong-form efficiency

The strong form of the EMH suggests that no investor can earn any excess return whether using a trading rule based on either public or private information. If the stock market is strongly efficient even an insider would not be able to earn superior investment returns from his privileged position.

We would note here that semi-strong efficiency conforms more clearly with the concept of Rational Expectations since we assume that agents know the market equilibrium return and they also use publicly available information in determining the expectations of asset prices (Minford and Peel, 1983).

Where the previous discussion has a general applicability to asset prices, the following step will consider its implication to the foreign exchange market. So we should now apply the previous model to the forward market for foreign exchange.

The general model which can be used can be expressed as:

$$E(S_{t+1}|I_t) = f_{t+1} \quad (3.10)$$

which suggests that market participants set the forward exchange rate, for maturity in period t+1, equal to the rationally expected future spot rate for period t+1.

Where from the model:

E = the mathematical expectations operator.

I_t = the information set available to agents at time t.

We can denote $E(S_{t+1}|I_t)$ as S_{t+1}^e .

Assuming that market participants are risk neutral, and there are no profit opportunities for arbitrageurs, equation 3.10 will hold continuously (equation 3.10 is the condition of market equilibrium).

Now we add to equation 3.10 the hypothesis which says that agents are rational, then:

$$S_{t+1} = S_{t+1}^e + U_{t+1} \quad (3.11)$$

Where,

U_{t+1} = a white noise error term.

By combining 3.10 and 3.11 we obtain the market efficiency condition under assumptions.

$$S_{t+1} = f_t^{t+1} + U_{t+1} \quad (3.12)$$

Equation 3.12 simply means that the spot rate in period $t+1$ should be equal to a corresponding forward rate plus a random error.

As noted earlier, if we assume that agents are rational so that equation 3.11 continues to hold, but that they are risk averse, so in order to hold forward foreign exchange they have to receive a risk premium to compensate the uncertainty of what will be the future spot rate.

To incorporate the risk premium the model can be written as follows:

$$f_t^{t+1} = S_{t+1}^e + \lambda_t \quad (3.13)$$

λ_t is the risk premium

Following Frenkel (1981), it is assumed that the risk premium can be modelled in the following way:

$$\lambda_t = \alpha + \varepsilon_t \quad (3.14)$$

where,

α = the mean of the risk premium, and

ε_t = white noise error which assert that μ_t may vary randomly over time.

Instead of equation 3.10 we will use equation 3.13 to obtain:

$$S_{t+1} = -\alpha + f_t^{t+1} + U_{t+1} - \varepsilon_t \quad (3.15)$$

Frankel (1981) noted that the forward rate is a noisy predictor of the future exchange rate.

Equation 3.13 can be written in another way.

$$S_{t+1} = a + bf_{t+1} + Q_{t+1} \quad (3.16)$$

If the market for foreign exchange is efficient so that prices reflect all relevant available information, then the residual, Q_{t+1} , in equation 3.16 should contain no information and therefore should be serially uncorrelated (i.e. $E(Q_{t+1} | I_t) = 0$). Further, if the forward exchange rate is an unbiased forecast of the future spot exchange rate (as should be the case under the assumption of risk neutrality), then the constant term in equation 3.16 should not differ significantly from zero (i.e. $a=0$), and the slope coefficient should not differ significantly from unity (i.e. $b=1$).

If, however, market participants are risk averse the slope coefficient b is expected to be significantly negative and the error term to be serially correlated with b which leads to biased and inconsistent estimates of b and the error term to be non-white error (Frenkel, 1981).

The above implies that if we find that (a) is statistically significant and (b) differs from unity, where estimating equation 3.16 by OLS, we cannot conclude that the agents are irrational, the results may imply the existence of a risk premium such as defined earlier in equation 3.13.

Since the forward rate in time t includes all relevant information , thus it also contains the past information of previous forward rates f_{t-1}^t , f_{t-2}^{t-1} and so forth. This leads that if we add lagged forward rates to equation 3.16, for example, the equation's explanatory power should not be improved.

From the above discussion, we conclude that two major aspects has a great importance in the EMH. The first is the error orthogonality property, whereas the second is the existence of a risk premium.

As regard the error orthogonality property, the forecast error should be uncorrelated with the information set when agents are forming their expectations.

Following Hallwood and MacDonald (1986), this property can be tested by regressing the forecast error, $S_{t+1} - f_t^{t+1}$, on a suitable information set which may include last forecast errors or other publicly available information accessible to agents in period t , i.e.:

$$S_{t+1} - f_t^{t+1} = a + bI_t + \varepsilon_{t+1} \quad (3.17)$$

Where it is expected that both a and b should differ insignificantly from zero.

Concerning The existence of a risk premium, a great deal of literature has been published on this issue. First the issue of the joint hypothesis and no risk premium has created a lot of controversy among researchers. All of them have tried to explain the rejection of the unbiasedness hypothesis. The existence of the risk premium is one explanation to this common rejection. There are strong empirical and theoretical reasons for believing in the existence of a risk premium. For instance, Cornell (1977) has documented the existence of large differences in the average holding period returns on a variety of assets. Most financial economists view these differences as reflecting risk premiums, and one should therefore expect to find a risk premium in the forward foreign exchange market especially, when given the modern approach to exchange rate determination which argues that exchange rates are determined in asset markets (Hodrick and Srivastava, 1984).

We will be discussing the issue of risk premium in section 3 of this chapter, considerations are now given to the implication of cointegration to the EMH.

3-3-1 Efficient Markets Hypothesis and Cointegration

One important implication of cointegration is that prices in a speculative market cannot be cointegrated. This implication as demonstrated by Granger (1986) is twofold. First, it is argued that two spot prices cannot be cointegrated since all available information is used and no other opportunities can be exploited, thus given one spot price cannot help to forecast the other. Second, market efficiency implies that even if the spot and forward rates are random walks, they never drift apart so that they are cointegrated.

Before analysing these implications we note, however, that cointegration requires the same order of integrability between variables. The question is whether exchange rates (i.e. spot and forward rates) are $I(1)$. In other words, do they follow a random walk.

3.3.1.1 The Random Walk Hypothesis of Exchange Rates

The idea that asset prices are denominated by random walk components seem to have been formulated first by Samuelson (1965). In the context of exchange rate, like any other asset prices, many authors have argued that it follows a random walk. Mussa (1979), for example, states that: 'The natural logarithm of the spot exchange rate follows approximately a random walk'. Meese and Rogoff (1983), also extended the random walk hypothesis to foreign exchange rates and found that a simple random walk consistently outperformed in exchange rate models in out-of-sample predictive failure tests.

Using unit root tests, Meese and Singleton (1982), were unable to reject the null hypothesis of a random walk for a number of spot and forward rates in a analysis of weekly data. Indeed, the random walk behavior appears to be an important characteristic of exchange rates: see, for example, Mussa (1982), Goodhart (1987), Goodhart and Taylor (1987), Meese and Rogoff (1988) and Mills and Taylor (1989). Many other authors also discuss the conditions under which the exchange rate (real or nominal) follows a random walk. A set of sufficient conditions for the real exchange rate to follow a random walk, therefore begins with interest rate parity, the Fisher hypothesis, and unbiased forward exchange rates. These conditions are discussed in chapter 4. Empirical evidence suggests, however, that these conditions may not hold. Clearly this gives evidence of contradictory results: some evidence suggests that the exchange rate follows a random walk, whereas other evidence suggests the opposite. Hakkio (1986) stated that one explanation to this contradictory evidence is the low power of the tests that have been used. In fact, when using a Monte Carlo study of Four tests for a random walk to the exchange rates, he was unable to reject this hypothesis.

Using Dickey-Fuller testing procedure for unit roots, recent studies give evidence in favour of the random walk hypothesis. Taylor (1988), MacDonald and Taylor (1989), Hakkio and Rush (1989), found that spot exchange rates are I(1) series.

Although, the I(1) hypothesis is generally accepted for spot exchange rates, the non-stationarity hypothesis of forward exchange rates have not considered that much attention. Nevertheless, Baillie and Bollerslev (1989) and Hakkio and Rush (1989) found that forward rates, similar to spot rates, follow a random walk, i.e. I(1) series.

Accepting that the spot and forward rates are I(1) series, we next consider the implication of cointegration for market efficiency.

3.3.1.2 Implication of Cointegration for Spot Rates

Following a review of basic concepts and models, Granger (1986) draws six implications of cointegration, which relate that concept to short and long run forecasts, control, Granger causality, and speculative markets. In the latter implication, cointegration suggests that if two spot prices S^a_t , S^b_t are a pair of series from a jointly efficient market, speculative market, they would not be cointegrated. If they would, this follows that there exists an error-correction model for them, and one can be used to forecast the other even when taking into account lagged values of the forecasted rate. We know, however, that if the market is efficient, the price at any time should contain all available information. Thus, given past prices, no other information should be in use in predicting future prices. Clearly, there is a contradiction between the error -correcting models and the EMH.

This is the basis of our test. If the spot prices are efficient they could not be cointegrated.

The first attempt to test the above implication is by MacDonald, R. and Taylor, M.P. (1989). The implication was tested for ten (10) Dollar bilateral exchange rates over the period June 1973 -December 1985. They found n strong evidence of cointegration for any of the exchange rate series examined. The findings are consistent with the Efficient Markets hypothesis.

3.4. An Empirical Review of the EMH

The majority of the tests of the joint hypothesis have concentrated on econometrically estimating equation 3.16 which is :

$$S_{t+1} = a + b f_t^{t+1} + Q_{t+1}$$

Researchers have also used the equivalent representation of 3.16 in rates of change as shown in this equation

$$S_{t+1} - S_t = a + b(f^{t+1} - S)_t + U_{t+1}$$

The two equations have been tested by a large number of researchers. If the forward market is efficient, it is expected that a is statistically insignificant, b to differ insignificantly from unity, and the error term to be serially uncorrelated. Here some selected results of these tests in table (3.1).

From table 3.1, we can see that the results obtained by Levich (1978) when he used the OLS method to test equation 3.16 are supportive of the EMH. He found that the joint hypothesis cannot be rejected, and that the residuals fall within the conventional level except for West Germany. For the latter the DW statistic is 1.40, so it is very low, and the residuals appear to suffer from autocorrelation.

The OLS method, however, will have many disadvantages if the agents are risk averse. In this case, we would expect a and b to be insignificant, and Q_{t+1} to be serially correlated with f_t^{t+1} .

Taking the risk aversion into consideration, Frankel (1979) and Frenkel (1981) have used the instrumental variables method (IV).

Using the IV method, Frankel (1979) tested the efficiency of 6 currencies (The Italian Lira, the Swiss Franc and the Dutch Guilder are not reported in table 3.1. He found that only two of these currencies (The Pound Sterling and The Swiss Franc) are supportive to the EMH. The others estimated have constant terms that are significantly different from zero and slope coefficient that are significantly less than one. Frankel argues that one possible explanation to this rejection is that the forward market in that period (1973-1979) have not adapted

to the floating-rate system immediately. Agents may still have been learning some time after the beginning of generalised floating in March 1973. Furthermore, the oil crisis (1973) has its effects on the exchange rate markets. Frankel repeated again his tests to the EMH but from July 1974 to April 1978. Indeed, the results have been improved. For all the currencies, the rejection is only for the Italian Lira.

Frenkel (1981) has also used the IV method to estimate equation 3.9 using monthly data from June 1973 to July 1979. The beginning of the period was set to correspond with the new floating-exchange rate regime. As seen from table 3.1, the results show that the joint hypothesis, that the constant is zero and that the slope coefficient is unity cannot be rejected at the 95% level for the Dollar/Pound and the Dollar/DM exchange rates, and at the 99% level for the Dollar/Franc exchange rates. He also found that there is no evidence of first order autocorrelation.

We have noted earlier that all the tests have basically concentrated on estimating equation 3.16. When comparing this equation with equation 3.15, we find that Q_{t+1} , in fact, equals $U_{t+1} - \varepsilon_t$. Frenkel argued that in order to examine the possibility that the OLS estimates might be subject to the errors in variable bias, one needs to test the hypothesis that $cov(U_t, f_t^{t+1}) = 0$

This test was outlined by Hausman (1978). To perform this test equation 3.9 is tested by either OLS procedure and IV method. The test used is of the following form:

$$m = (\hat{b}_1 - \hat{b}_0) \left(\text{var } \hat{b}_1 - \hat{b}_0 \right)^{-1} (\hat{b}_1 - \hat{b}_0)$$

Where \hat{b}_1 is an estimate of b obtained by IV method, whereas \hat{b}_0 is the b estimate obtained by OLS. Var represents the variance-covariance matrix. m is distributed as X^2 with 2 degrees of freedom under the null hypothesis. The results of m -statistics are reported in table 3.1. For all the three exchange rates the m -statistics are well below the critical value of $X^2(2)$ at the 95 percent confidence level, which is 5.99.

Table 3.1 The Forward rate as an unbiased predictor to the spot rate

Authors	Exchange Rate	Time Period	a	b	DW	R ²	F	n	Estimation
Levich (1978)	1	March 1978- December 1977	0.017 [0.103]	0.980 [0.105]	1.51	0.81	87.6	-	OLS
	2		0.004 [0.004]	0.864 [0.171]	1.79	0.59	25.5	-	OLS
	3		0.001 [0.001]	0.997 [0.009]	1.40	0.79	204.69	-	OLS
Frenkel (1979)	1	January 1974- December 1977	0.015 [0.015]	0.980 [0.020]	-	-	-	-	IV
	2		0.237 [0.090]	0.843* [0.059]	-	-	-	-	IV
	3		-0.109* [0.052]	0.876* [0.057]	-	-	-	-	IV
Frenkel (1981)	1	June 1973- July 1979			1.74	0.95	1.86	2.01	IV
	2				2.24	0.78	4.83	2.26	IV
	3				2.10	0.93	0.51	0.91	IV
Baillie et al (1983)	1	June 1973- April (1980)			1.33	0.99	2.12	-	OLS
	2				1.85	0.99	4.57	-	OLS
	3				1.98	0.99	0.97	-	OLS
Edwards (1983)	1	June 1973- September (1979)			1.70	0.95	3.52	-	ZSURE
	2				2.14	0.74	7.67	-	ZSURE
	3				2.11	0.93	0.78	-	ZSURE
McDonald (1983)	1	1721-1979IV	0.048 [0.03]	0.943 [0.04]	1.58	0.88	1.25	-	ZSURE
	2		0.284* [0.11]	0.808* [0.07]	1.77	0.54	3.75	-	ZSURE
	3		0.101* [0.103]	0.871* [0.03]	2.04	0.88	6.95	-	ZSURE

Frenkel concluded, therefore that the use of the forward exchange rate as a proxy for expectations does not introduce a significant error in variables bias into the estimates and, thus the use of OLS seems appropriate.

Table 3.1 also includes the results obtained by Baillie, R.T, Lippen, RE. And McMahon, P c(1983), for the estimation was based on four weekly data for six currencies (Italy , Canada and Switzerland are not reported in table 3.1) . They have used the OLS procedure to test the joint hypothesis of $a=0$ and $b=1$. The hypothesis is tested by means of a conventional F –statistic. The null hypothesis can not be rejected. For West Germany and Switzerland, while it can be rejected at the 1 per cent, 5 per cent and 10 per cent levels for Canada, France and Italy respectively. For the UK Pound, F-statistic is not significant while there is substantial residual autocorrelation, implying rejection of the unbiasedness hypothesis.

As noted earlier in this chapter, besides equation (3.16), another equation was also tested using rates of exchange. For instance, Bilson (1981) tested the efficiency for 9 currencies using an estimating equation for the form :

$$\Delta S_t - X_{t-1} = B_0 + (B_1 - 1)X_{t-1} + U_t$$

his form has the advantage that the value of both the constant and the slope coefficient are Zero under the null hypothesis . From table 3.2 which gives the results of Bilson , we can see that on the one hand it not possible to reject the hypothesis that the constant and the slope coefficient are Zero in all but two of the cases studied , and this failure to reject is particularly strong in the case of the major currencies – Pound Sterling , the German Mark and the Swiss Franc. On the other hand, however, significance autocorrelation is indicated in three of the nine cases studied , and the hypothesis on the coefficient is rejected for the cases of Italy and Netherlands .

The results also show that in all the currencies except the pound Sterling, the estimated coefficients are close to 1 rather than Zero. This shows that the results are inconsistent with the EMH.

Going back to table 3.1, and as Frenkel (1981) reports that although there is no evidence of autocorrelation when estimating equation (3.16) to a single currency , it is possible however , to find correlations between the error term. (Q_{t+1}) for different exchange rates. In fact, it is possible to show that in a multi- currency world the error term (Q_{t+1}) for different exchange rates. This means that OLS estimates of equation (3.16) may not be the most efficient estimates. The correlation of the error term across the equation is due to the fact that all the currencies depend on the Dollar rate. In short, they are all bilateral dollar rates.

To account with such correlation across the exchange rates , Edwards (1983) and MacDonald (1983) have used Zellner's seemingly unrelated regressions procedure (SURE).

Table 3.2 OLS estimates of the equation $\Delta S_t - X_{t-1} = \beta_0 + (\beta_1 - 1) X_{t-1} + U_t$

Country	β_0	$\beta_1 - 1$	R2	SE	D.W	$F(2,71)$
Canada	-4.010 [2.05]	-1.804 [.92]	.050	14.17	2.06	2.35
UK	-1.928 [5.21]	-.327 [.99]	.222	30.52	1.57*	.20
Belgium	5.270 [3.86]	-.973 [.69]	.027	29.88	2.18	1.29
France	.407 [4.39]	-1.849* [.86]	.061	27.72	2.32	2.62
Germany	6.737 [6.29]	-1.208 [1.65]	.007	31.91	2.33	.37
Italy	7.428 [4.73]	-1.372 [.35]	.178	26.44	1.50**	8.04**
Netherlands	7.287 [3.61]	-2.741 [1.05]	.086	29.38	2.32	3.52**
Switzerland	11.32 [8.52]	-1.184 [1.38]	.010	40.11	1.99	.48
Japan	3.917 [4.03]	-1.665 [.86]	.049	32.50	1.57**	1.89

Standard errors are in parentheses beneath the coefficients. Asterisks indicate that the estimated coefficient is significantly different from zero at 5% significance level. The F -statistic tests to joint hypothesis: $\beta_0 = \beta_1 = 1$ The 5% critical value for the F with 2 and 71 degrees of freedom is 3.12. An asterisk indicates and calculated which exceeded this value. A dagger indicates that the estimated Durbin-Watson statistic (DW) falls below the lower bound for this statistic, thus indicating the presence of significant first-order autocorrelation in the residuals. The estimation period included 4 weekly observations from July 1974 to January 1980.

Table 3.3 Exchange rates market efficiency: single currency and multi-currency tests

Rate	Constant	f_t	R^2	F	DW
<i>(a) Single currency tests (OLS)</i>					
Pound\ Dollar	-0.030 [0.017]	0.961[0.024]	0.0950	3.52	1.701
French Franc/ Dollar	-0.457[0.170]	0.853[0.055]	0.758	7.67	2.093
DM/Dollar	0.026[0.027]	0.965[0.032]	0.923	0.78	1.938
Lira/ Dollar	0.301[0.137]	0.954[0.021]	0.965	4.56	1.960
<i>(b) Single currency tests (SURE)</i>					
Pound\ Dollar	-0.029[0.004]	0.964[0.020]	-	-	-
French Franc/ Dollar	-0.155[0.104]	0.951[0.034]	-	-	-
DM/Dollar	0.029[0.018]	0.961[0.021]	-	-	-
Lira/ Dollar	0.272[0.114]	0.958[0.017]	-	-	-

Edwards (1983) tested equation (3.16) for the three currencies plus the Italian Lira. Table 3.3 reports the results obtained using both OLS and SURE note that SURE results are also reported in table 3.1. As may be seen, when the multi-currency procedure (SURE) is used, the precision of the estimates improves significantly. The result shows that, when the OLS is used, the EMH is rejected for the franc /Dollar and Lira /Dollar rates.

MacDonald's (1983) SURE estimates indicate a rejection of the individual hypothesis of $a=0$ and $b=1$ for Germany and France.

3.4.1. Issues Raised by the Empirical Evidence

the conclusion which can be made following the major studies is that the problems which faced the EMH can be summarized as follows :

1. The existence of risk premium and the error orthogonality problem.
2. the empirical regularities
3. econometric problems and techniques.

3.4.1.1 The Risk Premium and the Error Orthogonality Problem

There is a general agreement over the rejection of the hypothesis for the exchange market efficiency. Researches, however, remain divided on which (if not both) of the individual hypothesis is responsible for this rejection . It has been difficult to

test for the presence of the risk premium .First , we note that there will be a risk premium when there is a rejection of the equality of expected future spot rates $E(S_{t+1})$ and forward rates (F_t).

$$E(S_{t+1}) - F_t = 0$$

which is simply the error orthogonality property discussed in equation (3.17) whenever the value of $S_{t+1} - F_t$ is predictably different from Zero, there is evidence of a risk premium market inefficiency or both . Which is the true answer of the rejection is a point of disagreement between researches. From basic financial theory , it is clear that assets that covary positively with the over all portfolio make a positive contribution to its overall variance and therefore bear a positive risk premium and vice-versa.

Since exchange as assets, if a currency's returns covary negatively with overall portfolio returns, a negative risk premium should be paid. Here, we expect that $S_{t+1} - F_t < 0$.

Going further into the notion of risk premium we now try to specify its theoretical determinants and see what would cause a currency's return to covary with its overall portfolio returns.

Following Boothe and Longworth (1986) 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 the 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 bond, determinate demands for the respective bond and real yield differentials are raised. This might be the justification of using an asset demand equation in empirical tests, leaving $S_{t+1} - F_t$ a noisy measure of the risk premium on the late side of equation. In the second type of modern 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 than it follows that their will be a

risk premium w , whenever changes in the exchange rates come from changes in the real exchange rate.

The empirical evidence have mainly concentrated on the first type of models. MacDonald (1986) found in the majority of the cases studied, that lagged spot rates and uncovered interest parity deviations significant. He also found that lagged intervention helped to explain deviations from uncovered interest parity in about half the cases considered, lending some support to the risk premium interpretation. These results would be evidence for the markets inefficiency interpretation in the absence of a link from these variables to risk premiums. These findings serve as a reminder that the two parts of the joint hypothesis are not necessarily mutually exclusive alternatives.

In his article, Frankel (1988) has shown that if economic agents are mean-variance optimisers, if the covariance of returns does not change over time, and if the coefficient of relative risk aversion is the range estimated by earlier studies, than empirically risk premiums would too small to account for rejection of the joint hypothesis of efficiency and no risk premium. In short, under Frankel's assumption the conclusion would be market inefficiency.

The empirical tests based on the second type of models are less common. This is because these kinds of models are difficult to estimate.

The conclusion which can be drawn from the tests on the existence of a risk premium, unfortunately are not very much. 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 existence. Despite its lack of empirical support the issue of risk premium will continue to be prominent in the EMH literature.

3.4.1.2 Empirical Regularities

Mussa (1979) held that: "The forward exchange rate is an unbiased predictor of the corresponding spot rate, is close to the best available predictor of the corresponding spot rate, but it is not a very good predictor of the corresponding future spot exchange rate". Boothe and Longworth (1986) argued that if Mussa

were to re-write his article he might well decide to replace 'forward exchange rates' with 'current spot exchange rates, since there is evidence now that the exchange rate behaves more like a random walk than a price set where the forward rate can be regarded as an unbiased predictor of the future change in the spot rate.

As Bilson (1981) has shown, the empirical regularities across countries is that the future change in the spot rate is negatively correlated with the forward premium rather than positively correlated as it will be in a speculatively efficient market. The regression that supports this argument is as follows:

$$S_{t+k} - S_t = a + b(f_t^k - S_t) + U_t$$

where S_t is the logarithm of the spot rate, f_t^k is the logarithm of the k-month forward rate and U_t is an error term. Table 3.4 shows that the b coefficient is negative rather than 1 for the $k=1$ month maturity. Not only b is negative for most countries at $k=1$, but it is also negative for most sub periods of two years or more.

As far as the Canadian Dollar is concerned, Longworth (1981) found the same above results in the period 1971-78, and then showed that it continued to hold whenever new data became available (Longworth and Boothe 1986). Table 3.5 confirms these results up-dated to end 1984 using end of month data.

3.4.1.3 Econometric Problems and Techniques

The econometric problems which have been raised from the empirical evidence can be summarized as follows:

- i- The autocorrelation of the error term
- ii- The problem of overlapping contracts, the heteroscedasticity and the cross correlation of the error terms (SURE).
- iii- The stability of the estimated equation.

These problems have arisen especially when testing for the speculative efficiency. Concerning the first problem, autocorrelation is a violation of speculative

efficiency because past information can be used to improve the forecasting of the forward rates.

Table 3.4 OLS estimates of the equation: $S_{t+1} - S_t = a + b(f_t - S_t)$

$S_{t+1} - S_t = a + b(f_t - S_t)$				
Currency	Period	a	B	SEE
Canadian Dollar	70M7- 81M12	0.0005 [0.0009]	-0.389*[0.555]	0.0107
French Franc	73M8- 81M12	-0.0066 [0.0038]	-1.8376 *[0.8756]	0.0323
Germany Mark	73M7- 81M12	0.0021 [0.0051]	-0.5333 [1.4169]	0.0333
Italian Lira	73M6- 81M12	0.0106 [0.0044]	-0.4786*[0.4716]	0.0289
Japanes Yen	73M6- 81M12	0.0008[0.0031]	0.4803 [0.4174]	0.0309
UK Pound	73M6- 81M12	-0.0060 [0.0037]	-1.5330 [0.8434]	0.0292

Standard error in parentheses

*Significantly different from 1 at $\alpha=0.05$

Table 3.5 OLS estimates of the equation (Canada): $S_t - S_{t-1} = a + b(f_{t-1} - S_{t-1})$

$S_t - S_{t-1} = a + b(f_{t-1} - S_{t-1})$				
Period	a	b	SEE	DW
70M7- 84M12	0.0017[1.82]	-0.644[1.15]	0.0120	2.20
71M8- 84M12	0.0020[2.02]	-0.740[1.29]	0.0122	2.22
70M7- 72M12	-0.0014[1.44]	-0.526[0.471]	0.0051	1.66
73M1- 74M12	0.0010 [0.537]	-1.02[0.722]	0.0072	1.97
75M1- 76M12	0.0037[0.607]	-1.31[0.581]	0.0166	2.34
77M1- 78M12	0.0063[2.05]	0.510[0.218]	0.0121	2.27
79M1- 80M12	-0.0004[0.138]	-2.55[1.44]	0.0150	2.21
81M1- 82M12	0.0054[0.946]	-2.47[0.904]	0.0163	2.59
83M1- 84M12	0.0034[2.05]	-1.09[0.996]	0.0179	2.44

The numbers in parentheses are *t*-statistic

As regard the second problem, the overlapping contracts, heteroscedastisity and cross correlation of error terms do not indicate a violation of speculative efficiency nor do they lead to biasedness of OLS estimates. But in this case, the coefficients are rather inefficient estimates.

As far as the overlapping contract are concerned, for example, if in testing equation 3.16 we use a forward exchange rate with a one month contract and weekly data we would expect a priori that the error term, Q_{t+1} would be serially correlated . This follows that error term will not be independent of past forecast errors when the number of observations are more frequent than the maturity length . Thus for example if f_t^{t+1} represents a one month period rate and we have weekly data then information that becomes available between week one and four will be correlated with information that becomes available between two and five. Thus when testing the EMH care must be taken in the choice of contract length and frequency of the data.

The third problem, as noted earlier, deals with the stability of the estimated equation. This problem is more difficult to analyse because it is concerned with idea of testing the exact definitions of null and alternatives hypothesis. The alternative hypothesis does not need to be a stable equation overtime, otherwise it can be exploited profitably for example, if the b coefficient is nearly always negative and a is always small this fact can be used to make profit.

After the theoretical issue of the EMH and the revue of its empirical evidence considerations will be given to the examination the efficiency of the forward exchange market by presenting a full analysis using cointegration methodology. This will be the main concern of the next chapter.

3.5 Concluding remarks

In this chapter we have examined all the aspects of the EMH theoretically and empirically. As have been demonstrated, the available evidence would seem to question the efficiency of the forward market for foreign exchange. Researchers have been testing a joint hypothesis that agents are rational and that they know the expected equilibrium return. So, when rejecting the EMH, one cannot discern

if this is due to the irrational information processing or rather it implies that there has been a general deal of information that has led to a divergence of the actual spot rate from the expected value set last period.

In short, and as proved by the empirical evidence, the rejection of the EMH may be due to other factors rather than the irrationality of the market participants. The risk premium plays a dominant role in rejecting the joint hypothesis. If a risk premium varies over time it may introduce autocorrelated disturbances into estimates of the EMH. A second possible explanation of this rejection is at government intervention changes. If the government set a new policy, for example, participants may not adapt immediately with the new regime, so they cannot use all available information that can also induce serially correlated error terms.

We may conclude that whether the foreign markets are efficient or not cannot be answered by a single "yes" or "no". Till now, the study of the EMH is confronted with many issues, such as the question of risk premium, which is still under consideration and must give a convincing answer. This is the subject matter of our thesis. Thus, using a new way of testing the EMH, i.e. using cointegration would improve the quality of the results. The next chapter will shed light on some ambiguous issues of foreign market efficiency.

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CHAPTER 4

The implications of cointegration for the Efficient Markets hypothesis: Analysis and Discussions of the results

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The implications of cointegration for the Efficient

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4.0. Abstract

This chapter deals with the implications of cointegration for the Efficient Markets hypothesis. Although many tests have been used in the literature to test the validity of the EMH, we will be using the cointegration methodology and giving a new way of testing different aspects of market efficiency for exchange rates. Considerations are first given to a background that summarises the previous tests of the EMH and some other issues that have been raised analysis and discussions of the results.

4.1 Introduction

The advent of flexible exchange rates in 1973 has led to a great amount of empirical research concerning the relation between the spot and forward exchange rates. The important issue here is whether or not the foreign exchange market can be regarded as an efficient market. In an efficient market, prices fully reflect all available information and it should not be possible for a market operator to make abnormal profits. Assuming rational expectations and risk neutrality on the part of the agents in the foreign exchange market, it can be shown that the forward rate is an unbiased predictor of the future spot rate. The Efficient Market Hypothesis (EMH) is very important for the construction of macroeconomic models and for testing monetarist theories concerning the asset approach to the exchange rate.

Our researches will assess the implications of the EMH to the foreign exchange rate. Although many tests have been used in the literature to test the validity of the EMH, we will be using the recently developed cointegration methodology and giving a new way of testing different aspects of market efficiency for exchange rates. Considerations are first given to a background that summarises the previous tests of the EMH and some other issues that have been raised.

4.2 Research background

The majority of the Efficient Market Hypothesis have concentrated on econometrically estimating an equation of the following form:

$$\ln S_t = a + b \ln F_{t-1} + U_t \quad (4.1)$$

If the forward market is efficient, it is expected that (a) will be statistically significant, (b) will differ significantly from unity, and the error term to be serially uncorrelated.

For instance, using the OLS (Ordinary Least Square) to estimate this equation, Levich (1979) found that the joint hypothesis cannot be rejected and

the residuals fall within the conventional level for the United Kingdom and France. Using the Instrumental Variables (IV) method to account for the risk aversion, Frankel (1979) tested the efficiency of six currencies. He found that, except in two of these currencies (UK pound and Swiss Franc), the hypothesis cannot be rejected. Frenkel (1981) has also used the IV method to test the efficiency of France, UK, and West Germany. He concluded that the joint hypothesis cannot be rejected.

Although the above equation has proved to be the most popular way of testing the EMH for the foreign exchange market, researchers have argued that the stochastic process generating S_t and F_{t-1} in the above equation may be non-stationary and therefore forward market efficiency should be tested using rates of change (see, e.g. Hansen and Hodrick (1980), and Meese and Rogoff (1984)). Thus, we regress the rate of depreciation of the spot rate on the forward premium as follows:

$$S_t - S_{t-1} = a + b (f_t - s_{t-1}) + U_t \quad (4.2)$$

where again, it is expected that $(a) = 0$, $(b) = 1$ and U_t to be a white noise process and orthogonal to the information set. This equation is illustrated in figure (4-1) for the DEM/USD (German Mark and the US Dollar) exchange rates over the period 80M1 to 96M6.

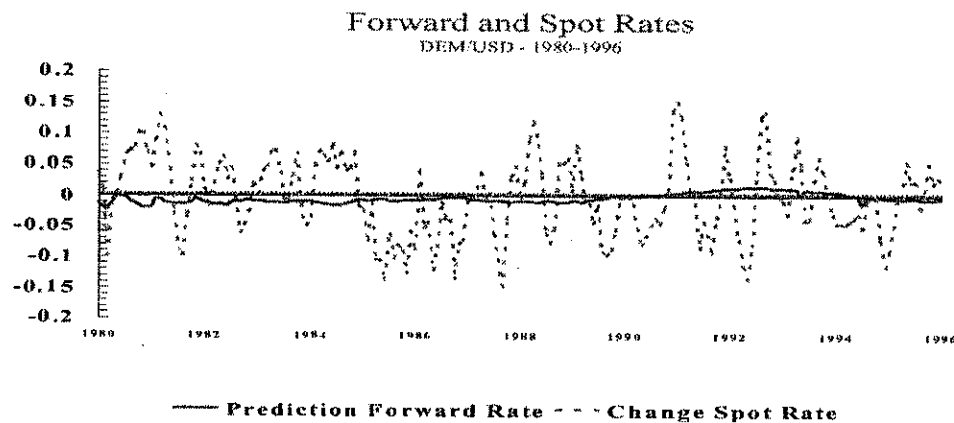


Figure 4.1 Spot rate depreciation and the forward premium

Bilson (1981) reports estimates of equation (4-2) for a selection of nine currencies . He rejects the unbiasedness proposition for only two of these currencies. The result indicates also significant autocorrelation in three cases. Furthermore, the results show that the slope coefficients are close to -1 rather than 1.

Our research however will use a different method for testing the efficiency of the foreign exchange market. In fact, the proposed test is based on recently developed cointegration methodology (Granger (1986), Granger and Engle (1985, 1993, 1999) and Engle and Granger (1987)). The main implications of cointegration for market efficiency is that two spot prices in an efficient market cannot be cointegrated, and secondly the spot and forward rates of an exchange rate are cointegrated since they move closely together in the long run.

4.2.1 Implication of cointegration for spot prices

Following a review of basic concepts and models, Granger (1986) draws six implications of cointegration, which relate that concept to short, and long run forecasts, control, Granger causality, and speculative markets. In the latter implication, cointegration suggests that if two spot prices S^a_t , S^b_t are a pair of series from a jointly efficient market, speculative market, they would not be cointegrated. If they would, this follows that there exists an error-correction model for them, and one can be used to forecast the other even when taking into account lagged values of the forecasted rate. We know, however, that if the market is efficient, the price at any time should contain all available information. Thus, given past prices, no other information should be in use in predicting future prices. Clearly , there is a contradiction between the error -correcting models and the EMH.

This is the basis of our test. If the spot prices are efficient they could not be cointegrated.

The first attempt to test the above implication is by MacDonald and Taylor (1989). The implication was tested for ten (10) Dollar bilateral exchange rates over the period June 1973 -December 1985. They found n strong evidence of cointegration for any of the exchange rate series examined. The findings are consistent with the Efficient Markets hypothesis.

4.2.2 Implication of cointegration for the spot-forward relationship

Every major newspaper, such as the Wall Street Journal or the Financial Times, prints everyday a list of exchange rates. For major currencies, two different prices are quoted. One is the « spot price ». The other is the « forward price ». The spot exchange rate is the domestic currency price of a unit of foreign exchange for immediate delivery (two working days in the interbank market) . The forward rate for each currency is the price one have to pay when you sign a contract today to buy that currency on a specific future date (30, 90 , or 180 days forward).

Following the asset approach to the exchange rate, one important implication of this is that expectations about future exchange rate will be important in the determination of the current exchange rate. Since money is durable, expectations will affect the future exchange rate. Therefore, if agents are revise their expected future spot rate then the current spot rate must change by a similar amount , otherwise there will be large unexploited expected returns.

The simple monetary approach provides an explanation to the close correlation between actual and expected spot exchange rates. First, and assuming perfect capital mobility, but that arbitrageurs are risk neutral so that they do not use the forward market for cover, there exists the *uncovered interest parity* which must hold at any moment in time. Arbitrageurs use the expected spot rate in place of the forward rate of the currency. The *uncovered interest parity* implies that:

$$S^e = (i - i^*) \quad (4.3)$$

where S^e is the expected change in the spot rate.

Following the flex-price monetary approach reduced form, the exchange rate equation is :

$$S = m - \alpha_1 y + \alpha_2 i \quad (4.4)$$

Where an x percent increase in the domestic money supply leads to an x percent in S (exchange rate depreciation). Whereas an increase in income leads to an exchange rate appreciation, and an increase in the rate of interest appreciation leads to an exchange rate depreciation.

If we substitute the uncovered interest parity to the flex-price monetary approach to the exchange rate (FMAER) reduced form, and by normalising the foreign interest rate to have a value of zero, we obtain :

$$S = m - \alpha_1 y + \alpha_2 S^e \quad (4.5)$$

Or, dating variables,

$$S = m - \alpha_1 y + \alpha_2 [S_{t+1}^e - S_t] \quad (4.6)$$

assuming rational expectations, agents will know the path of the exchange rate and thus :

$$S_{t+1}^e = E_t S_{t+1}$$

Thus the FMAER reduced form can be rewritten in the following way :

$$S_t = \frac{1}{1 + \alpha_2} [m_t + \alpha_1 y_t + E_t S_{t+1}] \quad (4.7)$$

Using equation (4.7), we can find the expected value of the exchange rate in any future period $t+j$. the importance of this is that the factors that determine the exchange rate are what agents expect the money supply and income to be in the future. Thus the equation (4.7) will be:

$$E_t S_{t+j} = \frac{1}{1+\alpha_2} \left[E_t (m - \alpha_1 y)_{t+j} + \alpha_2 E_t S_{t+j+1} \right] \quad (4.8)$$

From the above discussion, the FMAER reduced form can be used to show the close correlation between the actual spot rate and the expected future spot rate as in equation (4.8). Where if α_2 , was large the actual and the expected exchange rate would have a correlation coefficient of close to unity.

As mentioned earlier the concept of the forward rate is synonymous with the market's expected future spot rate. It follows that the spot and forward rate should be closely tied together. The relationship spot –forward is illustrated in figures (4.2) for the German Mark and the US Dollar exchange rate, over the period January 1980 to June 1996. The correlation coefficient being 0.987.

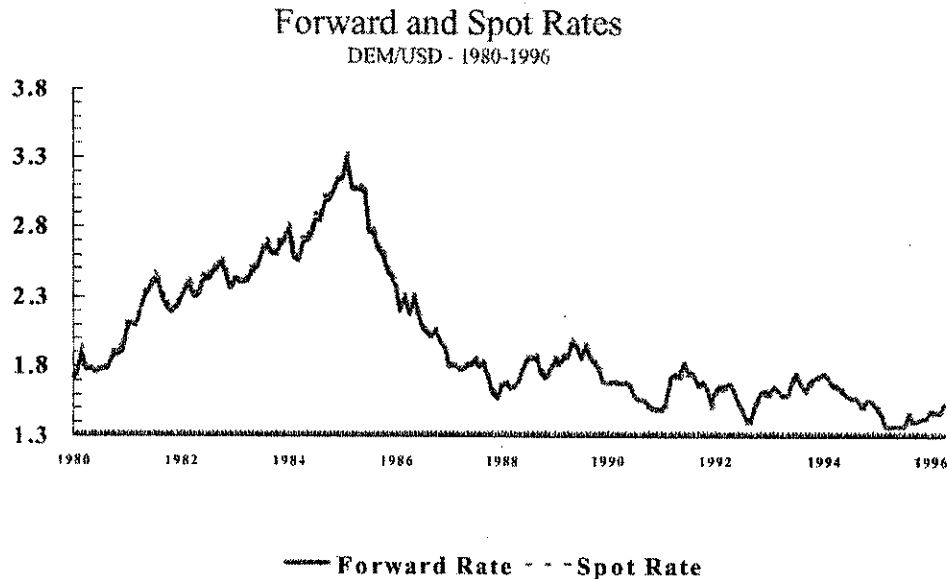


Figure 4.2 The spot –forward rates relationship

We conclude that the forward rate can be used to predict the actual spot rate since they move closely together. This is the main idea of efficiency. Moreover, following Engle and Granger (1987), if some individual time series move closely together in the long-run, it follows that they should be cointegrated.

Engle and Granger (1987) point out that "An individual variable, viewed as a time series, can wander extensively and yet some pairs of series may be expected to move so that they do not drift too far apart". Clearly, the spot and forward rate correspond well with the kind of series that do not drift too far apart. In fact, they are always tied together. It follows that, $S_t - bF_{t-1} = U_t$ is stationary (i.e. S_t and F_{t-1} are cointegrated).

Comparing the tests that have been used for market efficiency with the recent technique of cointegration, some useful points can be drawn. First, the EMH suggests that the slope coefficient in (4.1) should equal 1, for the forward rate to be an unbiased predictor, whereas, in cointegration it is not necessary for the cointegration vector to be 1. On the other hand, the EMH seeks the error term U_t (like in equation 4.1) to be white noise, whereas cointegration suggests that U_t should be stationary.

4.2.3 Error-Correction and the Spot -forward Relationship

If the spot and forward rates are cointegrated, it has been proved in Granger (1983,1986) and Engle and Granger (1987) that there always exists a generating mechanism having what is called "error-correcting form":

$$\Delta S_t = -\rho_1 U_{t-1} + \text{lagged } (\Delta S_t, \Delta F_{t-1}) + d(B) \varepsilon_{1t} \quad (4.9)$$

$$\Delta F_{t-1} = -\rho_2 U_{t-1} + \text{lagged } (\Delta S_t, \Delta F_{t-1}) + d(B) \varepsilon_{2t}$$

Where,

$$U_t = S_t - b F_{t-1}$$

$d(B)$ is a finite polynomial in the lag operator B that ($B^k S_t = S_{t-k}$), and $\varepsilon_{1t}, \varepsilon_{2t}$ are joint white noise, and with $|\rho_1| + |\rho_2| \neq 0$

The models were introduced into economics by Sargan (1964) and Phillips (1957) and has generated a lot of interest following the work of

Davidson , Hendry, Srba and Yes (1978) Hendry and Von Ungern Sternberg (1980) , Currie (1981) and Salmon (1982) .

We will draw here the interpretation of Davidson Hendry et al.(1978) to the error correcting models , and I will use it for the spot and forward rates .Thus the differenced variable equivalent of equation (4.1) which is :

$$S_t = a + b F_{t-1} \quad \text{will be}$$

$$\Delta_1 S_t = \Delta_1 F_{t-1} \quad (4.10)$$

However, to assume that (4.10) has a white noise error term would deny the existence of any “long – run relationship” like in (4.1) , and to assume that the error term in (4.1) is I (0) would cause a negatively autocorrelated error to occur in (4.10) .

In the absence of a well –articulated theory of the dynamic adjustment of S_t to F_{t-1} , it is reasonable to use the general rational lag model of the form:

$$\alpha(L)S_t = a + \beta(L)F_{t-1} + V_t \quad (4.11)$$

$\alpha(L)$ and $\beta(L)$ are polynomials in the lag operator of high order to assure the error term to be white noise . The first order polynomial is:

$$S_t = a + \beta_1 F_{t-1} - \beta_2 F_{t-2} + \alpha_1 S_{t-1} + V_t \quad (4.12)$$

Equations (4.1) and (4.10) are the special cases of (4.12). The equation (4.1) is the case where $\alpha_1 = \beta_2 = 0$, $\beta_1 = 1$, whereas equation (4.10) suggests that $\beta_1 = \beta_2 = 1$, $a = 0$, $\alpha_1 = 1$. The constraints ensure the long-run behaviour of the spot-forward rates at any time. Therefore, to be sure that this is true for all estimated parameters we need to impose some coefficient restrictions such as:

$\beta_1 + \beta_2 + \alpha_1 = 1$ or $\beta_1 = -\beta_2 + \gamma$ and $\alpha_1 = 1 - \gamma$, which yield the following equation:

$$\Delta_1 S_t = a + \beta_1 \Delta F_{t-1} - \gamma(F_{t-2} - S_{t-1}) + V_t \quad (4.13)$$

The importance of the final form of equation (4.13) is crucial ; if the rate of depreciation is relatively constant , then S_t and bF_{t-1} will be approximately equal in (4.1), and $(S_{t-1} - F_{t-2} \cong a)$.

In this condition the intercept a and $(S_{t-1} - F_{t-2})$ would be almost perfectly collinear in (4.13). Davidson .Hendry et .al (1978) argued, when using the same error correcting form as in (4.13), that if we drop either regressor in this equation, it will not loose the goodness of fit. However, if we set $a= 0$, the long run behaviour will not be affected, whereas setting $\gamma = 0$ does affect the long-run behaviour.

We conclude that the error-correcting form of the spot-forward relationship could be rewritten as follows:

$$\Delta S_t = \beta_1(F_{t-1} - F_{t-2}) + \beta_2(F_{t-2} - S_{t-1}) + \varepsilon_t \quad (4.14)$$

Looking to equations (4.2) and (4.10), we can say that (4.2) is the same as in equation (4.14) with the rate of change of forward rate omitted , whereas (4.10) omits the cointegration regression $(S_t - bF_{t-1})$.

Equation (4.2) regress the rate of exchange of the spot rate on the forward premium $(F_t - S_t)$. Combining (4.2) and (4.10) in (4.14), the restrictions $(\beta_1 = \beta_2 = 1)$ are imposed. The EMH, also suggests that $b=1$.

Although equation (4.14) is different from (4.1) and (4.2), it has got the same implication for the EMH, since it is a joint hypothesis that suggests the rationality and risk neutrality of the agents. We will use equation (4.14) to test the EMH, and see whether to accept or reject this hypothesis.

4.3 Research Methodology

4.3.1 Hypotheses

Summing up what have been said in section (4-1), many hypotheses are raised when using cointegration techniques for testing the efficiency of the foreign exchange market.

Before proceeding to an analysis of the cointegration in any series, we must determine the order of integration of the individual series. For a pair of variables to be cointegrated, a necessary (but no sufficient) is that they be integrated of the same order.

The main hypotheses to be tested in this research are as follows:

i)- Are S_t and F_{t-1} $I(1)$ series?, if they are, cointegration suggests that the combination

$$S_t - bF_{t-1} = U_t \text{ is } I(0).$$

ii)- The EMH implies that the spot prices cannot be cointegrated.

$$H_0 : S_t^a, S_t^b \text{ are not cointegrated.}$$

iii)- As seen from section (4-1) the spot and forward rates move always closely together. Thus if determined in a efficient market, it follows that two forward prices cannot be cointegrated.

$$H_0: F_t^a, F_t^b \text{ are not cointegrated,}$$

iv)- S_t and F_{t-1} are cointegrated

$$S_t - bF_{t-1} = U_t \text{ is stationary}$$

$$H_0: U_t \sim I(0)$$

v)- $b=1$ in $[S_t - bF_{t-1} = U_t]$, Since the market is efficient we expect the cointegrating vector to be 1.

vi)- There exist an error-correcting model for the cointegrating regression, which is (4.14)

$$\Delta S_t = \alpha_0 + \beta_1 [F_{t-2} - S_{t-1}] + \beta_2 [F_{t-1} - F_{t-2}] + \text{lagged}[\Delta F_{t-1}, \Delta U_{t-1}] + \varepsilon_t$$

We can see that $\beta_1 [F_{t-2} - S_{t-1}] = -U_{t-1}$ and it is the same as in equation (4.9), b being 1 in hypothesis (v).

$$H_0 : \beta_1 = \beta_2 = 1, \text{ Lags} = 0, \text{ and } \varepsilon_t \text{ is a white noise error.}$$

4.3.2 Definition of the variables

The research concentrates mainly on the relationship in (4.1), which states that the forward rate is an unbiased predictor to the spot rate. From this equation (i.e. 4.1) only two variables are needed:

- 1- S_t = the spot exchange rate
- 2- F_{t-1} = the forward exchange rate (lagged one period).

Notice that in the previous discussion, we have been using the logarithm of the spot and forward rates rather than the levels. The usefulness of using logarithmic transformations in efficiency tests has been demonstrated by Siegel (1972). Thus, if we try to conduct the EMH using levels in equation (4.1), two possible answers would be obtained. The answer depends on whether we use the home currency value of a unit of foreign currency or the foreign currency value to a unit of currency definitions for an exchange rate. This follows because the expectation of a variable and its inverse is not the same $(E(S_t | I) \neq E(1/S_t | I))$. Hallwood & MacDonald R (1986).

The study is conducted into seven countries: United Kingdom, Germany, Belgium, Canada, Switzerland and the Netherlands. The spot rate of each

country is versus the US Dollar (End of Month), whereas the forward rate is a one month forward for each country.

4.3.3 Stages of Analysis

A number of procedures have been suggested in the literature for testing whether a set of variables is cointegrated. Engle and Granger (1987) provide a detailed review and comparison of the major procedures.

Before proceeding to test the set of variables for cointegration, it is sensible to establish the properties of the individual time series. Much of the theory of Cointegration has been developed for the case where all the series are $I(1)$. So, we must determine the order of integration of each exchange rate series. This is the basis of the first stage of the analysis. Then, we go further and test for cointegration, which is the second stage. After that, and if the series in question are cointegrated the third stage is concerned with testing the joint hypothesis of the EMH in the error correcting models.

i)- Testing for Unit Roots

To test if the series in question have unit roots, we use a test based on the work of Fuller (1976) and Dickey & Fuller (1979,1981). So, to check the validity of the first hypothesis, which is $S_t \sim I(1)$, we estimate the following equation by OLS.

$$\Delta S_t = \alpha_0 + \alpha_1 S_{t-1} + U_t \quad (4.15)$$

The test which has been used by Dickey-Fuller(1981) is the ratio of α_1 to its calculated standard error that is obtained from the regression. The null hypothesis is that:

$$H_0 : S_t \sim I(1),$$

This is rejected if α_1 is negative and significantly different from zero. The Dickey-Fuller test does not have a t-distribution but tables of significance have been provided to test this hypothesis (Dickey-Fuller 1979).

The other test is similar to the DF test in (4.15) but modified to:

$$\Delta S_t = \alpha_0 + \alpha_1 S_{t-1} \sum_{i=1}^p b \Delta S_{t-i} + U_t \quad (4.16)$$

Where p is selected large enough to ensure that their residual U_t is an empirical white noise. This test is called the Augmented Dickey-Fuller (ADF) test. And again it is the ratio of α_1 to its calculated standard error in equation (4.16). If the error term is white noise without addition of any auxiliary lagged variables, the DF is the appropriate test, whereas if it is needed to add lags in (4.15) to achieve the residual whiteness then the ADF test is more appropriate.

Nachrane *et al* (1988), argued that the application of DF and ADF tests is complicated by the fact that when lags are present in the relationship, equation (4.15) is inappropriate, and when lags are absent equation (4.16) is over-parameterised. Another difficulty is that critical values given by Engel and Granger (1987) are available only for $p=1$, and $p=4$.

Our objective is to test whether the series are $I(1)$, and which is the appropriate test? The complication here is that when using the DF test for testing the $I(1)$ hypothesis, we will reject the random walk behaviour of the exchange rate. Conversely, the ADF test discerns that the hypothesis of the random walk is rejected. The latter, contradicts Mussa's findings (1979).

For instance, Taylor (1988) tested the $I(1)$ hypothesis for five currencies during the period June 1973 to December 1985. He found that only in two of the series, we need to add lags in the regression to achieve the whiteness of the residuals. Taylor and MacDonald (1989) tested the same hypothesis over the same period using ten currencies (they found that only in one of these series that we do not need to add lags). They concluded that the exchange rates do not follow a simple random walk.

ii)-Testing for cointegration

If we cannot reject the null hypothesis that both the spot and forward rates are $I(1)$, we can go on to test for cointegration, and see if U_t (the residual from the cointegration regression) appear to be $I(0)$. In this stage and according to the hypothesis made, three tests are to be conducted. The first is the non-cointegration hypothesis of the spot rates, the second is analogous to the first, and it is the non-cointegration hypothesis of the forward rates, whereas the third test consists of the spot and forward exchange rates.

Because of the different properties of the tests proposed by Engel and Granger (1987), we will be using all of them. They propose seven test statistics that are calculated by Ordinary Least Squares. A brief description of each test is useful.

1- Cointegration Regression Durbin Watson (CRDW) Test.

The test statistic is the DW-statistic of the cointegration regression. The DW is tested to see if the residuals appear to be stationary. If they are non-stationary, the DW will approach Zero, thus accepting the hypothesis of non-cointegration in the case of spot prices and also in forward prices. Critical values of CRDW have been furnished by Engel and Granger (1987), who also note some limitations on this test. However, since the simplicity of its computation, it can be used as a quick approximate result.

2 - Dickey-Fuller (DF) test.

This is based on the test for unit roots as initially formulated by Fuller (1976), and then extended by Dickey and Fuller (1979, 1981). Let U_t denote the residuals from the cointegration regression, U_{t-1} their first differences, and consider

$$\Delta U_t = \phi U_{t-1} + \varepsilon_t \quad (4.17)$$

6- Unrestricted Vector Autoregression (UVAR) test

The UVAR test is based on a vector autoregression in the levels which is not restricted to satisfy the cointegration constraints. It determines if S_t , F_{t-1} satisfy a Vector Autoregression (VAR) in the levels by estimating:

$$\begin{aligned}\Delta S_t &= \beta_1 S_{t-1} + \beta_2 F_{t-2} + c_1 + \varepsilon_{1t} \\ \Delta F_{t-1} &= \beta_3 S_{t-1} + \beta_4 F_{t-2} + c_2 + \varepsilon_{2t}\end{aligned}\quad (4.20)$$

The test consists on looking for the significance of the β 's. The UVAR test $= 2(F_1 + F_2)$, where F_1 is the F -statistic for testing β_1 and β_2 both equal zero in the first equation, and F_2 is the comparable statistic in the second equation.

7 - Augmented Unrestricted Vector Autoregression (AUVAR) test

This test proceeds essentially as the UVAR test but with equation (4.20) modified to a higher order system. Equation (4.20) will include p lags of ΔS_t , ΔF_{t-1} in each equation.

iii)- Testing the validity of the Error Correcting Forms

The cointegration of S_t and F_{t-1} implies that there is an error correction representation for them such as in equation (4.14). Thus, the third stage of the analysis is to test the significance and the validity of these models in the foreign exchange market. This stage should be articulated as follows:

a) First, we estimate equation (4.14) by OLS, then we test the joint hypothesis of $\beta_1 = \beta_2 = 1$. It is the joint hypothesis of rational behaviour and risk neutrality of the agents. The test we will be using is the F -statistic of both β_1 and β_2 are unity and that the lags = 0. So the steps in this test are:

- Impose the restrictions $\beta_1 = \beta_2 = 1$ to obtain the restricted form and calculate the residual sum of squares. This is called the restricted Sum of squares (RSS_R).

$$RSS_R = \sum_{t=1}^n (\Delta S_t - \Delta F_{t-1} - (F_{t-2} - S_{t-1}))^2 = \sum_{t=1}^n (S_t - F_{t-1})^2 = \sum_{t=1}^n e_t^2$$

Then, we estimate the original equation (4.14) which is unrestricted, and calculate the residual sum of squares RSS_u

- Finally, we calculate the ratio

$$F = \frac{(RSS_R - RSS_U)d}{RSS_U/(n-k)}$$

This ratio, will our test statistic.

b) Carry out LM tests for serial correlation.

The aim of these tests is to test whether the residuals from equation (4.14) are serially correlated. Since we have been using monthly data in our analysis. The LM test will be conducted up to twelve-order correlation.

c) Carry out autoregressive conditional heteroscedasticity tests (ARCH), to examine this hypothesis in the residuals in equation (4.14).

d) carry out structural stability tests. We use here the CUSUM and CUSUMSQ tests. These tests were proposed by Brown *et.al* (1975). The first one is particularly useful for detecting changes in the systematic regression coefficients, whereas the second is useful in situations where the departure from constancy of the regression coefficients is haphazard and sudden.

4.4 Database

Our analysis is based on monthly data of the exchange rates of the following currencies: The British Pound, the French Franc, the German Mark, the Belgium Franc, the Canadian Dollar, the Swiss Franc and the Dutch Guilder. These are all US Dollar bilateral exchange rates. The exchange rates are the spot and forward rates of each country. The spot rates are all end of month observations, whereas the forward rates are 30 days forward. This data covers the period from January 1985 to June 1994. The Data source is DATASTREAM (IMF) tape. As can be seen from the chosen period, there are 114 observations, so that the critical values reported in Fuller (1976), and Engle & Granger (1987) are appropriate.

4.5 Analysis of the Results

Before proceeding to an analysis of the results, we first show how the tests are conducted. For instance, the cointegration regression of the UK and France spot rates is examined in the following form:

$$S_t^a = x + AS_t^b + U_t \quad (4.21)a$$

but the problem is that we cannot define which variable is S_t^a and which is S_t^b . We take them simultaneously, once with the UK spot rate as S_t^a , and the second with France spot rate as S_t^a . The other spot exchange rates are examined following the same concept. Furthermore the cointegrating regression for the forward rates is taken in the manner as the above explanation.

As far as the spot-forward relationship is concerned, we first regress the spot rate on the forward rate, and then we permute the regression to consider regressing the forward rate on the spot rate.

4.5.5 On the Unit Roots for Spot and Forward rates:

As discussed earlier, we start by examining, for each exchange rate, whether the logarithm of the spot as well as the forward exchange rates are individually $I(1)$. This hypothesis will be tested by the DF and ADF tests. As shown before, these are both t-tests and rely on whether rejecting or accepting the hypothesis in question follow a random walk in favour of stationarity; this requires a significant test statistic.

Table (4.1) reports the DF and ADF test statistics for the spot rates. For all the seven exchange rates, we are unable to reject the hypothesis that the logarithm of the spot exchange rate is an $I(1)$ series. In fact, both DF and ADF tests yield negative and significant test statistics. Moreover, the Chi-squared test statistic shows that the residuals do not suffer from autocorrelation at the twelfth-order, and it was not necessary to add lagged first differences into the auxiliary regression in order to achieve the residual whiteness and stationarity. Thus the DF test was the appropriate one, and we cannot reject the hypothesis that spot exchange rates follow a pure random walk, thus confirming Mussa's findings (Mussa, 1979).

Table (4.2) reports the results for the $I(1)$ hypothesis of the forward exchange rates. The tests are the same used in table (4.1). Again we are unable to reject the hypothesis of first order integrability. It was also unnecessary to add lags in the regression. The results are confirmed by using Chi-sq(12) as shown in table (4.2). We concluded that the DF is the appropriate test for both spot and forward rates.

4.5.2 Non cointegration of spot rates

After the satisfaction that all the spot rates are $I(1)$ series, we then proceed with the following cointegration regression:

$$S_t^a = x + \alpha S_t^b + \varepsilon_t \quad (4.21)b$$

and we test if the residuals ε_t appears to be $I(0)$. Granger (1986) noted that when S_t^a and S_t^b are cointegrated, OLS should give a true estimate of the cointegrating parameter A , as in equation (4.21)a, in large samples. We note that ε_t will have a finite (small) variance only if $\alpha=A$, otherwise ε_t will be $I(1)$. Thus it will have theoretically a very large variance in a large sample.

We have used the tests outlined earlier: namely the CRDW from the cointegrating regression, DF, ADF, RVAR, ARVAR, UVAR, and AUVAR of the residuals.

Engle and Granger (1987) noted that we cannot use the critical values provided by Fuller (1976), to test for Unit Roots in the cointegrating residuals. The reason is that only when the series are cointegrated can α be simply estimated by the "cointegrating regression", but a test must be based upon distribution when the null is true. OLS seeks the α which minimises the residual variance and therefore will reject the null hypothesis of $I(1)$ residuals rather more often than suggested by the nominal test size. For this, the critical values must be raised to correct bias. Indeed, the critical values we are using are those from Engle and Granger (1987) and are based on Monte Carlo simulations with 100 observations.

The results of the null hypothesis that all the seven spot exchange rates are not cointegrated, are reported in the following tables:

Table (4.3) gives the CRDW tests. Table (4.4)a and (4.4)b give the DF and ADF tests. Tables (4.5)a and (4.5)b give the RVAR and ARVAR tests. UVAR and AUVAR tests are given in tables (4.6)a and (4.6)b respectively.

Table (4.3) shows that the null hypothesis cannot be rejected even at the 10% level. The CRDW test for all the exchange rates is well below the critical values. Although the CRDW test has a better performance overall, Engle and Granger (1987) notes that this test is not the commended choice because its critical values are so sensitive to the particular parameter within the null. For

most economic data, the differences are not white noise, and one is confused which critical value to use. Engle and Granger add that the ADF test has a good observed power properties in most comparisons, and is therefore the recommended approach. But, as mentioned earlier, the simplicity of the CRDW and its computation makes the test a quick approximate result.

The results show that none of the exchange rates is cointegrated even at the 10% level of significance. The results are supportive and in favour of the Efficient Market Hypothesis (EMH), thus confirming the implication outlined by Granger (1986) which states that prices determined in a speculative efficient market cannot be cointegrated.

In fact, the remaining tests: namely the RVAR, ARVAR, UVAR and AUVAR confirm (with some minor exceptions, as seen from tables (4.5)a, (4.5)b, (4.6)a and (4.6)b) that in all exchange rates, the hypothesis of non-cointegration cannot be rejected at any level. This is consistent with the EMH.

4.5.3 Non – cointegration of forward rates

This test is analogous to the analysis of the spot exchange rates. The results show, indeed, that none of the forward rates is cointegrated, which is consistent with the EMH. Tables of the seven test statistics used in this context are reported in Appendix(4.1) at the end of this chapter..

4.5.4 The Cointegration of the Spot and Forward rates

We, now, turn to test the cointegration hypothesis for the spot and forward rates within the same country. We will test equation (4.1), and see if the residuals U_t appears to be $I(0)$. Usefully, Stock (1984) has demonstrated that if the series in question are cointegrated, then the OLS estimate \hat{b} of the true cointegrating vector b will be highly sufficient with a variance $\varphi(T^{-2})$, T being the sample size as opposed to the usual case $\varphi(1/T)$. Table (4.7) show the cointegrating regression for both the case of regressing the spot on forward rates and its reverse. In fact, b is close to 1.0 in all cases. It ranges from 0.97 to 1.01,

thus the individual hypothesis that $b = 1$ is not rejected. That is why, in the error-correcting forms as in equation (4.14), we have made the equals to 1, because it is not possible to test $b = 1$ in equation like (4.14).

Table (4.8)a reports the seven test statistics for all countries. Here we regress the spot on forward rates. The results show (with the exception of ARVAR test in the case of Canada) that the spot and forward rates are cointegrated. This is consistent with the EMH. Table (4.8)b is simply the same as (4.8)a, but here we regress the forward on spot rates. Again, the hypothesis that the series in question are cointegrated cannot be rejected at any level. Therefore, we conclude that the results are consistent with the EMH.

4.5.5 Validity of the Error- Correction Models:

After finding that the spot and forward rates are cointegrated, we next turn to examine the error correction representation of the relationship spot-forward.

Table (4.10) reports the estimates of equation (4.14). We have also used lags in this equation, and only the first lags were the most significant.

As far as the validity of the equation, is concerned, we have examined the statistical properties of its residuals. Table (4.11) gives the LM and F version of both serial correlation and ARCH tests. Autocorrelation of the residuals cannot be found in any of the series taken. There is no evidence, either, of heteroscedasticity in any of the exchange rates. Regarding the stability tests of the regression we conducted the CUSUM and CUSUMSQ tests. Figures (4.3) and (4.4) illustrate the CUSUM tests for UK and France respectively, and show that the stability cannot be rejected at the 5% level. Figures (4.5) and (4.6) plot the CUSUMSQ tests for UK and France respectively, and again they show that the hypothesis cannot be rejected. The CUSUM and CUSUMSQ tests for the other exchange rates are reported in appendix 4.2).

The Efficient Market Hypothesis (EMH) implies that $\beta_1 = \beta_2 = 1$ and lags = 0 in equation (4.14). The F-statistic of this hypothesis is given in Table (4.10). The F-statistic is above the critical values at any level, thus rejecting the hypothesis of rationality and risk neutrality of the agents. This is not consistent with the EMH.

4.6 Conclusion

In this chapter we have developed the cointegration techniques for testing the Efficient Markets Hypothesis (EMH) in the foreign exchange markets.

First, we found that both spot exchange rates and forward rates are I(1) series, which is a necessary condition for cointegration. Unlike the results of MacDonald and Taylor (1989), our chosen exchange rates do follow a random walk.

Neither the spot nor the forward rates are cointegrated. This is consistent with the EMH. Conversely, the spot and forward rate of each country are cointegrated which, again is consistent with the EMH.

When using the error -correction representation of the spot forward relationship, however, we reject the joint hypothesis of rationality and risk neutrality of the market operators. Clearly, this is not consistent with the EMH.

Table (4.1) Testing for Unit Roots in Spot exchange rates*

<i>Exchange rate</i>	<i>DF test</i>	<i>ADF test</i>	<i>Chi(sq)(12)</i>	<i>Appropriate test</i>
United Kingdom	-1.11	-1.218	12.76	DF
France	-1.47	-1.44	10.89	DF
Germany	-0.90	-1.10	16.27	DF
Belgium	-1.37	-1.42	14.21	DF
Canada	-1.18	-1.19	14.93	DF
Switzerland	-0.88	-0.96	14.48	DF
Netherlands	-0.98	-1.04	16.46	DF

* the null hypothesis is that the series in question is I(1). Approximate critical value at 5% level is -2.89, with rejection region $\{\theta | \theta < -2.89\}$. DF and ADF stand for Dickey-Fuller and Augmented Dickey-Fuller respectively. Critical values for Chi-sq (12) are 26.21, 21.03 and 18.55 at the 1% , 5% and 10% level respectively.

Table (4.2) Testing for Unit Roots in forward exchange rates*

<i>Exchange rate</i>	<i>DF test</i>	<i>ADF test</i>	<i>Chi(sq)(12)</i>	<i>Appropriate test</i>
United Kingdom	0.73	0.63	13.92	DF
France	-1.50	-1.52	12.18	DF
Germany	-0.90	1.12	15.24	DF
Belgium	-1.38	-1.45	16.45	DF
Canada	-1.26	-1.51	11.73	DF
Switzerland	-0.88	-1.04	15.67	DF
Netherlands	-1.05	-1.15	12.08	DF

*see table (4.1) for notes.

Table (4.3) Testing for Unit Roots in the Cointegrating Residuals*: CRDW test

	U K	France	Germany	Belgium	Canada	Switzerland	Netherlands
U K		0.173	0.038	0.103	0.101	0.030	0.031
France	0.116		0.010	0.101	0.051	0.013	0.012
Germany	0.040	0.026		0.031	0.034	0.128	0.248
Belgium	0.092	0.101	0.018		0.039	0.021	0.017
Canada	0.116	0.079	0.017	0.065		0.043	0.048
Switzerland	0.045	0.042	0.142	0.048	0.044		0.0105
Netherlands	0.038	0.025	0.241	0.028	0.033	0.091	

* The null hypothesis is that the series in question are I(1). Statistics are the CRDW. Critical values are 0.511, 0.386, 0.322 for the 1% , 5% and 10% level respectively, Engle and Granger (1987). Sample period is 85M1 to 94M6.

Table (4.4)a Testing for the Unit Roots in the cointegrating residuals*. DF test

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		-2.64	-0.81	-1.85	-1.63	-0.81	-0.80
France	-2.75		-0.325	-1.32	-1.49	-0.93	-0.151
Germany	-0.63	-0.02		-0.38	-0.915	-2.07	-2.90
Belgium	-1.95	-1.30	-0.72		-1.06	-1.16	-0.51
Canada	-1.70	-1.41	-1.20	-1.31		-1.19	-1.19
Switzerland	-0.64	-0.51	-2.05	-0.77	-0.88		-1.80
Netherlands	-0.68	-0.044	-2.94	-0.27	-0.98	-1.88	

* The null hypothesis is that the series in question are I(1). The approximate critical values for DF are -4.07, -3.37 and -3.03 at the 1%, 5% and 10% level respectively. Sample period is 85M1 to 94M6.

Table (4.4)b Testing for Unit Roots in the cointegrating residuals*. ADF test:

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		-2.77	-0.95	-1.88	-1.90	-1.07	-0.99
France	-2.54		-0.365	-0.52	-1.35	-0.96	-0.51
Germany	-0.81	-0.35		-0.77	-1.23	-1.90	-2.11
Belgium	-1.87	-0.44	-0.85		-1.26	-1.10	-1.27
Canada	-1.81	-1.28	-1.29	-1.21		-1.31	-1.26
Switzerland	-0.79	-0.54	-1.84	-1.09	-1.01		-1.60
Netherlands	-0.98	-0.44	-2.42	-0.73	-1.24	-1.75	

*See table (4.4)a for notes.

Critical values for ADF are -3.77, -3.17 and -2.84 at the 1, 5 and 10 percent level respectively.

Table (4.5)a Testing for Unit Roots in cointegrating residuals*: RVAR test:

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		17.64*	7.05	14.85*	5.52	3.90	7.48
France	15.55*		3.59	5.07	7.35	3.70	2.97
Germany	5.27	2.38		4.08	8.40	5.94	6.63
Belgium	12.30	4.50	4.99		8.04	4.24	3.57
Canada	6.90	14.13*	12.13*	16.03*		8.27	13.43*
Switzerland	3.38	2.63	6.07	3.24	8.23		6.61
Netherlands	5.43	1.75	14.29*	2.71	8.53	6.50	

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

* indicates rejection of the null hypothesis. Approximate critical values are 18.3, 13.6 and 11.0 at the 1, 5 and 10% level respectively. Sample period is 85M1 to 94M1.

Table (4.5)b Testing for Unit Roots in cointegrating residuals*: ARVAR test:

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		15.84*	6.25	12.43*	5.36	3.59	8.41
France	12.02*		2.27	4.84	5.76	2.51	2.30
Germany	3.40	1.39		1.87	8.35	5.30	9.64*
Belgium	8.80	4.24	2.92		6.94	2.95	2.92
Canada	7.17	11.30*	11.09*	13.06*		8.21	11.19*
Switzerland	2.63	1.49	5.83	2.18	8.76		4.67
Netherlands	3.28	1.49	9.14*	2.08	8.35	4.51	

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

* indicates rejection of the null hypothesis. Approximate critical values for ARVAR-statistic are 15.8, 11.8 and 9.7 at the 1, 5 and 10% level respectively. Sample period is 85M1 to 94M1.

Table (4.6)a Testing for Unit Roots in cointegrating residuals*: UVAR test:

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		9.38	5.46	17.7	4.17	4.36	6.07
France	8.27		11.19	3.36	13.89	7.14	9.56
Germany	11.81	6.32		9.36	17.12*	5.11	4.10
Belgium	7.52	3.05	8.54		16.78*	8.54	8.42
Canada	9.62	11.26	9.52	14.15		9.48	13.34
Switzerland	4.05	9.82	5.56	8.29	9.06		4.67
Netherlands	11.21	4.47	6.51	5.21	4.26	5.32	

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

* indicates rejection of the null hypothesis. Approximate critical values for UVAR are: 43.4, 18.6 and 16.0 at the 1, 5 and 10% level respectively. Sample period is 85M1 to 94M1.

Table (4.6)b Testing for Unit Roots in cointegrating residuals*: **AUVAR** test:

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		5.52	4.27	8.06	2.19	3.75	4.63
France	4.26		12.66	3.34	7.37	6.68	9.12
Germany	8.01	11.12		8.22	12.94	4.49	1.56
Belgium	7.53	3.05	8.26		9.22	5.11	6.02
Canada	2.26	8.75	9.34	6.26		8.80	10.54
Switzerland	3.04	9.61	4.45	4.41	5.45		3.17
Netherlands	8.09	2.74	5.53	4.32	4.12	6.28	

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

Approximate critical values for AUVAR-statistic are: 22.6, 17.9 and 15.5 at the 1, 5 and 10% level respectively. Sample period is 85M1 to 94M1.

Table (4.7) Cointegration regression in Spot-forward rates:

	Spot rate on Forward rate		Spot rate on Forward rate			
		R ²	F	R ²	F	
United Kingdom	$-0.001 + 0.99 F_{t-1}$	0.968	1.54	$-0.01 + 0.97 S_t$	0.968	1.85
France	$-0.08 + 0.97 F_{t-1}$	0.982	1.58	$-0.03 + 1.01 S_t$	0.982	1.53
Germany	$-0.02 + 0.98 F_{t-1}$	0.964	1.53	$-0.006 + 0.98 S_t$	0.964	1.58
Belgium	$-0.02 + 0.97 F_{t-1}$	0.979	1.25	$-0.003 + 1.004 S_t$	0.979	1.26
Canada	$-0.01 + 0.98 F_{t-1}$	0.945	1.61	$-0.003 + 1.01 S_t$	0.945	1.68
Switzerland	$-0.03 + 0.98 F_{t-1}$	0.949	1.45	$-0.005 + 0.97 S_t$	0.949	1.54
Netherlands	$-0.02 + 0.98 F_{t-1}$	0.965	1.58	$-0.01 + 0.97 S_t$	0.965	1.62

The F-statistic is the test-statistic of the joint hypothesis that $(a = 0 \text{ and } b = 1)$. Sample period 85M1 to 94M6

Table (1.8)a Testing for cointegration : Spot on Forward rates*

	CRDW	DF	ADF	RVAR	ARVAR	UVAR	AUVAR
UK	1.75	-9.34	-5.67	1869.8	21.64	1966.8	19.76
France	1.78	-9.46	-4.67	2391.2	9.5*	2379.6	21.96
Germany	1.78	-9.40	-4.59	4719.2	26.4	2857.3	30.15
Belgium	1.78	-9.43	-4.70	2500.1	9.3*	4700.4	21.58
Canada	1.79	-9.49	-5.92	930.3	21.4	1048.0	55.8
Switzerland	1.70	-9.04	-4.45	2997.8	20.3	2704.0	18.29
Netherlands	1.79	-9.49	-4.63	1443.6	41.7	1706.6	59.6

* the null hypothesis is that the series are I(0).

Approximate critical values for the tests are as follows:

	1%	5%	10%
CRDW	0.511	0.386	0.322
DF	4.07	3.37	3.03
ADF	3.77	3.17	2.84
RVAR	18.3	13.6	11.0
ARVAR	15.8	11.8	9.7
UVAR	23.4	18.6	16.0
AUVAR	22.6	17.9	15.5

Table (4.10) Cointegration Regressions for Error Correction Forms:

	Constant	$F_{t-2}-S_{t-1}$	$F_{t-1}-F_{t-2}$	ΔS_{t-1}	ΔF_{t-2}	F	R2	DW	se
UK	-0.0036	0.620	0.066	0.663	-0.0142	22.6	0.024	1.97	0.036
France	-0.0027	-0.271	0.149	-0.248	-0.065	14.5	0.032	1.99	0.035
Germany	-0.0072	-0.68	0.117	-0.685	0.0071	158.4	0.028	2.001	0.035
Belgium	-0.0002	0.76	0.193	-0.807	0.0901	20.85	0.044	1.98	0.035
Canada	-0.0017	-0.47	-0.107	-0.587	0.029	25.23	0.054	1.96	0.013
Switzerland	-0.01	-0.593	0.020	-0.578	0.034	284.5	0.018	1.99	0.039
Netherlands	-0.003	-0.45	0.148	-0.427	0.0078	72.4	0.034	1.96	0.035

The F-statistic test the hypothesis of $\beta_1=\beta_2=1$, and lags =0. Sample period 85M1 to 94M6.

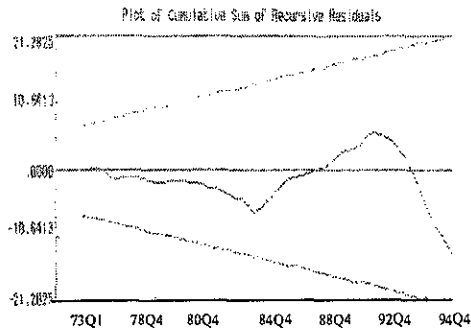
Table (4. 11) Diagnostic checking for Error – Correction Models:

Test \longrightarrow	Serial Correlation (a)		Heteroscedasticity (b)	
$S_t \downarrow$	X^2	F-test	X^2	F-test
United Kingdom	12.49	0.99	0.0279	0.0274
France	7.31	0.55	0.7095	0.7012
Germany	12.28	0.97	0.399	0.3936
Belgium	8.36	0.63	2.25	2.26
Canada	11.42	0.89	0.153	0.150
Switzerland	12.77	1.01	2.59	2.60
Netherlands	11.32	0.88	1.07	1.06

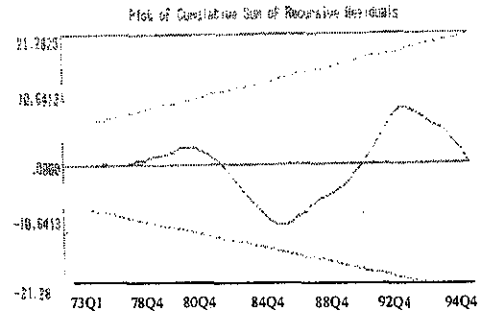
(a) Lagrange multiplier test of residual serial correlation.

(b) Based on the regression of squared residuals on squared fitted values.

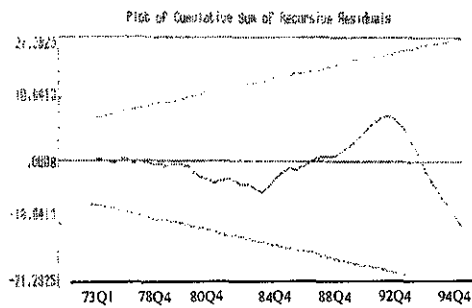
-Critical values for Chi-sq(12) are: 26.21, 21.02 and 18.54 at the 1% , 5% and 10% level, Whereas for the F-statistic the critical values are: 2.39, 1.86 and 1.62 at the 1, 5 and 10percent level.



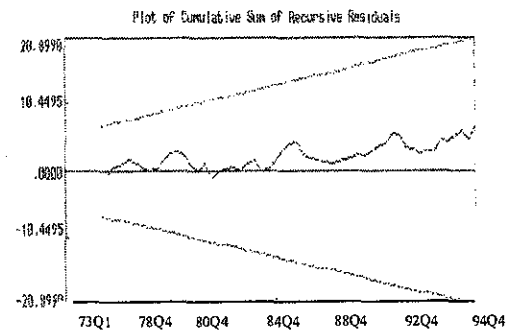
CUSUM test UK/US exchange rate
FIGURE 4.3



CUSUM test FF/US exchange rate
Figure 4.4



CUSUMSQ test UK/US exchange rate
FIGURE 4.5



CUSUMSQ test FF/US exchange rate
Figure 4.6

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Appendix (4.1)

Non cointegration of forward rates

Table (1) Testing for Unit Roots in the Cointegrating Residuals*: CRDW test

	U K	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		0.194	0.045	0.148	0.096	0.045	0.045
France	0.205		0.015	0.156	0.081	0.026	0.026
Germany	0.038	0.026		0.085	0.057	0.152	0.285
Belgium	0.082	0.101	0.035		0.068	0.065	0.025
Canada	0.196	0.079	0.046	0.093		0.074	0.065
Switzerland	0.085	0.042	0.186	0.086	0.084		0.0152
Netherlands	0.045	0.025	0.134	0.065	0.065	0.085	

* The null hypothesis is that the series in question are $I(1)$. Statistics are the CRDW. Critical values are 0.511, 0.386, 0.322 for the 1%, 5% and 10% level respectively, Engle and Granger (1987). Sample period is 85M1 to 94M6.

Table (2)a Testing for the Unit Roots in the cointegrating residuals*. DF test:

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		-2.45	-0.78	-1.68	-1.83	-0.78	-0.95
France	-2.25		-0.295	-1.45	-1.59	-0.88	-0.161
Germany	-0.61	-0.08		-0.68	-0.903	-2.24	-2.65
Belgium	-1.65	-1.56	-0.93		-1.25	-1.34	-0.45
Canada	-1.54	-1.58	-1.85	-1.47		-1.25	-1.36
Switzerland	-0.45	-0.25	-2.13	-0.65	-0.64		-1.76
Netherlands	-0.36	-0.089	-2.48	-0.69	-0.58	-1.23	

* The null hypothesis is that the series in question are $I(1)$. The approximate critical values for DF are -4.07, -3.37 and -3.03 at the 1%, 5% and 10% level respectively. Sample period is 85M1 to 94M6.

Table (2)b Testing for Unit Roots in the cointegrating residuals*. ADF test:

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		-2.13	-0.84	-1.58	-1.85	-1.44	-0.89
France	-2.02		-0.295	-0.53	-1.45	-0.98	-0.56
Germany	-0.65	-0.56		-0.85	-1.33	-1.90	-2.56
Belgium	-1.57	-0.54	-0.54		-1.25	-1.14	-1.25
Canada	-1.68	-1.42	-1.35	-1.32		-1.52	-1.34
Switzerland	-0.58	-0.43	-1.65	-1.11	-1.09		-1.75
Netherlands	-0.88	-0.39	-2.34	-0.85	-1.26	-1.24	

*See table (1)a for notes. Critical values for ADF are -3.77, -3.17 and -2.84 at the 1, 5 and 10 percent level respectively.

Table (3)a Testing for Unit Roots in cointegrating residuals*: RVAR test

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		18.23*	8.23	16.19*	4.55	4.25	7.88
France	17.43*		4.11	6.23	6.28	4.11	3.23
Germany	6.23	3.32		5.14	7.44	6.23	7.01
Belgium	11.42	5.01	5.23		7.48	5.11	4.10
Canada	7.28	13.28*	13.28*	17.28*		8.65	14.28*
Switzerland	4.34	3.13	7.24	4.12	7.65		7.32
Netherlands	6.33	2.24	15.32*	3.36	7.88	7.42	

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

* indicates rejection of the null hypothesis. Approximate critical values are 18.3, 13.6 and 11.0 at the 1, 5 and 10% level respectively. Sample period is 85M1 to 94M1.

Table (3)b Testing for Unit Roots in cointegrating residuals*: ARVAR test:

	United Kingdom	France	Germany	Belgium	Canada	Switzerland	Netherlands
United Kingdom		16.23*	7.21	13.25*	6.23	4.11	7.66
France	14.14*		2.86	5.02	6.11	2.68	3.11
Germany	4.12	1.68		2.11	7.66	6.11	10.21*
Belgium	6.56	4.85	3.23		6.23	3.25	3.11
Canada	7.28	12.32*	12.25*	14.25*		7.58	13.52*
Switzerland	3.12	2.11	6.52	2.36	7.52		5.11
Netherlands	3.85	1.89	10.11*	1.96	7.09	3.85	

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

* indicates rejection of the null hypothesis. Approximate critical values for ARVAR-statistic are 15.8, 11.8 and 9.7 at the 1, 5 and 10% level respectively. Sample period is 85M1 to 94M1.

Table(4)a Testing for Unit Roots in cointegrating residuals*: UVAR test:

	United Kingdo m	Franc e	Germany	Belgiu m	Canad a	Switzerlan d	Netherland s
United Kingdom		10.02	6.36	17.8*	5.33	6.66	5.23
France	6.33		12.39	4.52	11.32	6.36	5.66
Germany	9.88	5.65		10.23	17.12*	6.25	5.58
Belgium	6.65	3.80	9.34		16.21*	17..54*	7.54
Canada	10.02	9.66	9.55	17.15*		8.63	10.04
Switzerland	4.85	8.56	6.32	6.53	10.02		4.25
Netherland	9.61	3.65	7.23	4.21	5.26	4.25	

a

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

* indicates rejection of the null hypothesis. Approximate critical values for UVAR are: 43.4, 18.6 and 16.0 at the 1, 5 and 10% level respectively. Sample period is 85M1 to 94M1.

Table (4)b Testing for Unit Roots in cointegrating residuals*: AUVAR test:

	United Kingdo m	Franc e	Germany	Belgiu m	Canad a	Switzerlan d	Netherland s
United Kingdom		4.88	4.66	7.43	3.11	4.11	5.12
France	3.86		9.62	2.96	6.53	5.83	8.88
Germany	6.86	10.56		7.53	9.34	5.62	2.11
Belgium	5.43	3.36	7.35		7.66	4.52	4.85
Canada	3.23	6.56	8.65	2.26		7.77	9.02
Switzerland	2.88	7.56	5.11	3.56	4.84		2.96
Netherland	6.35	3.11	4.86	3.45	3.65	7.02	

s

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

Approximate critical values for AUVAR-statistic are: 22.6, 17.9 and 15.5 at the 1, 5 and 10% level respectively. Sample period is 85M1 to 94M1.

CHAPTER 5

The Movement of Exchange Rates and the Role of News

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The Movement of Exchange Rates and the Role of News

5.0 Abstract

This chapter is concerned with the movement of exchange rates and the role of news. The first section shows how exchange rates have been volatile during the last sixteen years. The second section puts into perspective the relationship between exchange rates and national price levels, whereas the third section considers the relationship between exchange rates and interest rates. The implementation of 'News' to the EMH framework is discussed in section 4, then it should be more appropriate to implement exchange rate models. In this section, the attempt is to build a model of exchange rate determination as a news format into the EMH framework. Thus, the research is carried out for both monetarist and portfolio balance theories, in order to explain the behaviour of each variable within the model taken.

Finally, in section 5, we show how cointegration technique can be used for testing the long run equilibrium relationship in exchange rate determination models.

5.1. Introduction

Since 1973, the move to generalised floating exchange rates between major countries, large fluctuations have been displayed. As a result of this turbulence, considerable efforts have been devoted to empirical investigations concerning exchange rate dynamics. Frenkel and Mussa (1980) pointed out that this turbulence is an important concern of government policy and its explanation is a challenge for theories of foreign exchange market behaviour.

Empirical research inside the asset-market approach has not given a consensus view about how the flexible exchange rate system has really been working during the last sixteen years. Highly conflicting findings have indeed been achieved on relevant questions pertinent to the asset-market framework, such as the exchange rate volatility, the validity of interest rate parity and the existence of an efficient exchange rate market.

In the previous chapter, we dealt with the theoretical issues with of efficient markets hypothesis and the implication of cointegration for these markets. This chapter extends the notion of EMH using a news approach, since it is known that the new information plays a predominant role in foreign exchange markets.

The first section of this chapter shows how exchange rates have been volatile during the last sixteen years. The second section puts into perspective the relationship between exchange rates and national price levels, whereas the third section considers the relationship between exchange rates and interest rates. The implementation of 'News' to the EMH framework is discussed in section 4. In the context of exchange rate determination, as emphasised by Dornbush (1980), the predominant cause of exchange rate movements is 'news' which could not be anticipated. If new information is important in the foreign exchange market, then it should be more appropriate to implement exchange rate models. In this section, the attempt is to build a model of exchange rate determination as a news format into the EMH framework. Thus, the research is carried out for both monetarist and portfolio balance theories, in order to explain the behaviour of each variable within the model taken.

Finally, in section 5, we show how cointegration technique can be used for testing the long run equilibrium relationship in exchange rate determination models. By doing so, the variables that are cointegrated with the exchange rate (i.e. there exists an equilibrium relationship within the exchange rate model) can be used as a news term within the EMH framework. As mentioned earlier, considerations are first given to exchange rate volatility.

5.2. Exchange Rate Volatility

A useful starting point may be represented by an inspection of figures (5.1) and (5.2) reported below.

Looking at the German/US dollar exchange rates over the period 80M1 to 96M6, figure (5.1) compares the first differences of the spot exchange rate with the forward discount (or premium) relative to the preceding period. Exchange rate has been notably high during the sample period: the standard deviation of the variable spot exchange rate (0.047) is in fact about four times greater than that of the forward premium (0.013).

The lagged forward premium represents predicted exchange rate changes: it appears from the figure that these changes account only for a very small fraction of the effective ones. This finding, in line with the asset-market literature, confirms that the role of "News" is crucial in explaining exchange rate dynamics. This findings, in fact, are similar to Frenkel's (1981). Predicted changes (at time $t-1$) are poor forecasters of effective changes (occurring between $t-1$ and t) because new events, appearing in every period, cause the unexpected component of a vector of exogenous variables to the main force driving exchange rate performance.

Crucial additional insights are found in figure (5.2) where indices of the logs of the spot and the forward GermanMark/US Dollar exchange rates are reported over the period 80M1 to 96M6.

According to the aforementioned approach, spot and forward rates should be closely tied together, since both current spot rate and its current expectations for the future (forward rate) depend upon the same vector of exogenous variables.

To explain this behaviour of exchange rates, Frenkel and Mussa (1980) suggested the following equation:

$$\ln S_t = Z_t + bE_t(\ln S_{t+1} - \ln S_t) \quad (5.1)$$

where $E_t(\ln S_{t+1} - \ln S_t)$ denotes the expected percentage change in exchange rate between t

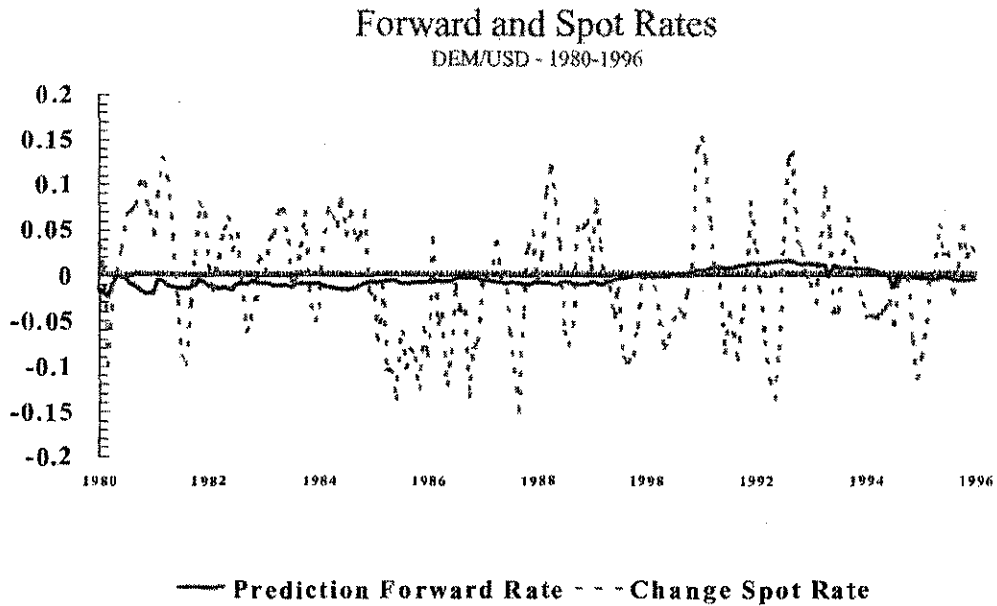


FIGURE 5.1 Spot Exchange Rate Changes and lagged forward premium

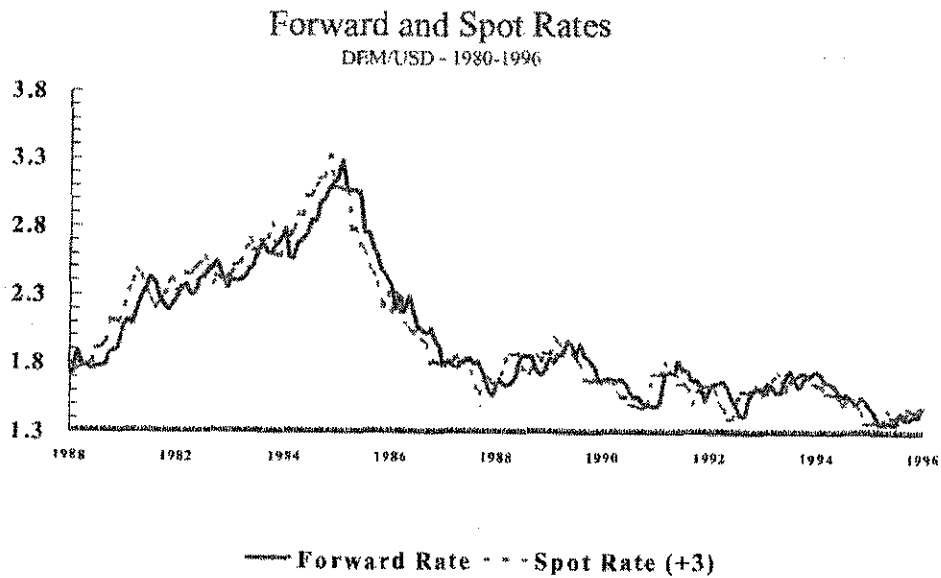


FIGURE 5.2 The Spot and Forward rate Relationship

and $t+1$ based on the information available at t , and where Z_t is the factors of supply and demand which affect the exchange rate at time t .

From the assumption that, current exchange rate and current expectations of future exchange rates are linked because both depend on expectations on what the future will be, we may write $\ln S_t = E_t \ln S_t$ which should also be linked to the current expectation of the next period's exchange rate $E_t \ln S_{t+1}$ and so on. This can be seen clearly from figure (5.2). It indicates that the new information appears to alter views concerning current and expected exchange rates by approximately the same amount. This comovement of spot and forward rates is evidence of the close link between current and expected future exchange rates, as proved by Frenkel (1981) who used the following equation, which is the same above equation but with forward iteration:

$$E_t \ln S_{t+1} = \frac{1}{1+b} \sum_{k=0}^{\infty} \left(\frac{1}{1+b} \right)^k E_t Z_{t+j+k} \quad (4.2)$$

Thus, following Frenkel, the current exchange rate ($j=0$) and current expectations of future exchange rates are linked, because both depend on expectations concerning the future Z 's.

The important remark that can be drawn here, is that the general view of looking to exchange rates as asset prices is vital in explaining the volatility and turbulence of the exchange rates. This perspective implies that exchange rates will not adjust slowly but like other asset prices will display random fluctuations in response to new information that is continually being received by the market.

5.3. Exchange Rates and National Price Levels

5.3.1. The Purchasing Power Parity (PPP)

The Purchasing Power Parity (PPP) concept is one of the oldest and most controversial relationships in the theory of exchange rates. Among the most popular versions of PPP, there exist the "absolute" version which states that the exchange rate between two currencies of any pair of countries should equal the ratio of the aggregate

price levels in the two currencies, and the "strict" version which relates changes in exchange rates to in inflation differential rates.

The earlier promises of the flexible exchange rates were that long-run trends in exchange markets would be denominated by relative rates of inflation, i.e. that exchange rates would follow the PPP (Friedman, 1953), and that temporary factors such as shifting interest rates might cause temporary deviations from PPP but such deviations are reduced because speculators force the market towards its long long-run equilibrium.

The two mentioned versions can be written as follows:

Absolute Version

$$\ln S_t = a + b \ln (p / p^*)_t + U_t \quad (5.3)$$

Relative Version

$$\Delta \ln S_t = b \Delta \ln (p / p^*)_t + V_t \quad (5.4)$$

where S_t = the exchange rate

(p / p^*) = the ratio of domestic to foreign price indices, the asterisk denotes the foreign country.

U_t, V_t = error terms

Δ = the first difference operator

a = the intercept term

b = the slope coefficient.

There is not, however, a unique view about which price index should be used in these versions. According to one extreme view, exchange rates should be held in line with general price indices, i.e. prices of both traded and non-traded goods. Advocates of this view emphasise the role of asset equilibrium in determining the exchange rate (Cassel, 1930). A second view focuses on commodity arbitrage as the international

mechanism that correct purchasing power disparities and therefore argues that only prices of traded goods should be included in the calculation of the ratio of price indices. Supporters of this view are, for example, (Angell, 1922; Bunting, 1939; Hecksher, 1930; Pigou, 1930; Viner, 1937).

The third view goes further to account for non-traded goods only. According to Keynes, the use of prices of traded goods only, is no more than a tautology, because it simply means that the price of a commodity must be the same elsewhere when converted into a common currency. Hansen and Hodrick (1980) for example claimed for the use of production indices.

The choice of the price index is not the only deficiency to the PPP, other factors such as the choice of base period for relative PPP and the transportation costs may also bias the calculation of PPP. These deficiencies have weakened the theoretical basis of PPP.

The PPP doctrine is seen as an equilibrium relationship between an exchange rate and some designated ratio of price indices. This relationship implies that any divergence from the ratio will set in motion corrective forces acting to restore equilibrium. The question that can be asked here is which causes which? is it the changes in prices that cause exchange rate movements or is it the opposite?

The majority of authors recognised that prices and exchange rates are determined simultaneously. A minority, however, argued that there exists a causal relationship between prices and exchange rates. Cassel (1930), for example, claimed that the causality goes from prices to the exchange rate, Einzig (1937) claimed the opposite.

5.3.2. Violation of Purchasing Power Parity

This section considers some empirical results concerning the validity of purchasing power parity. Frenkel (1978, 1981), tested both the absolute and relative versions of the PPP for two different periods. The first period was the interwar period, whereas the second coincides with the 1970's and the recent floating exchange rates.

Frenkel estimated the following equations:

$$\text{Absolute PPP } \ln S_t = \alpha + \beta \ln P_t - \beta^* \ln P_t \quad (5.5)$$

$$\text{Relative PPP } \Delta \ln S_t = \beta \ln \Delta P_t - \beta^* \ln \Delta P_t \quad (5.6)$$

Where for the PPP to hold, it is expected that $\alpha=0$, $\beta=1$ and $\beta^*=1$.

The above equations were estimated for the US/UK, France/US and France/UK exchange rates. He used the ratio of material price indices, the ratio of food price indices and the ratio of wholesale price indices for the period February 1921 - May 1925. The results are supportive to the PPP in both versions. For the relative version the inclusion of a constant term is shown to be statistically insignificant.

The same equations are used by Frenkel for the second period (floating exchange rates) 1973-1979. The results, were extremely poor and the estimates were extremely imprecise. Moreover, the poor performance of both versions of PPP during the 1970's was augmented by the fact that in some cases the estimates did not remain stable during the sample period. Frenkel concluded that the PPP doctrine did not hold during the 1970's, and he pointed out that this failure could be a US phenomenon. Accordingly, after reexamination for various exchange rates which do not include the US dollar or the US price level, the results were much more improved. His explanation to this, is that this phenomenon is due to :

i)- Transportation costs, where PPP is expected to hold better among European countries than if it is between a European country and the US.

ii)- Commercial policies and non-tariff barriers to trade have been more stable within Europe than between Europe and the US.

iii)- The effects of institutional agreements.

5.3.3. Cointegration and Purchasing Power Parity

Following the aforementioned concept of PPP, the central idea underlying this assumption is that exchange rates and prices should not diverge from each other by too far apart, at least in the long-run. In the short-run, they may drift apart due to some

seasonal factors, but economic forces, such as commodity arbitrage, will tend to bring them together again. Clearly, this notion of long-run equilibrium coincides with the concept of cointegration. Cointegration suggests that if exchange rates and prices form a long-run equilibrium relationship, they must be cointegrated.

The cointegration technique was used by Taylor (1988) who examined the long-run PPP relationship for the UK, West Germany, France, Canada and Japan exchange rates, against the US Dollar. He tested the PPP over the period June 1973 through December 1985. The results obtained were not supportive to the PPP. In fact, he found that exchange rates and prices are not cointegrated. Thus, there is not long-run purchasing power parity relationship.

In chapter 6, our test results of the long-run PPP using cointegration technique will be considered. The problem of causality, (i.e. which causes which? Is it the change in prices that causes exchange rates movements or is it the opposite?) will also be discussed in chapter 6.

5.4. Exchange Rates and Interest Rates

Einzig (1970) pointed out that the concept of interest rate parity is credited to Keynes (1923). This concept focuses on relationships between exchange rates and interest rates.

Interest rate parity implies that investors have the choice between holding assets denominated in domestic currency, that yield the own rate of interest i_d , and holding assets denominated in foreign currency, that yield the own rate of interest i_f . Anyone investing a unit of domestic currency have to compare the return $(1 + i_d)$ with the option to convert it at the spot rate into s units of foreign currency, and arranging to convert back $(1 + i_d)$ at the forward rate f into $s(1 + i_f) / f$ units of domestic currency for delivery at the end of the interest payment.

There exists two different views of the above mentioned concept of interest rate parity. The first one is the Covered Interest Parity (CIP), the other is the Uncovered Interest Parity (UIP).

5.4.1. Covered Interest Parity (CIP)

Assuming perfect capital mobility, the covered interest parity implies that the premium on forward exchange is equal to the difference in interest rates between a given pair of currencies. This can be expressed as follows:

$$(1 + i_d) = s (1 + i_f) / f \quad (5.7)$$

or, for sufficiently small values

$$\begin{aligned} (f - s) / s &= (1 + i_f) / (1 + i_d) - 1 \\ &= (i_f - i_d) / (1 + i_d) \approx i_f - i_d \end{aligned} \quad (5.8)$$

Setting the forward premium $(f - s) / s = p$, and replacing in (5.8), we obtain

$$P = i_f - i_d \quad (5.9)$$

Thus, if $i_f > i_d$, forward sterling is at premium.

Rearranging equation (5.9), the covered interest differential (CID) is obtained

$$\text{CID} = (i_f - i_d) - p \quad (5.10)$$

Just as water flows downhill, so capital always flows where the return are greatest. Thus if $\text{CID} > 0$, funds will flow from the UK to the US (taking UK, US as home and foreign countries respectively). Assuming that $(i_f - i_d)$, the profit of investing at the high interest rate will be greater than the cost of forward cover (p). When $\text{CID} = 0$, arbitrageurs portfolios are in equilibrium, and when $\text{CID} < 0$ funds will flow to the UK.

5.4.2. Uncovered Interest Parity (UIP)

If we now add to the above analysis of CIP, the assumption that arbitrageurs are risk neutral, so that they do not use the forward market for cover, there exists the relationship of Uncovered Interest Parity (UIP), which must hold at any moment of

time. UIP means that assets denominated in different currencies are perfect substitutes; in other words, agents are indifferent as to the currency composition of their portfolios (Tronzano, 1992).

In formal terms, UIP implies that the nominal interest differential between bonds denominated in different currencies is just equal to the expected change of the exchange rate during the corresponding period. Following the same above notations of CIP, and instead of using the forward rate for cover, arbitrageurs use the expected future spot rate s^e . In this case, equilibrium requires that if $(i_f - i_d)$, there must be a premium on the expected future spot rate, s^e , to offset the interest rate disadvantage.

The premium (p) in equation (5.9) will be $(s^e - s)/s$. Rearranging (p) into (5.8), the UIP implies:

$$(s^e - s) / s = (i_f - i_d) / (1 + i_d) \approx i_f - i_d$$

That is, the expected proportionate appreciation of the dollar is equal to the difference in nominal interest rates.

5.4.3. The Empirical Validity of Covered and Uncovered Interest Parities

Although there exists some confusion in some of the literature on the CIP condition, it is agreed that departures from the CIP is due to transportation costs and the influence of capital controls. Dooley and Isard (1980) added that deviations from CIP are due to the fact that the empirical data on interest rates do not refer to sufficiently comparable foreign and domestic assets. Chrystal, K.A (1982) argued that the CIP does hold if the chosen interest rates are Eurocurrency deposit rates of the same duration. In other words, if for the US interest rate, we take the three-month deposit rate in Paris and for the UK interest rate we take the three-month euro sterling deposit rate in Paris, then the CIP will hold just about exactly.

As regards the UIP, the validity remains controversial. The empirical evidence regarding its validity is rather inconclusive. Indeed, the majority of works which the UIP proposition directly, indicate a failure (see, for example, Cumby and Obsfeld

(1981), Hodrick and Srivastava (1984)). Frankel (1982), by contrast, draws opposite conclusions.

It must, however, be noted that many other tests have looked for indirect evidence by relying on the assumption that expectations are taken rationally such as UIP implies that the forward rate is an unbiased predictor of the spot rate. In this case, provided that the CIP holds, market efficiency implies the validity of UIP.

Since CIP is well supported by the data (Frenkel and Levich (1977), McCormick (1979)), the highly conflicting empirical evidence surrounding the market efficiency hypothesis may also be regarded as a inconclusive evidence about the uncovered interest parity (UIP).

As seen from this section, the UIP implies that the expected proportionate appreciation of the spot rate is equal to the difference in nominal interest rates. Clearly, if the UIP holds, there exists an equilibrium relationship. Accordingly, the test we propose to see whether this equilibrium exists or not is similar to the one we will be using for the long-run PPP, namely the cointegration technique. The latter implies that, if the UIP holds, then the expected appreciation of the spot rate and the difference in nominal interest rates should be cointegrated. The results will be given in Chapter 6.

5.5. Exchange Rates and "News"

It has been suggested by Dornbush (1980) and Frenkel (1981) among others, that exchange rates movements basically respond to new information that is made available to economic agents in every period.

Unanticipated events "News", play a predominant role in affecting real variables and asset yields. In the context of exchange rate determination, as emphasised by Dornbush (1980), the predominant cause of exchange rate movements is "news", which could not have been anticipated.

Although the Efficient Markets Hypothesis implies that anticipated changes in the exchange rates will be orthogonal to the forecast error, unanticipated changes in

$$\ln S_t = a + b \ln F_{t-1} + \text{"News"} + w_t \quad (5.11)$$

which shows the role of news as the determinants of the exchange rate, where $(\ln S_t)$ is the logarithm of the spot exchange rate and $(\ln F_{t-1})$ is the logarithm of the forward exchange rate. More precisely, he used the following model:

$$\ln S_t = a + b \ln F_{t-1} + \alpha [(i - i^*)_t - E_{t-1}(i - i^*)_t] + w_t \quad (5.12)$$

expected exchange rate

News

where $(i - i^*)$ is the interest rate differential.

This equation was tested for the US Dollar/UK Pound, US Dollar/French Franc, and the US Dollar/German Mark exchange rates over the period June 1973 to June 1979, using essentially an autoregression to measure the expected interest differential series. The results of the above equation, using two stage Least Squares, show that in all cases α , the coefficient of the unexpected interest differential is positive, and in the case of the US Dollar/UK Pound exchange rates is statistically significant. This positive association between the exchange rate and the unexpected interest differential, according to Frenkel, is due to the fact that the sample period was taken in a period in which the interest rate reflects inflationary expectations.

However, when again estimating the same equation using the actual interest differential, the results state that the coefficient on the actual interest differential is insignificant in all cases.

Edwards (1982) expanded his tests to a multi-currency world. In this world, it is possible to see that U_t (the white noise error term) will be correlated across exchange rates. This correlation can be incorporated to the analysis using Zellner's Seemingly Unrelated Regressions procedure (SURE), Zellner (1962).

Following Edwards, it is possible to show that the error term U_t , in a simple EMH equation can be a linear function of unanticipated "News" of money differentials, real income differentials and real interest differentials. In fact, he estimated the

FMAER (flexible price monetary approach to the exchange rate) reduced form in a news format for the same currencies considered by Frenkel plus the Italian Lira over the period June 1973 to September 1979. The equation that was tested can be expressed as follows:

$$S_t = a + b f_{t-1} + [\alpha_0(m_t^u - m_t^{u*}) + \alpha_1(y_t^u - y_t^{u*}) + \alpha_2(r_t^u - r_t^{u*})] + w_t$$

where,

$(m_t^u - m_t^{u*})$ = unanticipated changes in the log of money at home and abroad.

$(y_t^u - y_t^{u*})$ = unanticipated changes in the log of real incomes.

$(r_t^u - r_t^{u*})$ = unanticipated changes in real interest rates.

Under the assumption that markets are efficient, it is expected that in the above equation $a=0$, $b=1.0$, $\alpha_0 > 0$, $\alpha_1 < 0$, $\alpha_2 \geq 0$ and w_t to be a white noise error. The results are supportive to the FMAER news equation. the Hypothesis that $a=0$ and $b=1.0$ cannot be rejected at the conventional levels. With respect to the role of 'News', the coefficients for unanticipated money growth differentials are significantly positive, and as expected, for the Franc/Dollar and the Mark/Dollar exchange rates. It was found that a 10 % unanticipated increase in money differentials for the currencies would result in a depreciation of the domestic currency of about 3.5 % over and above what had been expected. α_1 , however is only significant and positive for the case of Pound/Dollar exchange rates, whereas α_2 is only significant for the Lira/Dollar exchange rates.

Clearly, from the work of Frenkel and Edwards, in any attempt to implement the 'News' model, a researcher must decide on an appropriate model to the exchange rate determination, and on some method of generating the expected values of the determining variables. Frenkel and Edwards have generated the expected values using regressions analysis.

Other studies have been carried out and are supportive of the model used (see, for example, Dornbusch (1980), MacDonald(1983), Bomhoff and Kortwegg (1983) and

Branson (1983). The interesting results of these studies is the finding that lagged 'news' is statistically significant, and also that these studies are reasonably supported by the data.

5.5.2. Looking for a Better 'News' Model

In this section we do not attempt to give a different news format for the EMH condition. In fact we will be using the same models used by previous studies, but the test we propose for generating the expected values of the news, however, is rather different. The models that we will be dealing with are those of exchange rate determination, namely the monetary and portfolio balance models. To test for the existence and long-run cointegrability of these models, cointegration technique is used. Using this technique we can decide on the appropriate model for the news format. The main idea is that the appropriate model should be cointegrated. If not all the variables are cointegrated, some of them, at least, should pass the cointegrability test, thus suggesting an equilibrium relationship. So we think that the variables which reflect the news immediately are those that are cointegrated with exchange rate.

The tests procedure and results are given and discussed in Chapter 6. Considerations are first given to some properties of each model of exchange rate determination by taking up the more important question on how the flexible spot rates themselves are determined.

Since the resolution of the Bretton Woods system, models of asset stock have dominated professional thinking about exchange rate determination. Accordingly, exchange rate adjusts instantly to equilibrate the international demand for stocks of national assets rather than the international demand for flows of goods as under the traditional view. All asset market models share the assumption of perfect capital mobility. They differ according to whether or not domestic and foreign bonds are assumed to be perfect substitutes in asset holders' portfolios, which implies uncovered interest parity (UIP).

One class of asset-market models assumes perfect substitutability between foreign and domestic bonds, this is the "monetary approach". By contrast, another

class assumes that domestic and foreign bonds are imperfect substitutes, this is called the "portfolio-balance approach".

5.5.2.1. The Monetary Approach

There are two different views within the monetary approach. The first one is the flexible-price monetary model, whereas the other is the sticky-price ("overshooting") monetary model.

a). The Flexible-Price ('Monetarist') Monetary Model

The Flexible-Price model assumes perfect substitutability between domestic and foreign goods, this is the idea of purchasing power parity (PPP) which states that the domestic price level is equal to the foreign price level times the exchange rate. The flexible-price model or, as sometimes called the "Chicago" theory has been developed by Frenkel (1976, 1977, 1980), Mussa (1976), Girton and Roper (1977), Hodrick (1978), and Bilson (1979). The fundamental equation in the monetary approach is a conventional money demand function:

$$m = p - \phi y - \lambda i \quad (5.13)$$

Where,

m = log of the domestic money supply,

p = log of the domestic price level,

y = log of domestic real income,

i = the domestic short term interest rate,

ϕ = the money demand elasticity with respect to income,

λ = the money demand semielasticity with respect to the interest rate.

Assuming a similar money demand function for the foreign country:

$$m^* = p^* + \phi y^* - \lambda i^*$$

Where asterisks denote foreign variables and the parameters are assumed to be equal in home and foreign country. If we take the difference of the two equations we obtain the relative money demand function:

$$(m - m^*) = (p - p^*) + \phi(y - y^*) - \lambda(i - i^*) \quad (5.14)$$

The uncovered interest parity implies:

$$(i - i^*) = \xi(\Delta e) = \text{the expected depreciation in domestic currency} \quad (5.15)$$

Replacing it, i.e. $\xi(\Delta e)$ into (5.14) we obtain, by solving for the relative price level:

$$(p - p^*) = (m - m^*) - \phi(y - y^*) + \lambda\xi(\Delta e) \quad (5.16)$$

The assumption of purchasing power parity implies:

$$s = p - p^*, \quad (5.17)$$

where s = the log of the spot exchange rate. In the long run the expected depreciation is equal to the expected inflation differential:

$$\xi(\Delta e) = \xi(\Delta p) - \xi(\Delta p^*) \quad (5.18)$$

Combining (5.16), (5.17), and (5.18) we obtain the monetarist equation of exchange rate determination:

$$S = (m - m^*) - \phi(y - y^*) + \lambda(\xi(\Delta p) - \xi(\Delta p^*)) \quad (5.19)$$

One implication from regarding exchange rates as asset prices is that expectations are important in determining the current spot rate. Assuming the rationality of the agents, the stability of the system, and that income growth is exogenous (for simplicity equal to zero, so $y - y^* = \bar{y} - \bar{y}^*$). Then the expected inflation rate is equal to the rationally expected monetary growth, which we will represent by $(II - II^*)$. Equation (5.19) becomes:

$$S = (m - m^*) - \phi (\bar{y} - \bar{y}^*) + \lambda (\pi - \pi^*) \quad (5.20)$$

which is the flexible price monetary approach reduced form.

b). The Sticky-Price "Overshooting" Monetary Model

This version is due to Dornbush (1976). The model is also called "fixed-price", because it assumes that prices are sticky, so the PPP is no longer valid in the short run. The demand for money function as in (5.13), and the UIP, however, are still maintained.

The important model of this feature of this model is that it gives another example of exchange rate volatility in terms of "overshooting". This can be best explained in the following way using figure (5.3).

The line $p=s$ plots the long-run relationship between the price level and the exchange rate with 45° representing one to one unity. The schedule MM represents combinations of s and p consistent with asset market equilibrium: It is assumed that at all points in time the UIP holds continuously and the money market is assumed to clear.

The initial equilibrium is at A. A monetary expansion shifts MM to M'M', and the new long run equilibrium is at B. But in the short run prices are sticky so that they do not adjust quickly, thus the exchange rate moves to C and then slowly moves back up to B at a rate known in Dornbush model as "the speed of adjustment", which reflects the degree of stickiness of prices.

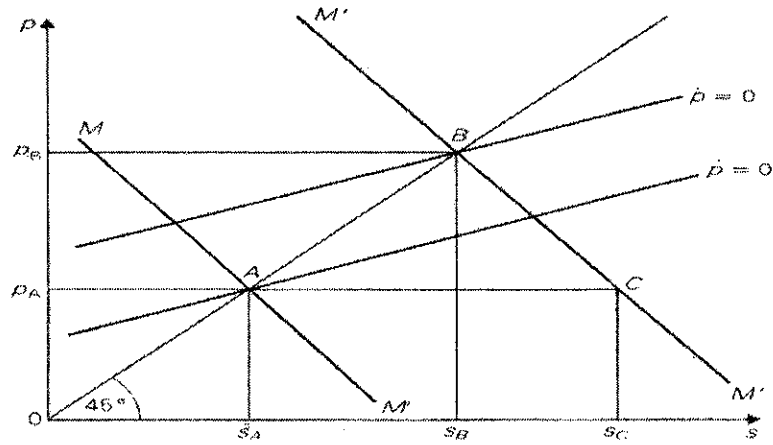


Figure 5.3 The Overshooting Model

From the figure we can see that the economy is always on MM, which means that asset markets are continuously in equilibrium. Secondly, the appreciation from C to B is fully consistent with rational expectations because the exchange rate appreciates at exactly the rate which is expected. Thirdly, money is not neutral in the short run. At a point like C the PPP has been violated, the domestic currency has depreciated but domestic prices have not changed.

We now return to how this model is determined. First, we replace the PPP by a long-run version:

$$S = \bar{p} - \bar{p}^* \quad (5.21)$$

where a bar denotes long run, or equilibrium, value. Thus the monetarist exchange rate equation (5.19) is replaced by a long run version:

$$\bar{S} = (\bar{m} - \bar{m}^*) - \phi(\bar{y} - \bar{y}^*) + \lambda(\bar{\xi}(\Delta p) - \bar{\xi}(\Delta p^*)) \quad (5.22)$$

and, adding the same assumptions as those given in (5.19) we get:

$$\bar{S} = (m - m^*) - \phi(y - y^*) + \lambda(\pi - \pi^*) \quad (5.23)$$

In the short run, when the exchange rate deviates from its equilibrium path, it is expected to close the gap with a speed of adjustment θ . In the long run, when the exchange rate lies on its equilibrium path, it is expected to increase at $(\Pi - \Pi^*)$:

$$\xi(\Delta S) = -\theta(S - \bar{S}) + (\Pi - \Pi^*) \quad (5.24)$$

Combining (5.24) with the UIP in (5.15) we obtain:

$$S - \bar{S} = -\frac{1}{\theta} [(i - \Pi) - (i^* - \Pi^*)] \quad (5.25)$$

The gap between the exchange rate and its equilibrium level is proportionate to the real rate of interest. If we combine (5.25), which is the short run overshooting effect, with (5.23) we obtain the general monetary model of exchange rate determination:

$$S = (m - m^*) - \phi(y - y^*) + \lambda (\Pi - \Pi^*) - \frac{1}{\theta} [(i - \Pi) - (i^* - \Pi^*)] \quad (5.26)$$

If the fix-price monetary model is correct then in an estimated version of equation 5.26 we would expect $1/\theta$ to be negative and λ to be zero. where in the flex-monetary approach we would expect λ to be positive and $1/\theta$ to be zero.

Equation (5.26) can be reproduced in another form:

$$S = (m - m^*) - \phi(y - y^*) + \alpha (i - i^*) + \beta (\Pi - \Pi^*) \quad (5.27)$$

where $\alpha = -1/\theta$ is hypothesized negative and $\beta = 1/\theta + \lambda$ is hypothesized positive and greater than in absolute value.

Many other alternatives have been discussed in the literature of exchange rate determination, and they can be summarised in term of equation (5.27) as follows:

Chicago or flexible model:

$$\text{Bilson} \quad \alpha > 0, \quad \beta = 0$$

$$\text{Frenkel} \quad \alpha = 0, \quad \beta > 0$$

Keynesian or sticky-price model:

Dornbusch $\alpha < 0, \beta = 0$

Real Interest Differential $\alpha < 0, \beta > 0$

A number of empirical studies tended to support the implications of the monetary approach, but such studies produced different results. For instance, the evidence from the Pound/Dollar exchange rates by Bilson (1978) supported the flexible price model, Hodrick (1978) claimed support for the sticky-price version while the results of Frankel (1979) were supportive to the real interest differential model.

5.5.2.2. The Portfolio Balance Model

a). The effect of the current account

Although the interest rate differential was highly favourable to the United States, and money growth was lower in US than other countries like Japan, West Germany and Switzerland, the dollar depreciated sharply in 1978 against the aforementioned exchange rates.

The most popular explanation for the decline was the large US current account deficit. Moreover, the correlation between current account deficits and exchange rates has been undeniably strong when the pattern was reversed in 1979 and 1980. That is, the currencies of Japan and West Germany depreciated while the Dollar appreciated. The US having current account surplus, and West Germany and Japan having a deficit account.

Frankel (1983) states that there are three main channels through which current account imbalances are thought to affect exchange rates. The first one is that current accounts development have been largely dominated by oil. Since The United States produces oil while West Germany and Japan produce none, the sharp increase in oil prices in 1979 raised the demand for the dollar at the expense of the Mark and Yen. Financial analysts argued, however, that this increase in oil prices hurts the dollar because the US has not decontrolled domestic oil prices. The second channel through which current account imbalances are viewed to influence exchange rates is the effect

of current account surprises on equilibrium exchange rates; the release of unexpected figures on current account can have immediate effects on the exchange rate. The third one is the effects of wealth transfers on portfolio balance, since the counterpart of a current account imbalance is a transfer of wealth between regions (i.e. foreign and domestic residents).

Each of the above channels could be interpreted in a model, we focus on the third one which gives us the "portfolio-balance" effect.

b). The Portfolio-Balance Model

The important feature of this model is that, in contrast with the monetary models, it assumes imperfect substitutability of bonds, and thus allows a role for portfolio diversification between countries. The Portfolio balance model is due to the work by McKinnon and Oates (1966); McKinnon (1969); Branson (1968, 1975).

This model has been applied to the exchange rate determination by Branson (1977); Isard (1978); Dornbusch and Fisher (1980) among others.

From the above, the UIP assumption in (5.15) does not hold but instead we write:

$$i - i^* - \xi \Delta s = \varphi \tag{5.28}$$

Where φ represents the risk premium, which was equal to zero in the case of the previous model (i.e. monetary approach).

There are many reasons why two assets can be imperfect substitutes such as liquidity, political risk, tax treatment, default risk, and exchange risk. The majority of the studies, however concentrates mainly on the latter factor which is the exchange risk.

We assume that wealth holders distinguish between domestic and foreign bonds only by their currency of denomination. In order to diversify the risk that comes from exchange variability, investors balance their portfolios between domestic and foreign

bonds in proportions that depend on the expected relative rate of return (or risk premium).

Frankel (1979) presented the above relationship as follows:

We can write (φ) as a function of relative supplies of bonds:

$$\varphi = \frac{1}{\gamma} B / F_s \quad (5.29)$$

Combining this equation with (5.28) we obtain:

$$B / F_s = \gamma (i - i^* - \xi \Delta s) \quad (5.30)$$

where B, F are domestic and foreign bonds respectively. Making (4.30) in logs we get:

$$b - s - f = a_0 + \gamma (i - i^* - \xi \Delta s) \quad (5.31)$$

Assuming that expectations are static, i.e. $\xi \Delta s = 0$, the exchange rate will be determined by relative bond supplies and interest differential:

$$s = a_0 + \gamma (i - i^*) + b - f \quad (5.32)$$

Equation (5.32) represents the portfolio balance model under the assumption of 'uniform preference' (Dornbusch (1980)). Such assumption means that all agents consume the same goods or the same basket of goods.

An alternative model assumes that the home country is too small and thus domestic bonds are held by domestic residents only. Branson (1975), and others developed this assumption:

$$S = -a_H - \gamma_H (i - i^*) + b - f_H \quad (5.33)$$

where γ_H is the asset demand function shared by all home residents. A model of small domestic country is unrealistic for most countries, at least with floating exchange rates. A realistic model, however, would recognise that residents of both countries hold

bonds issued by both countries. Such model goes under the name of "Preferred Local Habitat" Kouri (1976).

Table (5.1) provides a summary of the coefficients signs implied by various models that were discussed previously.

Table (5.1) *Implied regression coefficients of asset market models*

	$(m-m^*)$	$(y-y^*)$	$(i-i^*)$	$(\square-\square^*)$	$(b-f)$
1 - Monetary Approach					
- Monetarist eq(5.20)	+	-	+	+	
- Overhooting eq(5.27)	+	-	-		
- Real Interest differential eq(5.26)	+	-	-	+	
2 - Portfolio Balance Model (5.32)			-		+

As seen from the table the implications are so conflicting that one would find that a regression could hardly help but reject some models in favour of others.

We have seen so far the various implications of the asset market models. Chapter 6 will give the results of estimating each model. Thus, we will see which model performs the best, and which model can be used as a news term using cointegration techniques.

5.6. Conclusion

The chapter has considered the various models of exchange rate determination. Initially, the first section states that the exchange rates were very volatile during the last sixteen years. The poor performance of exchange rate models to explain exchange rate behaviour, concerning this high volatility and variability, has raised many questions about the reasons for this failure. To some extent this failure is due to the imperfect foresight of stances of monetary and fiscal policies and, of the consequences of those policies for inflation rates, interest rates, and other economic conditions. Another explanation that may have caused exchange rate movements, could be "news" that would not have been anticipated, since the new information plays a predominant role in determining the exchange rate pattern. In addition, the statistical tests that have been used indicated that the explanatory power of exchange rate models has been extremely poor during this period.

Section 5.3 and 5.4 give some elements of truth about relationships between exchange rates, national price levels and interest rates. Thus both implications and empirical validity of purchasing power parity (PPP) and interest rate parity assumptions are discussed. Since both concepts are based on a long-run equilibrium relationship, cointegration techniques could be used to detect this equilibrium. The test results using this technique are given in chapter 6.

Many studies, as mentioned previously, have used the cointegration techniques in the context of exchange rate determination. Figure (5.3) is a simple chart that links exchange rate to other variables, and gives some recent studies concerning the above assumptions.

As seen from Fig (5.3), most of the studies in exchange rate relationships were pioneered by MacDonald R. and Taylor M (1988, 1989). The chart, however, shows that there is still to come, and future research would be fruitful using this new technique. Consequently, in this research the UIP is tested using the aforementioned method. Considerations are also given to the PPP and the problem of causality.

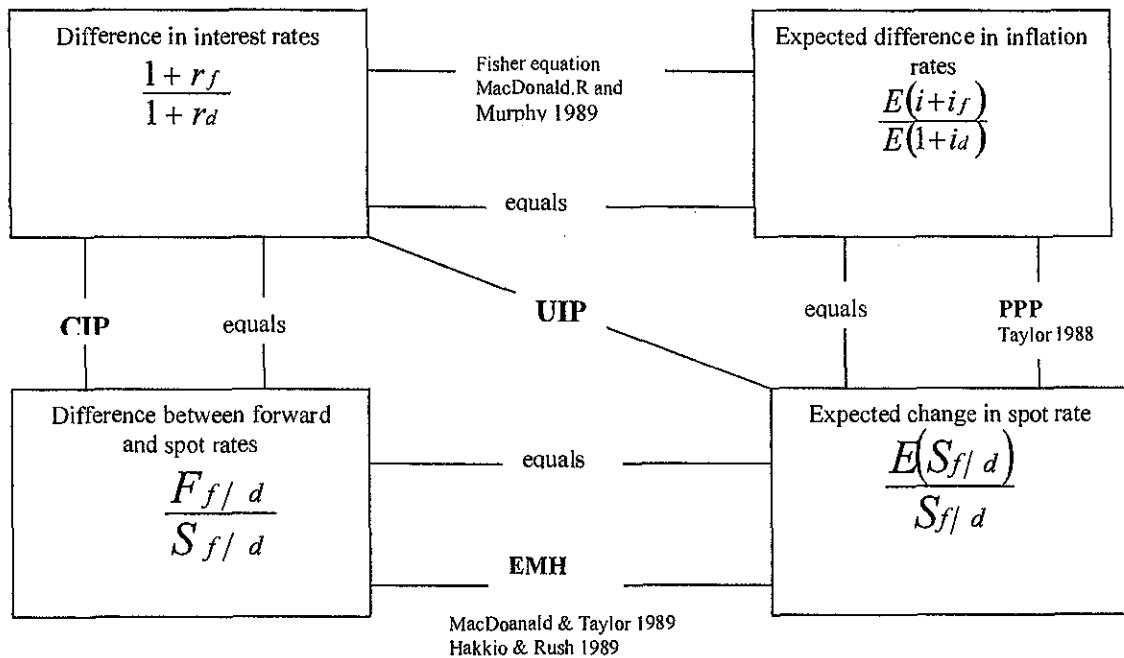


Figure 5.3 : Exchange rate assumptions

As far as the "news" approach is concerned, section 5.5 has provided a description of the candidate models that can be used as a "news" term in the context of EMH framework. Where again, using the aforementioned technique, the variables that are cointegrated are detected within each model of exchange rate determination. If the model is not entirely cointegrated (i.e. not all the variables are cointegrated in the model), there must be at least one or two variables that could form a long-run relationship with the exchange rate. These variables, that are cointegrated reflect the news term and will be used in a news format. The results and discussions on this matter are given in chapter 6.

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CHAPTER 6

The EMH, News and Cointegration: Analysis and Discussions

CHAPTER 6

The EMH, News and Cointegration:

Analysis and Discussions

6.0. Abstract

This chapter is a continuity of the previous one. In fact we will be presenting the analysis and discussions for testing the 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 chapter 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.

6.1. Introduction

Unanticipated events "news" plays 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 and portfolio approaches, in a 'news' context rather than regressing the exchange rate on the levels of, for example, relative money supplies.

Chapter 5 has discussed the problem of how this "news" can be modelled in foreign exchange markets. 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.

6.2. Limitations of the study

Cointegration analysis provides a way of investigating the possible existence of equilibrium relationships and of estimating any such relationship if it exists. Engle and Granger (1987) gives a detailed paper on the estimation, representation and testing of cointegrated variables. In Their work, however, they concentrated mainly on the bivariate case. Thus, the same implications of their study cannot be applied to the multivariate case. Consequently, this section gives some extended implications when the analysis is taken for more than two variables.

1) Cointegration does not necessarily mean that all the variables in question are $I(1)$ processes. For instance, all the variables may be $I(2)$ (i.e. requiring differencing twice to yield stationarity). All that is required is that all the variables entering the cointegrating regression have the same order of integration. This is not actually all that restrictive. Suppose that the variables x , y , and z are $I(1)$, $I(2)$, and $I(2)$ respectively. If there was a separate equilibrium relationship between y and z such that the deviations from this equilibrium were $I(1)$, then we could enter these $I(1)$ deviations into a relationship with x .

2) Engle and Granger (1987) provide critical values for testing unit roots of the residuals in the cointegrating regression between two variables only. Engle and Yoo (1987) extended the simulation results for the above test statistic to the case of 3, 4 and 5 regressors, (see Appendix 6.1). Their results show that the inference becomes much less precise as the number of regressors increases. For example the DF 5% critical value for 5 regressors and 100 observations is 4.58, compared to 2.89 with two regressors. Engle and Yoo (1987) argued that the critical values of DF differ from those of the ADF when the sample size is small. This suggests that the values of DF are likely to be conservative in small samples. If the sample size is about two hundred, the difference becomes negligible so that the values of the DF seem to be fairly appropriate for higher order systems as well.

The behaviour of the Durbin Watson statistic was also examined by Engle and Yoo (1987). They found that the discrepancy between the critical values for different systems remains significant even for the sample of size two hundred. Hence this statistic does not appear to be too useful for testing cointegration.

3) Another question which has been raised in the context of cointegration is that of choosing between alternative equilibrium relationships. Suppose that we have estimated the following statistic relationships:

$$y = a_1 x_1 + a_2 x_2 \quad (6.1)$$

$$y = b_1 x_1 + b_2 x_3 \quad (6.2)$$

and that both sets of variables (y, x_1, x_2) and (y, x_1, x_3) appear to cointegrate. The problem is how can we best discriminate between these two equilibrium specification.

Drobny and Hall (1987) advocated a non-nested testing procedure to solve this problem.

If both equations (6.1) and (6.2) appear to be admissible cointegrating regressions, this suggests that they are two equations from the system because, for instance, there cannot exist two different consumption functions in reality. So, if they are equations from the system, this leads to the question of why it is necessary to choose between them in the first place. On the other hand, if they are both alternative specifications of a single equation, for example, two different consumption functions, then under the null one

must be false so that either the residuals from (6.1) or the residuals from (6.2) is non-stationary.

6.3. 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:

6.3.1. 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 = 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.

$\pi - \pi^*$ = expected inflation differential at home and abroad, proxied by long-term government bond differential.

6.3.2. Portfolio Balance Model

In this context, we will be using the "Uniform Preference Model" as in equation (5.32). It will be tested for the case of Germany. The variables considered are:

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.

6.4. 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 94Q1. There are 84 observations of each variable, so that the critical values reported by Fuller (1976), Engle and Granger (1987) and Engel and Yoo are appropriate.

6.5. 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.

6.5.1. Statistical and Stability Tests

6.5.1.1. The General Monetary Model

In the previous chapter, we have seen that 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, equation (5.27) is tested for Germany, UK, Switzerland, and France over the period 73Q1 – 94Q1. Using ordinary Least Squares, Table (6.2) 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 (Dornbusch, 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 test, 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 (6.1 to 6.4) 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.

Table 6-1 Testing for Unit Roots in variables of exchange rate models.

Variable	Germany		United Kingdom		Switzerland		France	
	DF	ADF	DF	ADF	DF	ADF	DF	ADF
$\Delta(m-m^*)$	-1.21	-2.08	0.78	0.71	-0.90	-0.78	-2.17	-2.41
$\Delta(y-y^*)$	-0.89	-0.60	-1.37	-1.45	-1.82	-1.60	-0.68	-0.63
$\Delta(i-i^*)$	-2.80	-2.22	-2.67	-2.82	-2.68	-2.49	-3.50*	-3.60*
$\Delta(\pi-\pi^*)$	-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 region $\{\theta | \theta < -2.89\}$. DF and ADF stand for the Dickey Fuller and Augmented Dickey Fuller tests respectively.

Table 6-2 Estimation of the General Monetary Exchange Rate, as in equation (5-27) Dependent variable is Log US \$/MAJOR Industrial currencies. Sample period 1973Q1- 94Q1

Country	α_0	$m-m^*$	$y-y^*$	$i-i^*$	$\pi-\pi^*$	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
U K	-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
SwitZerlan	-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 / US M_1 ; $y-y^* = \log$ of (country) production / US production; $i-i^* =$ short term country- US interest differential. $\pi-\pi^* =$ Expected country-US inflation differential, proxied by long term government bond differential.

The plot of (CUSUM) tests in figures (6.5 to 6.8) 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 - 94Q1. 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 (6.8) that the critical bonds at 5% level, and therefore the stability hypothesis is rejected in this model.

6.5.1.2. The Portfolio Balance Model

In this test we limit ourselves to the "uniform Preference" model represented in the previous chapter as in equation (5.32). Under this assumption, wealth redistribution via current account becomes irrelevant; all that matters are the supplies of bonds. From equation (5.32) 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.

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 - 94Q1. Table (6.5) 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.

6.5.2. 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 (6.1) 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.

6.5.3. Cointegration tests of Monetary and Portfolio Models

6.5.3.1. 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 (5.27) 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 (6.3) gives the DF, ADF tests, whereas the CRDW tests are given in Table (6.4). 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 (5.27) (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 6.3 Testing for Unit Roots in the cointegrating residuals. The General Monetary Model Equation (5.27) DF and ADF tests

Dependent Variable ^a	Germany		UK		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
$\pi - \pi^*$	-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 : $S_t = a_0 + (m-m^*) - \phi (y-y^*) + \alpha (i-i^*) + \beta (\pi - \pi^*)$, The 1%, 5% and 10% critical values for these statistics are as follows : DF , 4.94, 4.35 and 4.02 ; ADF, -4.80, -4.15 and -3.85 (see Engle and Yoo (1997)).

Table 6.4 Testing for Unit Roots in the cointegrating residuals: The General Monetary model (5.27) : 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
$\pi - \pi^*$	0.52	0.62	0.92	1.07

See table 6.3 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 $I(2)$.

6.5.3.2. Cointegration tests for the Portfolio Model

This test proceeds at the same manner as the above test for the monetary model. Table (6.6) 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 6.5 Estimation of the Portfolio Balance Model as in equation (5.32) for Germany. Dependent Variable is Log US\$ / Dutch Mark, Sample period 73Q1- 94Q1.

Depen 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 6.6 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 $S_t = a_0 + \gamma(i-i^*) + b - f$. 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).

6.5.4. The EMH, 'News' and Cointegration tests

6.5.4.1. The Monetary Model "News" Approach

As far as this section is concerned, the general monetary model of exchange rate determination. This model is used as the news term in equation such ((5.11) in chapter 5, which is): $\ln S_t = a + b \ln F_{t-1} + \text{"News"} + W_t$

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

$$\ln S_t = a + b \ln F_{t-1} + \lambda(m-m^*) - \phi(y-y^*) + \alpha(i-i^*) + \beta(\pi-\pi^*) + W_t$$

The EMH suggests that W_t 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 (6.12) shows the first case, whereas the second is presented in tables (6.7), (6.9) and (6.10). Table (6.12) indicates that the DW is low, suggesting evidence of autocorrelation. However, when using the monetary model as the news term, Table (6.7) shows that the DW is improved, except in the case of UK.

As regards cointegration tests, Table (6.12) shows that the spot and forward rates are cointegrated, which is consistent with the EMH. Moreover, when introducing the news term, Table (6.9) shows that the DF and ADF were much improved compared to Table (6.12), suggesting cointegration between the spot rate and the other variables.

Normalising on S_t , F_{t-1} , $(m-m^*)$, $(y-y^*)$, $(i-i^*)$ and $(\pi - \pi^*)$, tables (6.9) and (6.10) 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. Furthermore, 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 supports the cointegration test results of the monetary model (section 6.5.3.1).

Figures (6.9 to 6.12) plot this test for Germany, UK, Switzerland and France respectively. Clearly, the stability test cannot be rejected at the 5% level

6.5.4.2. The Portfolio Balance Model "news" approach

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

$$\ln S_t = a + b \ln F_{t-1} + \alpha (i - i^*) + b - f + W_t$$

Table (6.8) shows that the DW is 1.70 compared to 1.47 in table (6.12). Indeed, when adding the news term, the DW is improved, but the joint hypothesis of $a = 0$ and $b = 1$ is rejected.

Normalising for S_t , F_{t-1} , $(i - i^*)$, b and f , table (6.11) indicates that the DF and ADF tests, for S_t as the dependant variable, are improved compared to those reported in table (6.12), 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 (6.7) Testing for the EMH using the "monetary Model" as the news term

Country	a_0	F_{t-1}	$m - m^*$	$y - y^*$	$i - i^*$	$\pi - \pi^*$	s.e	DW
Germany	-0.067 (0.051)	.99 (0.029)	0.06 (0.080)	-0.098 (0.137)	0.013 (0.003)	-0.0023(0.003)	0.033	1.90
U K	-0.153 (0.329)	0.79 (0.056)	-0.012 (0.072)	0.133 (0.222)	-0.0032 0.0047)	0.0096(0.005)	0.063	1.27
SwitZerlan	0.182 (0.31)	1.01 (0.033)	0.05 (0.065)	-0.092 (0.103)	0.015 (0.0057)	0.0003(0.004)	0.039	2.05
France	0.023 (0.049)	0.99 (0.0314)	-0.014 (0.038)	0.099 (0.149)	0.0072 (0.0042)	-0.013(0.007)	0.033	1.59

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

Table (6.8) The EMH using the "portfolio balance model" as the news term

Country	α_0	F_{t-1}	$i - i^*$	B	f	SE	DW
Germany	1.47 (0.518)	0.95 (0.031)	0.0084 (0.0025)	-0.038 (0.012)	-0.094 (0.037)	0.03	1.70

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

Table (6.9) Testing for unit roots in the cointegrating residual. The General Monetary Model (5.27) as the news term in the EMH framework. DF and ADF tests.

Dependent Variable ^a	Germany		UK		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
$\pi - \pi^*$	-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 $S_t = \alpha_0 + F_{t-1} + (m - m^*) - \phi(y - y^*) + \alpha(i - i^*) + \beta(\pi - \pi^*)$, and then normalizing on S_t , F_{t-1} , $m - m^*$, $y - y^*$, $i - i^*$ and $\pi - \pi^*$. See table (6.3) for critical values.

Table (6.10) 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
$\pi - \pi^*$	0.51	0.66	0.96	1.24

See table (6.4) for notes.

Table (6.11) 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 (6.6) for details.

6.5.5. The Effects of Including the Cointegrated Variables.

Table (6.12) 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 be 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 (6.12), 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 (6.12).

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.

6.6. 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 (6.12), 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 to the EMH. The section also provides the implication of Purchasing Power Parity Using Cointegration tests.

Table (6.12) The effects of incorporating the variables that are cointegrated in the EMH framework.

Country	a_0	F_{t-1}	$i - i^*$	$\pi - \pi^*$	DW	DF	ADF	F
German Spot	0.032 (0.024)	0.969 (0.029)	0.009 (0.002)	-	1.47	-5.81	-4.34	74.6
Rate	-0.025 (0.026)	1.0001 (0.027)	-	-	1.78	-6.79	-4.86	47.66
UK Spot	0.055(0.0264)	0.91 (0.042)	-	-	1.23	-5.18	-4.15	23.13
Rate	-0.04(0.028)	0.92 (0.041)	0.005 (0.0037)	-	1.31	-5.45	-4.35	72.29
Swiss Spot	-0.048 (0.019)	0.95 (0.0253)	-	-	1.66	-6.39	-4.85	89.8
Rate	-0.054 (0.28)	1.012 (0.025)	0.0127 (0.002)	-	2.00	-7.66	-5.09	87.3
	-0.058 (0.031)	1.016 (0.0283)	0.0123(0.003)	0.001 (0.02)	2.02	-7.73	-5.19	64.42
French Spot	0.44 (0.024)	0.97 (0.025)	-	-	1.38	-5.55	-4.16	0.62
Rate	-0.034 (0.045)	1.017 (0.0234)	0.0084 (0.003)	-0.01 (0.04)	1.57	-6.15	-4.32	2.62

Standard errors are in parentheses. The F-statistic test the hypothesis that $a_0 = 0$, $F_{t-1} = 1$ and $i - i^* = 0$. Sample period 73Q1 - 94Q1

Table 6.13 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 $\{ \theta \mid \theta < -2.89 \}$.

6.6.1. 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):

$$E(S_t | I_t) = f_{t-1}$$

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 (6.12) 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 we have drawn in chapter 5, saying that provided the CIP holds, market efficiency implies the validity of UIP. Table (6.12) 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 (6.12).

6.6.5. 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 - 94Q1. 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 (6.13) 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 (6.14) 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 S_t or on $\text{Ln} (\frac{P_t}{P_t^*})$). 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 6.14 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
UK	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).

6.7. 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 (6.12) 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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Appendix 6.1 Critical Values for the Cointegration Test DF (Dickey-Fuller)

Numbers of Variables	Sample Size	Significance level		
		1%	5%	10%
	T			
	50	2.62	1.95	1.61
	100	2.60	1.95	1.61
1a	250	2.58	1.95	1.61
	500	2.58	1.95	1.62
	∞	2.58	1.95	
1b	50	3.58	2.93	2.60
	100	3.51	2.89	2.58
	250	3.46	2.88	2.57
	500	3.44	2.87	2.57
	∞	3.43	2.86	2.57
2	50	4.32	3.67	3.28
	100	4.07	3.37	3.03
	200	4.00	3.37	3.02
3	50	4.84	4.11	3.73
	100	4.45	3.93	3.59
	200	4.35	3.78	3.47
4	50	4.94	4.35	4.02
	100	4.75	4.22	3.89
	200	4.73	4.18	3.89
5	50	5.41	4.76	4.42
	100	5.18	4.58	4.26
	200	5.02	4.48	4.18

a Critical values of τ ; b Critical values of τ_{μ} . Both cited in (Fuller, 1976) p.373; These simulations results are reported by Engle and Yoo (1987)

Appendix 6.2 Critical Values for the ADF (Augmented Dickey Fuller) test

Numbers of Variables	Sample Size	Significance level		
	T	1%	5%	10%
2	50	4.12	3.29	2.90
	100	3.43	3.17	2.91
	200	3.78	3.25	2.98
3	50	4.46	3.75	3.36
	100	4.22	3.62	3.32
	200	4.34	3.78	3.51
4	50	4.61	3.98	3.67
	100	4.61	4.02	3.71
	200	4.72	4.13	3.83
5	50	4.80	4.15	3.85
	100	4.98	4.36	4.06
	200	4.97	4.43	4.14

These results are from Engle and Yoo (1987)

CHAPTER 6

The EMH, News and Cointegration: Analysis and Discussions

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The EMH, News and Cointegration:

Analysis and Discussions

6.0. Abstract

This chapter is a continuity of the previous one. In fact we will be presenting the analysis and discussions for testing the 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 chapter 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.

6.1. Introduction

Unanticipated events "news" plays 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 and portfolio approaches, in a 'news' context rather than regressing the exchange rate on the levels of, for example, relative money supplies.

Chapter 5 has discussed the problem of how this "news" can be modelled in foreign exchange markets. 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.

6.2. Limitations of the study

Cointegration analysis provides a way of investigating the possible existence of equilibrium relationships and of estimating any such relationship if it exists. Engle and Granger (1987) gives a detailed paper on the estimation, representation and testing of cointegrated variables. In Their work, however, they concentrated mainly on the bivariate case. Thus, the same implications of their study cannot be applied to the multivariate case. Consequently, this section gives some extended implications when the analysis is taken for more than two variables.

1) Cointegration does not necessarily mean that all the variables in question are $I(1)$ processes. For instance, all the variables may be $I(2)$ (i.e. requiring differencing twice to yield stationarity). All that is required is that all the variables entering the cointegrating regression have the same order of integration. This is not actually all that restrictive. Suppose that the variables x , y , and z are $I(1)$, $I(2)$, and $I(2)$ respectively. If there was a separate equilibrium relationship between y and z such that the deviations from this equilibrium were $I(1)$, then we could enter these $I(1)$ deviations into a relationship with x .

2) Engle and Granger (1987) provide critical values for testing unit roots of the residuals in the cointegrating regression between two variables only. Engle and Yoo (1987) extended the simulation results for the above test statistic to the case of 3, 4 and 5 regressors, (see Appendix 6.1). Their results show that the inference becomes much less precise as the number of regressors increases. For example the DF 5% critical value for 5 regressors and 100 observations is 4.58, compared to 2.89 with two regressors. Engle and Yoo (1987) argued that the critical values of DF differ from those of the ADF when the sample size is small. This suggests that the values of DF are likely to be conservative in small samples. If the sample size is about two hundred, the difference becomes negligible so that the values of the DF seem to be fairly appropriate for higher order systems as well.

The behaviour of the Durbin Watson statistic was also examined by Engle and Yoo (1987). They found that the discrepancy between the critical values for different systems remains significant even for the sample of size two hundred. Hence this statistic does not appear to be too useful for testing cointegration.

3) Another question which has been raised in the context of cointegration is that of choosing between alternative equilibrium relationships. Suppose that we have estimated the following statistic relationships:

$$y = a_1 x_1 + a_2 x_2 \quad (6.1)$$

$$y = b_1 x_1 + b_2 x_3 \quad (6.2)$$

and that both sets of variables (y, x_1, x_2) and (y, x_1, x_3) appear to cointegrate. The problem is how can we best discriminate between these two equilibrium specification. Drobny and Hall (1987) advocated a non-nested testing procedure to solve this problem.

If both equations (6.1) and (6.2) appear to be admissible cointegrating regressions, this suggests that they are two equations from the system because, for instance, there cannot exist two different consumption functions in reality. So, if they are equations from the system, this leads to the question of why it is necessary to choose between them in the first place. On the other hand, if they are both alternative specifications of a single equation, for example, two different consumption functions, then under the null one

must be false so that either the residuals from (6.1) or the residuals from (6.2) is non-stationary.

6.3. 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:

6.3.1. 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 = 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.

$\pi - \pi^*$ = expected inflation differential at home and abroad, proxied by long-term government bond differential.

6.3.2. Portfolio Balance Model

In this context, we will be using the "Uniform Preference Model" as in equation (5.32). It will be tested for the case of Germany. The variables considered are:

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.

6.4. 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 94Q1. There are 84 observations of each variable, so that the critical values reported by Fuller (1976), Engle and Granger (1987) and Engel and Yoo are appropriate.

6.5. 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.

6.5.1. Statistical and Stability Tests

6.5.1.1. The General Monetary Model

In the previous chapter, we have seen that 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, equation (5.27) is tested for Germany, UK, Switzerland, and France over the period 73Q1 – 94Q1. Using ordinary Least Squares, Table (6.2) 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 (Dornbusch, 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 test, 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 (6.1 to 6.4) 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.

Table 6-1 Testing for Unit Roots in variables of exchange rate models.

Variable	Germany		United Kingdom		Switzerland		France	
	DF	ADF	DF	ADF	DF	ADF	DF	ADF
$\Delta(m-m^*)$	-1.21	-2.08	0.78	0.71	-0.90	-0.78	-2.17	-2.41
$\Delta(y-y^*)$	-0.89	-0.60	-1.37	-1.45	-1.82	-1.60	-0.68	-0.63
$\Delta(i-i^*)$	-2.80	-2.22	-2.67	-2.82	-2.68	-2.49	-3.50*	-3.60*
$\Delta(\pi-\pi^*)$	-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 region $\{\theta | \theta < -2.89\}$. DF and ADF stand for the Dickey Fuller and Augmented Dickey Fuller tests respectively.

Table 6-2 Estimation of the General Monetary Exchange Rate, as in equation (5-27) Dependent variable is Log US \$/MAJOR Industrial currencies. Sample period 1973Q1- 94Q1

Country	α_0	$m-m^*$	$y-y^*$	$i-i^*$	$\pi-\pi^*$	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
U K	-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
SwitZerlan	-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 / US M_1 ; $y-y^*$ = log of (country) production / US production; $i-i^*$ = short term country- US interest differential. $\pi-\pi^*$ = Expected country-US inflation differential, proxied by long term government bond differential.

The plot of (CUSUM) tests in figures (6.5 to 6.8) 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 - 94Q1. 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 (6.8) that the critical bonds at 5% level, and therefore the stability hypothesis is rejected in this model.

6.5.1.2. The Portfolio Balance Model

In this test we limit ourselves to the "uniform Preference" model represented in the previous chapter as in equation (5.32). Under this assumption, wealth redistribution via current account becomes irrelevant; all that matters are the supplies of bonds. From equation (5.32) 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.

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 - 94Q1. Table (6.5) 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.

6.5.2. 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 (6.1) 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.

6.5.3. Cointegration tests of Monetary and Portfolio Models

6.5.3.1. 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 (5.27) 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 (6.3) gives the DF, ADF tests, whereas the CRDW tests are given in Table (6.4). 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 (5.27) (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 6.3 Testing for Unit Roots in the cointegrating residuals. The General Monetary Model Equation (5.27) DF and ADF tests

Dependent Variable ^a	Germany		UK		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
$\pi - \pi^*$	-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 : $S_t = a_0 + (m-m^*) - \phi (y-y^*) + \alpha (i-i^*) + \beta (\pi-\pi^*)$, 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 6.4 Testing for Unit Roots in the cointegrating residuals: The General Monetary model (5.27) : 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
$\pi - \pi^*$	0.52	0.62	0.92	1.07

See table 6.3 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).

6.5.3.2. Cointegration tests for the Portfolio Model

This test proceeds at the same manner as the above test for the monetary model. Table (6.6) 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 6.5 Estimation of the Portfolio Balance Model as in equation (5.32) for Germany. Dependent Variable is Log US\$ / Dutch Mark, Sample period 73Q1- 94Q1.

Depen 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 6.6 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 $S_t = a_0 + \gamma(i-i^*) + b - f$. 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).

6.5.4. The EMH, 'News' and Cointegration tests

6.5.4.1. The Monetary Model "News" Approach

As far as this section is concerned, the general monetary model of exchange rate determination. This model is used as the news term in equation such ((5.11) in chapter 5, which is): $\ln S_t = a + b \ln F_{t-1} + \text{"News"} + W_t$

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

$$\ln S_t = a + b \ln F_{t-1} + \lambda(m-m^*) - \phi(\gamma-\gamma^*) + \alpha(i-i^*) + \beta(\pi-\pi^*) + W_t$$

The EMH suggests that W_t 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 (6.12) shows the first case, whereas the second is presented in tables (6.7), (6.9) and (6.10). Table (6.12) indicates that the DW is low, suggesting evidence of autocorrelation. However, when using the monetary model as the news term, Table (6.7) shows that the DW is improved, except in the case of UK.

As regards cointegration tests, Table (6.12) shows that the spot and forward rates are cointegrated, which is consistent with the EMH. Moreover, when introducing the news term, Table (6.9) shows that the DF and ADF were much improved compared to Table (6.12), suggesting cointegration between the spot rate and the other variables.

Normalising on S_t , F_{t-1} , $(m-m^*)$, $(y-y^*)$, $(i-i^*)$ and $(\pi - \pi^*)$, tables (6.9) and (6.10) 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. Furthermore, 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 supports the cointegration test results of the monetary model (section 6.5.3.1).

Figures (6.9 to 6.12) plot this test for Germany, UK, Switzerland and France respectively. Clearly, the stability test cannot be rejected at the 5% level

6.5.4.2. The Portfolio Balance Model "news" approach

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

$$\ln St = a + b \ln Ft_{-1} + \alpha (i - i^*) + b - f + W_t$$

Table (6.8) shows that the DW is 1.70 compared to 1.47 in table (6.12). 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 (6.11) indicates that the DF and ADF tests, for St as the dependant variable, are improved compared to those reported in table (6.12), 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 (6.7) Testing for the EMH using the "monetary Model" as the news term

Country	a_0	F_{t-1}	$m - m^*$	$y - y^*$	$i - i^*$	$\pi - \pi^*$	s.e	DW
Germany	-0.067 (0.051)	.99 (0.029)	0.06 (0.080)	-0.098 (0.137)	0.013 (0.003)	-0.0023(0.003)	0.033	1.90
U K	-0.153 (0.329)	0.79 (0.056)	-0.012 (0.072)	0.133 (0.222)	-0.0032 (0.0047)	0.0096(0.005)	0.063	1.27
SwitZerlan	0.182 (0.31)	1.01 (0.033)	0.05 (0.065)	-0.092 (0.103)	0.015 (0.0057)	0.0003(0.004)	0.039	2.05
France	0.023 (0.049)	0.99 (0.0314)	-0.014 (0.038)	0.099 (0.149)	0.0072 (0.0042)	-0.013(0.007)	0.033	1.59

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

Table (6.8) The EMH using the "portfolio balance model" as the news term

Country	α_0	F_{t-1}	$i - i^*$	B	f	SE	DW
Germany	1.47 (0.518)	0.95 (0.031)	0.0084 (0.0025)	-0.038 (0.012)	-0.094 (0.037)	0.03	1.70

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

Table (6.9) Testing for unit roots in the cointegrating residual. The General Monetary Model (5.27) as the news term in the EMH framework. DF and ADF tests.

Dependent Variable ^a	Germany		U K		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
$\pi - \pi^*$	-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 $S_t = \alpha_0 + F_{t-1} + (m - m^*) - \phi(y - y^*) + \alpha(i - i^*) + \beta(\pi - \pi^*)$, and then normalizing on S_t , F_{t-1} , $m - m^*$, $y - y^*$, $i - i^*$ and $\pi - \pi^*$. See table (6.3) for critical values.

Table (6.10) 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
$\pi - \pi^*$	0.51	0.66	0.96	1.24

See table (6.4) for notes.

Table (6.11) 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 (6.6) for details.

6.5.5. The Effects of Including the Cointegrated Variables.

Table (6.12) 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 (6.12), 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 (6.12).

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.

6.6. 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 (6.12), 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 (6.12) The effects of incorporating the variables that are cointegrated in the EMH framework.

Country	a_0	F_{t-1}	$i - i^*$	$\pi - \pi^*$	DW	DF	ADF	F
German Spot	0.032 (0.024)	0.969 (0.029)	0.009 (0.002)	-	1.47	-5.81	-4.34	74.6
Rate	-0.025 (0.026)	1.0001 (0.027)	-	-	1.78	-6.79	-4.86	47.66
UK Spot	0.055(0.0264)	0.91 (0.042)	-	-	1.23	-5.18	-4.15	23.13
Rate	-0.04(0.028)	0.92 (0.041)	0.005 (0.0037)	-	1.31	-5.45	-4.35	72.29
Swiss Spot	-0.048 (0.019)	0.95 (0.0253)	-	-	1.66	-6.39	-4.85	89.8
Rate	-0.054 (0.28)	1.012 (0.025)	0.0127 (0.002)	-	2.00	-7.66	-5.09	87.3
	-0.058 (0.031)	1.016 (0.0283)	0.0123(0.003)	0.001 (0.02)	2.02	-7.73	-5.19	64.42
French Spot	0.44 (0.024)	0.97 (0.025)	-	-	1.38	-5.55	-4.16	0.62
Rate	-0.034 (0.045)	1.017 (0.0234)	0.0084 (0.003)	-0.01 (0.04)	1.57	-6.15	-4.32	2.62

Standard errors are in parentheses. The F-statistic test the hypothesis that $a_0 = 0$, $F_{t-1} = 1$ and $i - i^* = 0$. Sample period 73Q1 - 94Q1

Table 6.13 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 $\{ \theta \mid \theta < -2.89 \}$.

6.6.1. 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):

$$E(S_t | I_t) = f_{t-1}$$

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 (6.12) 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 we have drawn in chapter 5, saying that provided the CIP holds, market efficiency implies the validity of UIP. Table (6.12) 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 (6.12).

6.6.5. 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 - 94Q1. 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 (6.13) 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 (6.14) 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 S_t 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 6.14 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
UK	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).

6.7. 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 (6.12) 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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Appendix 6.1 Critical Values for the Cointegration Test DF (Dickey-Fuller)

Numbers of Variables	Sample Size	Significance level		
		1%	5%	10%
	T			
	50	2.62	1.95	1.61
	100	2.60	1.95	1.61
1a	250	2.58	1.95	1.61
	500	2.58	1.95	1.62
	∞	2.58	1.95	
1b	50	3.58	2.93	2.60
	100	3.51	2.89	2.58
	250	3.46	2.88	2.57
	500	3.44	2.87	2.57
	∞	3.43	2.86	2.57
2	50	4.32	3.67	3.28
	100	4.07	3.37	3.03
	200	4.00	3.37	3.02
3	50	4.84	4.11	3.73
	100	4.45	3.93	3.59
	200	4.35	3.78	3.47
4	50	4.94	4.35	4.02
	100	4.75	4.22	3.89
	200	4.73	4.18	3.89
5	50	5.41	4.76	4.42
	100	5.18	4.58	4.26
	200	5.02	4.48	4.18

a Critical values of τ ; b Critical values of τ_{μ} . Both cited in (Fuller, 1976) p.373; These simulations results are reported by Engle and Yoo (1987)

Appendix 6.2 Critical Values for the ADF (Augmented Dickey Fuller) test

Numbers of Variables	Sample Size	Significance level		
	T	1%	5%	10%
2	50	4.12	3.29	2.90
	100	3.43	3.17	2.91
	200	3.78	3.25	2.98
3	50	4.46	3.75	3.36
	100	4.22	3.62	3.32
	200	4.34	3.78	3.51
4	50	4.61	3.98	3.67
	100	4.61	4.02	3.71
	200	4.72	4.13	3.83
5	50	4.80	4.15	3.85
	100	4.98	4.36	4.06
	200	4.97	4.43	4.14

These results are from Engle and Yoo (1987)

CHAPTER 7

Exchange rates in developing countries

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Exchange rates in developing countries

7.0 Abstract

This chapter reviews recent trends in thinking on exchange rate regimes. It begins by classifying countries into regimes, noting the main determinants of these regimes. The advantages of fixed exchange rates versus floating are reviewed, including the recent exchange rate corner hypothesis. The following section provides the performance of nominal exchange rates and discuss what would be the future of the intermediate regimes. The next section is concerned with some issues raised by the exchange rate arrangements. This includes the concept of the real exchange rate (RER) and the misalignment of exchange rates. Some empirical evidence is also given concerning the purchasing power parity (PPP) and RER stationarity in developing countries. The last section deals with the use of parallel markets as a guide to setting the official exchange rate, examines where the debate now stands, and summarizes the consensus reached and lessons learned from recent experience.

7.1. Introduction

An exchange rate, as a price of one country's money in terms of another's, is among the most important prices in an open economy. It influences the flow of goods, services, and capital in a country, and exerts strong pressure on the balance of payments, inflation and other macroeconomic variables. Therefore, the choice and management of an exchange rate regime is a critical aspect of economic management to safeguard competitiveness, macroeconomic stability, and growth.

The choice of an appropriate exchange rate regime for developing countries has been at the center of the debate in international finance for a long time. What are the costs and benefits of various exchange rate regimes? What are the determinants of the choice of an exchange rate regime and how would country circumstances affect the choice? Does macroeconomic performance differ under alternative regimes? How would an exchange rate adjustment affect trade flows? The steady increase in magnitude and variability of international capital flows has intensified the debate in the past few years as each of the major currency crises in the 1990s has in some way involved a fixed exchange rate and sudden reversal of capital inflows. New questions include: Are pegged regimes inherently crisis-prone? Which regimes would be better suited to deal with increasingly global and unstable capital markets? While the debate continues, there are areas where some consensus is emerging, and there are valuable lessons from earlier experience for developing countries. This section provides a review of the main issues in selecting an appropriate regime, gives the main issues in exchange rate arrangements such as the corner hypothesis, the real exchange rate and the problem of misalignment in developing countries.

7.2. Choice Of Exchange Rate Regimes For Developing Countries

The choice of an appropriate exchange rate regime for developing countries has been the main concern in international finance for a long time. Questions such as: What are the costs and benefits of various exchange rate regimes? What are the determinants of the choice of an exchange rate regime and how would country circumstances affect the choice? , are the most debated in the literature of exchange rates. New questions

include: the future of the intermediate regimes and the introduction of the corner hypothesis, (Frankel, 2003).

While the debate continues, there are areas where some consensus is emerging, and there are valuable lessons from earlier experience for developing countries.

A growing consensus seems to be emerging on the following (Fahrettin, 2001):

(a) Selection of an exchange rate regime that is most likely to suit a country's economic interest would depend on a variety of factors including: specific country circumstances (the size and openness of the country to trade and financial flows, structure of its production and exports, stage of its financial development, its inflationary history, and the nature and source of shocks it faces); policymakers' preferences for the trade offs among the main policy objectives; political conditions in the country; and the credibility of its policy makers and institutions. Therefore, there is no single ideal exchange rate regime that is appropriate for all countries. The actual choice from an array of regimes depends on the relative weight given to each of these factors. In addition, an exchange rate regime appropriate for a country would change over time with changing country circumstances.

"For most countries ... the choice of exchange rate policy is probably their single most important macroeconomic policy decision, strongly influencing their freedom of action and effectiveness of other macroeconomic policies, the evolution of their financial system, and even the evolution of their economies" Cooper (1999).

(b) The steady increase in magnitude and variability of international capital flows in the past two decades has undermined the viability of soft peg arrangements (fixed, adjustable peg, and narrow band exchange rate regimes). A number of emerging market economies integrated or integrating into international capital markets with soft peg regimes have experienced severe currency crisis and economic disruption in the 1990s. As a result, an increasing number of countries are moving toward the ends of the spectrum - that is, independent floating exchange rates on the one end to dollarization on the other. This "disappearing middle" does not mean that all countries should move to the very ends of the spectrum. Intermediate regimes such as crawling bands could be

viable alternatives if they are supported by appropriate macroeconomic policies. It is also widely maintained that some form of soft peg regimes would be more viable and more appropriate for most poorer developing economies because their involvement in international capital markets is limited. However, as they develop over the longer term and want to open their capital accounts, they need to move away from soft pegs and towards either more flexibility or more fixity.

(c) For any exchange rate regime to maintain a stable and competitive real exchange rate requires, a strong financial sector, a supportive policy environment which would include prudent macroeconomic policies and credible institutions. Monetary policy should be consistent with exchange rate objectives. Failure to establish fiscal discipline would lead a country to crisis under any exchange rate regime. Adequate accounting standards and disclosure requirements, Better managed and supervised financial system, prudent foreign exchange exposure of the banking sector and domestic businesses, and efficient legal and judicial systems are also important requirements for an exchange rate regime to successfully maintain competitiveness and avoid a currency crisis.

(d) Empirical evidence shows that there is a strong correlation between overvaluation of the real exchange rate and the unsustainable balance of payments deficit, currency crisis, and low economic growth.

Hence, a key objective of the exchange rate policy is to maintain a stable and competitive real rate consistent with the economic fundamentals of the country. Empirical evidence on macroeconomic performance under alternative exchange rate regimes is limited, and the methodology used in these studies is not fully satisfactory. However, earlier studies indicate that, compared to the floating regimes, pegged exchange rate regimes are associated with lower inflation and slightly lower output growth. More recent studies found no significant impact of pegged regimes on inflation but they confirmed the negative correlation between the pegged regimes and per capita output growth.

(e) Nominal devaluation would not achieve a depreciation of real exchange rate because price elasticity of import demand, export demand, and export supply is very

low, thus leading to significant overvaluation of the national currency. Empirical evidence from a large number of developing countries shows that (Fahrettin, 2001) :

- successful devaluations have typically led to a depreciation of the real exchange rate of 30 to 70 percent;
- the import elasticity with respect to the real exchange rate has been within the range of -0.7 and -0.9;
- the price elasticity of supply of aggregate exports of non-oil exporting countries would be at least 1; and
- because the price elasticity of both demand and supply of traditional exports tend to be small, export diversification is necessary for commodity-exporting countries, for which a competitive real exchange rate is essential.

7.2.1 Main Determinants of the Choice of Exchange Rate Regimes

The experience with implementation of the exchange rate regime allows us to make some generalizations about the conditions under which various regimes would function reasonably well - though there are many exceptions. The floating regimes would be an appropriate choice for medium and large industrialized countries and some emerging market economies that have import and export sectors that are relatively small compared to GDP, but are fully integrated in the global capital markets and have diversified production and trade, a deep and broad financial sector, and strong prudential standards. The hard peg regimes are more appropriate for countries satisfying the optimum currency area criteria (countries in the European Economic and Monetary Union), small countries already integrated in a larger neighboring country (dollarization in Panama), or countries with a history of monetary disorder, high inflation, and low credibility of policymakers to maintain stability that need a strong anchor for monetary stabilization (currency board in Argentina and Bulgaria). The soft peg regimes would be best for countries with limited links to international capital markets, less diversified production and exports, and shallow financial markets, as well as countries stabilizing from high and protracted inflation under an exchange rate-based stabilization program (Turkey). These are largely but not exclusively non-emerging market developing countries. The intermediate regimes, a middle road

between floating rates and soft pegs, aim to incorporate the benefits of floating and pegged regimes while avoiding their shortcomings. They are better suited for emerging market economies and some other developing countries with relatively stronger financial sector and track record for disciplined macroeconomic policy (Frankel, 2003).

Dollarization is a generic name used to mean the replacement of a national currency by a foreign currency as legal tender, which would refer not only to the use of the dollar, but also for instance to the use of the Rand, Franc, etc (Frankel *et al*, 2001).

7.3. Nominal Exchange Rate Regimes and Macroeconomic Performance

The modern literature on exchange rate regimes has emphasized the existence of important tradeoffs between *credibility* and *flexibility* (Frankel, 1995, Rodrik, 1992, Edwards, 1996). In doing this, however, most theoretical analyses have considered two highly simplified extreme cases: (i) a fully flexible (or floating) exchange rate with minimal central bank intervention; and (ii) an irrevocably (and credibly) fixed nominal exchange rate. According to this bipolar characterization, a flexible exchange

rate regime allows a country to have an independent monetary policy, providing the economy with flexibility to accommodate domestic and foreign shocks, including changes in external terms of trade and interest rates. This flexibility, however, usually comes at the cost of some loss in credibility and, thus, tends to be associated (on average) with higher inflation. Alternatively, fixed exchange rates reduce the degree of flexibility of the system but impart (in theory) a higher degree of credibility to policy making. Since the public believes that, under fixed rates, the primary goal of monetary policy is to preserve the exchange rate parity, they moderate their wage and price expectations, thus allowing the economy to attain a lower rate of inflation. This analysis assumes that under a fixed exchange rate regime the authorities are always more disciplined and, thus, that the fixed exchange rate is never abandoned--that is, devaluations are not an option. This, of course, is an oversimplification. In fact, as history has shown again and again, fixed exchange rates often fail to impose macroeconomic discipline and end up in major devaluation crises (see, for example, Cooper, 1971, Kamin, 1988, and Edwards, 1989). For this reason, a number of analysts that favor credibility over flexibility increasingly argue that fixed exchange rates are a necessary, but not sufficient condition for achieving macroeconomic stability, and that

additional institutional constraints on policy makers--even at the constitutional level--have to be devised.

Purely floating and fixed systems are, of course, only two of the possible exchange rate regimes a country can choose. In reality, there are many layers between these two extremes. Table (7.1) contains a list of nine alternative exchange rate regimes, ranked according to the degree of flexibility that they impart to the economy or, in inverse order, according to the relative stability they afford to the nominal exchange rate. The table describes briefly the main features of each regime, summarizes their alleged merits and shortcomings, and mentions a few relevant historical experiences.

Table Alternative Exchange Rate Regimes

Regime	Main Features	Main Benefits	Main Shortcomings	Key episodes /Comments
1. Free Float	-Value of foreign exchange freely determined in the market. Actual and expected changes in demand/supply of assets and goods reflected in exchange rate changes.	-Changes in nominal exchange rate shoulder bulk of adjustment to foreign and domestic shocks. -High international reserves not required.	-High nominal (and real) exchange rate volatility may distort resource allocation. -Monetary policy needs to be framed in terms of nominal anchors different from the exchange rate; scope for discretion and inflation bias may be large.	-Virtually no country has a pure float. The United States, Germany, Switzerland (and Japan, according to some) come close.
2. "Dirty" Float	-Sporadic central bank interventions in foreign exchange market. Modes and frequency of intervention vary, as do the objectives guiding the intervention. -Active intervention (sterilized and non-sterilized) results in changes in international reserves. Indirect intervention (through changes in interest rates, liquidity and other financial instruments) does not result in changes in reserves.	-Same as in a free float, except that higher international reserves may be needed. -Dampens "excessive" fluctuations of exchange rates.	-Lack of transparency of central bank behavior may introduce too much uncertainty. -Effects of intervention are typically short-lived (even when intended as a signal) and may be destabilizing.	-Many advanced economies have adopted this regime—Canada, Australia (Japan, according to others). -Mexico adopted a system similar to this following the 1994-95 crisis. -A dirty float could be thought of as a managed float with wide bands, with the (undisclosed) position of the bands providing the criterion for intervention.
3. Floating within a Band (Target zone)	-The nominal exchange rate is allowed to fluctuate (somewhat freely) within a band. The center of the band is a <i>fixed rate</i> , either in terms of one currency or of a basket of currencies. The width of the band varies (in the ERM it was originally ± 2.25 percent). -Some band systems are the result of cooperative arrangements, others are unilateral.	-System combines the benefits of some flexibility with some credibility. -Key parameters (bands, mid-point) help guide the public's expectations. -Changes in the nominal rate within the bands help absorb shocks to fundamentals.	-In some cases (especially when the band is too narrow and when domestic macro policies are not consistent with a "horizontal" band) the system can be destabilizing and prone to speculative attacks. -Selecting the width of the band is not trivial. -Systems that allow for the possibility of realignment of the bands and central parity weaken the credibility afforded by the regime.	-The Exchange Rate Mechanism of the European Monetary System is the best known example of this type of regime. -The ERM crises of 1992-93 showed clearly that the system can be subjected to severe speculative pressures, and even collapse, when currencies become misaligned and central banks are hesitant to defend the bands.
4. Sliding Band	-There is no commitment by the authorities to maintain the central parity "indefinitely". Instead, it is clear at the outset that the central parity will be adjusted periodically (e.g., due to competitiveness considerations). -The system is an adaptation of the band regime to the case of high-inflation economies.	-The system allows countries with an ongoing rate of inflation higher than world inflation to adopt a band without having to experience a severe real appreciation.	-The fact that the tuning and size of central parity adjustments are unknown, introduces considerable volatility, which often leads to high interest rate volatility. -As in the case of the standard band system, it is difficult to choose the appropriate width for the band.	-Israel had a system similar to this from early 1989 to December 1991. -The uncertainty and volatility associated with this system makes it less attractive than other alternatives, such as the crawling band.
5. Crawling Band	-A band system whereby the central parity crawls over time. -Different rules can be used to determine the rate of crawl. The two most common are: backward-looking crawl (e.g., based on past inflation differentials), and forward-looking crawl (e.g., based on the expected, or target, rate of inflation).	-System allows high inflation countries to adopt a band system without having to undertake (large) stepwise adjustments of the central parity.	-Choosing the criteria for setting the rate of crawl entails serious risks. A backward-looking approach can introduce considerable inflationary inertia into the system. A forward-looking approach that sets the "wrong" inflation target can produce overvaluation and give rise to speculative pressures.	-Israel adopted this system in December 1991. -Chile had a widening band system from 1986 to mid-1998. Italy also had, effectively, a system of this type between 1979 and 1991.

Table (Concluded). Alternative Exchange Rate Regimes

Regime	Main Features	Main Benefits	Main Shortcomings	Key Episodes/Comments
6. Crawling peg	<p>-The nominal exchange rate is adjusted periodically according to a set of indicators (usually lagged inflation differentials) and is not allowed the fluctuate beyond a narrow range (say, two percent).</p> <p>-One variant of the system consists of adjusting the nominal rate by a pre-announced rate set deliberately below ongoing inflation (variant known as a "tablita" regime).</p>	<p>-Allows high-inflation countries to avoid severe real exchange rate overvaluation.</p> <p>-The "tablita" variant helps to guide the public's expectations, and buys a limited amount of credibility.</p>	<p>-A pure backward-looking crawling peg (where the nominal rate is mechanically adjusted according to past inflation differentials) introduces inflationary inertia and may eventually cause monetary policy to lose its role as nominal anchor.</p> <p>-Equilibrium changes in the real exchange rate are difficult to accommodate.</p> <p>-A "tablita" system will not last if fiscal and incomes policies are not supportive.</p>	<p>-This system became popular in the 1960s and 1970s in Chile, Colombia and Brazil. It had its longer running in Colombia, which to this date has a high degree of inflationary inertia.</p>
7. Fixed-but-adjustable exchange rate	<p>-The regime epitomized by the Bretton Woods system. The nominal exchange rate is fixed, but the central bank is not obliged to maintain the parity indefinitely. No tight constraints are imposed on the monetary and fiscal authorities, who can follow, if they so decide, policies that are inconsistent with preserving the parity.</p> <p>-Adjustments of the parity (devaluations) are a powerful policy instrument.</p>	<p>-Provides macroeconomic discipline by maintaining (tradable good prices) in line with foreign prices in a context of relatively low uncertainty.</p> <p>-The built-in "escape clause" (which allows the authorities to devalue in case of need) provides the system with some flexibility.</p>	<p>-Realignments (devaluations) under this system have typically been large and disruptive (introducing uncertainty and inflationary pressures) rather than smooth and orderly events.</p> <p>-If supplemented by the right institutions (e.g., an independent central bank) the time inconsistency problems embedded in the system could be attenuated.</p>	<p>-The most popular regime of this century. Most developing countries held on to (variants of) it after the formal collapse of the Bretton Woods agreement in 1973.</p> <p>-Many emerging countries continue to subscribe to this system de facto (e.g., Mexico 1993-93, Thailand, 1997), if not de jure.</p>
8. Currency board	<p>-Strict fixed exchange rate system, with institutional (legal, and even constitutional) constraints on monetary policy and no scope for altering the parity.</p> <p>-The monetary authority only can issue domestic money when it is fully backed by inflows of foreign exchange.</p>	<p>-The system maximizes credibility and reduces (eliminates) problems of "time inconsistency".</p>	<p>-The system is long on credibility but short on flexibility. Large external shocks cannot be accommodated through exchange rate changes but have to be fully absorbed by changes in unemployment and economic activity.</p> <p>-The central bank loses its role as lender of last resort.</p>	<p>-Historically, a number of small countries have had systems of this type. Some of them, however, have not been successful. When faced with major external shocks, countries have been forced to abandon the regime.</p> <p>-Currently, Hong Kong and Estonia have currency boards. Argentina and Bulgaria have (quasi)-currency boards arrangements.</p>
9. Full 'dollarization'	<p>-Generic name given to an extreme form of a currency board system where the country gives up completely its monetary autonomy by adopting another country's currency.</p>	<p>-Credibility is maximized under this regime. Monetary authorities have, in theory, no scope for "surprising" the public.</p>	<p>-As in the currency board, the system is long on credibility but short on flexibility. Adverse external shocks have to be absorbed fully by the real economy.</p> <p>-The central bank loses its role as lender of last resort.</p> <p>-A non trivial shortcoming of this system is that it is usually resisted on political and nationalistic grounds. Another one, is that the rules of the game can be changed under extreme circumstances.</p>	<p>There are few historical episodes of full dollarization. A regime similar to this has worked relatively well in Panama. However, the case of Liberia unmasked a serious shortcoming of this type of system: when faced with an emergency (civil war) politicians decided to change the rules of the game and issued a national currency.</p>

7.3.1. The Shift Away from Currency Pegs

Since the late 1970s single currency pegs have become increasingly less common among developing countries. This feature of the recent evolution of the international monetary system has been amply documented and discussed in the exchange rate literature. The standard way of illustrating this gradual shift toward more flexible exchange regimes by LDCs has been to trace the evolution over time of the official exchange rate arrangements that countries are obliged to report to the IMF. Table (7.2) (taken from IMF, 1997) is a typical example; the table shows a steady fall over the past two decades in the number of developing countries that maintain some type of pegged exchange rates, and a concomitant rise in the number of countries with "more flexible" exchange rate regimes.

At least two broad explanations have been offered to account for this trend toward greater exchange rate flexibility. One explanation is that starting in the late 1970s a confluence of factors of external and domestic origin prompted developing countries to rely more heavily on exchange rate changes as part of their process of macroeconomic adjustment. Those factors obviously vary from country to country (and from region-to-region) but are typically thought to include the large exchange rate fluctuations among major currencies that followed the breakdown of the Bretton Woods system, the oil shocks of the 1970s and 1980s, the debt crisis of the 1980s, and, especially in Latin America, fiscally-driven bouts of high and chronic inflation. A key premise underlying this explanation is that exchange rate changes can (and should) play a central role in restoring and preserving external and domestic equilibrium in shock-prone developing countries (see, for example, the discussion in Corden, 1990, Aghevli et al., 1991, and Little et al., 1993).

Chapter 7 : Exchange Rates in Developing Countries

Table (7.2) Developing Countries: Officially Reported Exchange Rate Arrangements (In percent of total)

	1976	1981	1986	1991	1996
Pegged	86	75	67	57	45
U.S. dollar	42	32	25	19	15
French franc	13	12	11	11	11
Other	7	4	4	3	4
SDR	12	13	8	5	2
Composite	12	14	18	20	14
Limited flexibility	3	10	5	4	3
Single	3	10	5	4	3
Cooperative	--	--	--	--	--
More flexible	11	15	28	34	52
Set to indicators	6	3	4	4	2
Managed floating	4	9	13	16	21
Independently floating	1	4	11	19	29
Number of countries	100	113	119	123	123

Source: IMF, 1997.

7.3.2. Five Common Propositions Regarding Exchange-Rate Regimes

Frankel, (1999) gave five propositions concerning exchange rate regimes. The first proposition is that countries should generally move to increased exchange-rate flexibility. This particularly came from policymakers who have tried over the last two years to help fight speculative pressures against exchange-rate targets in Thailand, Korea, Indonesia, Russia, and Brazil, where the attempts ended in costly crashes. When exchange rates float, there is no target that needs defending.

A second proposition, which is totally opposed to the first one, is that all countries should move toward enhanced institutional commitment to fixing the exchange rate. After all, none of those crisis-influenced currencies had been literally or formally fixed to the dollar. Enthusiasts point to currency boards that have successfully weathered the storms in Hong Kong and Argentina. Some even go further and suggest full official dollarization. They take encouragement from the euro-eleven's successful move to a common currency on January 1, 1999.

A third proposition is that countries in general must move increasingly in either direction on exchange-rate regimes--free-floating or firm-fixing--but that the intermediate regimes such as target zones are no longer tenable (See Figure 7.1 for definitions). This proposition, too, is in danger of being applied too broadly.

The fourth proposition is the prediction that the world is breaking up into a few big currency blocs as European countries give up their currencies for the euro and Western Hemisphere countries give up theirs for the dollar. (The perceived trends in the first two blocs have recently become more plausible in light of the success of the European Monetary Union (EMU) and talk in Latin America of dollarization. Not so the yen bloc, however.)

The final proposition is the opposite of the fourth. Some, particularly among European leaders, believe that the most important reform is to stabilize the cross-rates between the dollar, euro, and yen and let smaller countries do what they will, rather than stabilizing the exchange rates within each bloc and letting the three major currencies continue to float freely.

Figure 7.1:

Definitions of Nine Major Exchange Rate Regimes, Ranged Along the Continuum from the Most Flexible to the Strongest Fixed-Rate Commitment

FLEXIBLE CORNER

1. *Free floating--the absence of regular intervention in the foreign exchange market*
2. *Managed float--the absence of a specific target for the exchange rate*

INTERMEDIATE REGIMES

3. *Target zone, or band--a margin of fluctuation around some central rate*
4. *Basket peg--fixing not to a single foreign currency but to a weighted average of other currencies*
5. *Crawling peg--a preannounced policy of devaluing a bit each week*
6. *Adjustable peg--fixing the exchange rate, but without any open-ended commitment to resist devaluation or revaluation in the presence of a large balance of payments deficit or surplus*

FIXED CORNER

7. *Truly fixed peg--fixing, committing to buy or sell however much foreign currency is necessary at a given exchange rate, with a firm and lasting intention of maintaining the policy*
8. *Currency board--three defining characteristics: fixing not just by policy but by law, backing increases in the monetary base one-for-one with foreign exchange reserves, and allowing balance of payments deficits to tighten monetary policy and thereby adjust spending automatically*
9. *Monetary union--the adoption of a foreign currency as legal tender. This includes the special case of official dollarization*

7.3.3. Is there a future for Intermediate Regimes?

Most countries are somewhere in between the big United States and little Luxembourg. Until recently, many experts believed that countries intermediate with respect to size, openness, and the other optimum currency area criteria were probably suited to intermediate exchange-rate regimes. However, suddenly the view has become common that such regimes are not sustainable in a world of large-scale financial flows and, therefore, countries are being pushed to the corners of either firm-fixing or free-floating.

What is the logic behind the proposition that countries must choose between firm-fixing and free-floating? At first glance, it appears to be a corollary to the principle of the impossible trinity. That principle says that a country must give up one of three goals: exchange-rate stability, monetary independence, or financial-market integration. It cannot have all three simultaneously (Figure 7.2). One can attain any pair of attributes--the first two at the apex marked *capital controls*, the second two at the point marked *monetary union*, or the other two at the point marked *pure float*. But one cannot be on all three sides simultaneously.

According to the theorem of the impossible trinity a country cannot have simultaneously a fixed exchange rate, free capital mobility, and an independent monetary policy dedicated to domestic goals. Only two of these three objectives can be achieved at a time. Which one should

be given up depends on the country circumstances. For example, countries satisfying optimum currency area criterion would give up monetary discretion, while countries strongly integrated in the global capital markets would likely give up fixed exchange rate.

Some authors argue that the impossible trinity poses a false dilemma because there is no reason why developing economies have to permit free mobility of capital (Bhagwati 1998a and 1998b, Rodrik 1998). The fact that currency crises are almost invariably the result of private

capital flow reversals, has led these authors to argue that some restrictions on capital mobility, especially when the banking sector is inadequately regulated or supervised, can reduce the risk of a currency crisis or strongly moderate its impact. Selective capital inflows would discourage highly volatile "hot money" but facilitate the longer-term capital inflows. Therefore, with capital controls, it may be possible to give up a little bit of all three objectives and achieve in part all three simultaneously.

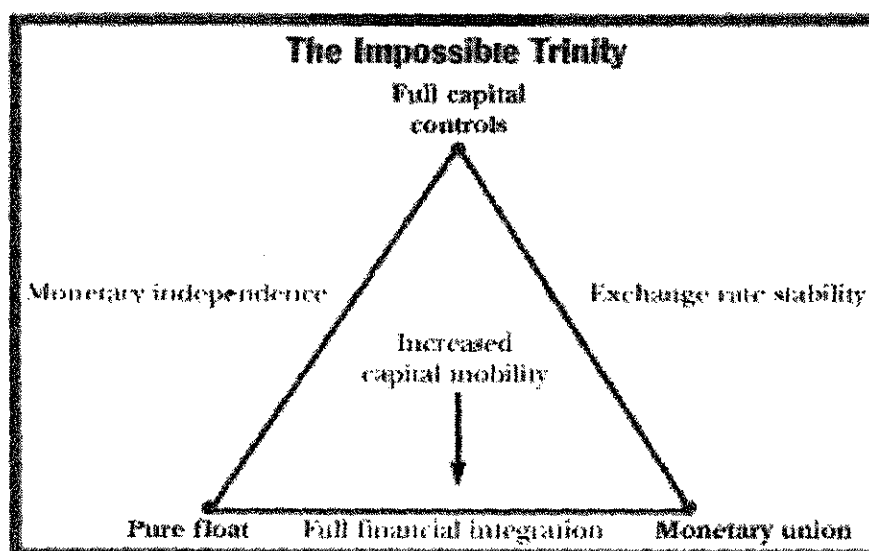


Figure 7.2: *The impossible trinity*

The general trend of financial integration has pushed most countries toward the lower part of the graph. If one is at the bottom leg of the triangle, the choice is narrowed down to a simple decision regarding the degree of exchange-rate flexibility. But even under perfect capital mobility, there is nothing to prevent the country from choosing an intermediate solution between floating and monetary union.

Whence, then, the hypothesis of the vanishing intermediate regime? Recent history makes it understandable that some would flee the soft middle ground of the intermediate regimes and seek the bedrock of the corners. Most of the intermediate regimes have been tried, and have failed, often spectacularly so. Contrary to claims that

currencies in Mexico, Thailand, Indonesia, Korea, Russia, or Brazil were formally pegged to the dollar when their recent crises hit, they actually were following varieties of bands, baskets, and crawling pegs. (See Figure (7.1) for definitions). Perhaps when international investors are lacking in confidence and risk-tolerance--the conditions that have characterized emerging markets from 1997 to 1999--governments can reclaim confidence only by proclaiming policies that are so simple and so transparent that investors can verify instantly that the government is, in fact, following them. Market participants can verify the announcement of a simple dollar peg simply by checking if today's exchange rate differs from yesterday's.

Alternatively, it may be that the search for a single regime that will eliminate currency speculation as an issue is doomed to fail (without capital flow restrictions). The rejection of the middle ground is then explained simply as a rejection of where most countries have been, with no reasonable expectation that the sanctuaries of monetary union or free-floating will, in fact, be any better. Therefore, a blanket recommendation to avoid the middle regimes in favor of firm-fixing or free-floating would not be appropriate.

7.3.4. Introduction to the corners hypothesis

The choice of exchange rate regime—floating, fixed, or somewhere in between—is an old question in international monetary economics. But the steady increase in magnitude and variability of international capital flows has complicated the question. This is particularly the case for the developing countries that in the 1990s became full-fledged participants in international financial markets (Frankel *et al.*, 2001), and (Frankel, 2003).

A major new element in the debate is the proposition that emerging market countries are, or should be, abandoning basket pegs, crawling pegs, bands, adjustable pegs, and various combinations of these. The currently fashionable view is that countries are being pushed to the corners, the extremes of either free floating or firm fixing. The intermediate regimes are said to be no longer viable. This proposition is variously called the hypothesis of the vanishing intermediate regime, the missing middle, or the corners

solution. Its life history has gone from birth to conventional wisdom in a remarkably short period of time.

After the East Asia crises of 1997–1998, the hypothesis of the vanishing intermediate regime was applied to emerging markets. In the effort to reform the international financial architecture so as to minimize the frequency and severity of crisis in the future, the proposition was rapidly adopted by the international financial establishment as the new conventional wisdom.

For example, Summers 2000 :

« There is no single answer, but in light of recent experience what is perhaps becoming increasingly clear—and will probably be increasingly reflected in the advice that the international community offers—is that in a world of freely flowing capital there is shrinking scope for countries to occupy the middle ground of fixed but adjustable pegs. As we go forward from the events of the past eighteen months, I expect that countries will be increasingly wary about committing themselves to fixed exchange rates, whatever the temptations these may offer in the short run, unless they are also prepared to dedicate policy wholeheartedly to their support and establish extraordinary domestic safeguards to keep them in place. »

Frankel, (2003) introduced the notion of verifiability, and suggested that a simple peg or a simple float may be more readily verifiable by market participants than a more complicated intermediate regime. Verifiability is a concrete instance of the more general principle of transparency that is so often invoked in recent discussions of the new international financial architecture but so seldom made precise.

Frankel argued that Verifiability is an instance of transparency, a means to credibility. The idea here, is that a simple regime such as a clear dollar peg, or even a free float, may be more verifiable by market participants than a complicated intermediate regime. In this way, simpler regimes could also contribute to reduce uncertainty, which in turn could affect consumption and investment decisions.

7.4. Some issues raised by exchange rate arrangements

7.4.1. The Real Exchange Rate

The real exchange rate is generally defined in the economic literature in two principal ways: either (a) in *external* terms as the nominal exchange rate adjusted for price level differences *between countries* (that is, as the ratio of the aggregate foreign price level or cost level to the home country's aggregate price level or cost level measured in a common currency) or (b) in *internal* terms as the ratio of the domestic price of tradable to nontradable goods *within a single country*. The first of these concepts of the RER derives originally from the purchasing power parity (PPP) theory. It compares the relative value of currencies by measuring the relative prices of foreign and domestic consumption or production baskets. The second concept, the internal RER, captures the internal relative price incentive in a particular economy for producing or consuming tradable as opposed to nontradable goods. The real exchange rate in this case is an indicator of domestic resource allocation incentives in the home economy. To distinguish this second concept *from* the first, this real exchange rate is referred to here as the *internal* RER (Hinkle & Montiel, 2001).

Within each of these two broad RER concepts, there are several alternative formulations derived from different analytical approaches. There are three primary versions of the external RER. These are based alternatively on purchasing power parity theory, on the Mundell-Fleming one composite good model, and on the law of one price and competitiveness in the pricing of internationally traded goods. Similarly, there are several different definitions of the internal RER based on two-, three-, or multi-good models. The existence of multiple concepts and alternative measures of the RER raises questions concerning the theoretical and empirical relationship among these, the interpretation of differences in their behavior, and the appropriate measure to use in given circumstances.

Several different types of problems are encountered in the measurement of the external RER. At a conceptual level, one set of problems arises from the multiplicity of theories underlying the external RER. The various theories that have motivated the different definitions of the external RER imply the use of different empirical price and cost indexes in computing the external RER. Some theories are also ambiguous as to

exactly what baskets and weightings of domestic and foreign goods should be used empirically. These conceptual problems are common to both industrial- and developing-country applications. A second set of problems is practical and empirical. These problems tend to be particularly acute in developing-country applications. Parallel foreign exchange markets, substantial smuggling and unrecorded trade, and large shifts in the terms of trade, trade policy, and trade patterns create complexities not commonly encountered in measuring the external RER in industrial countries. Moreover, even after one has sorted through the conceptual issues involved in the use of alternative price or cost indexes, it is often difficult to find reasonably exact empirical measures of the desired indexes in developing countries. For many developing countries only the consumer price index (CPI) and the gross domestic product (GDP) deflator are available. Hence, the analyst's choice is often limited to these.

7.4.2. Real exchange rate misalignment

Real exchange rate misalignment can be defined as a sustained departure of actual real exchange rate from its equilibrium value. Therefore the information about the extent of misalignment requires knowledge of the level of the equilibrium real exchange rate, which is unobservable and depends on both structural and macroeconomic factors (Achy, 2001)

In developing countries misalignment takes, in general, the form of domestic currency overvaluation, which hurts tradable activities and affects economic growth. In many less-developed countries official exchange rates are maintained artificially at overvalued levels with regard their equilibrium by imposing strict exchange controls .

The issue of estimating the extent of real exchange rate misalignment has attracted a great deal of attention recently and has been addressed using different approaches. One simple and direct approach is to use the magnitude of the premium on parallel market of exchange rate as an indicator of RER misalignment.

The intuition behind is that the more overvalued the RER is, the tighter will be the control on foreign exchange and, as an outcome, the higher will be the premia observed in the black market. This is why in many developing countries, exchange rate reform is designed to tighten the gap between both rates by depreciating the official rate and targeting the premium at a reduced level .

However, from an analytical standpoint, the case for treating the size of the parallel market premium (PMP) as an indicator of the magnitude of real exchange rate misalignment is far from obvious (Montiel and Ostry, 1994). Moreover, the PMP is an asset price, which can be expected to exhibit much greater volatility than the RER. Empirically, PMP captures also the influence of other distortions in the foreign exchange market.

7.4.2.1. Assessing Real Exchange Rate Misalignment

Questions related to the appropriateness of real exchange rates have for a number of years been at the center of discussions on emerging economies. In particular, analysts have been interested in understanding whether, at a given moment in time, a country's RER is (roughly) in equilibrium, or if it is facing a situation of misalignment. There are at least two reasons why these issues have become increasingly prominent in recent times: first, persistent overvaluation is seen as providing a powerful early warning for currency crises (Kaminsky et al., 1998, Merrill Lynch 1998). And second, situations of protracted or recurrent real exchange rate misalignment have been associated with lower economic growth over the medium and long run. Edwards & Savastano (1999), give the main empirical studies of real exchange rate misalignment in LDC's. This is shown in Table (7.3). The majority of the studies used the cointegration techniques, and error correction models. This is discussed in more details in the next section.

7.4.3. RER (Real Exchange Rate) stationarity and other tests of PPP

The body of empirical literature on PPP (Purchasing Power Parity) focused on developing countries is quite thin, both in absolute terms and when compared to that available for industrial economies (Breuer, 1994). This is probably a consequence of the developing countries' reluctance to adopt floating exchange rates following the breakdown of the Bretton Woods system. Indeed, the fact that the majority of these countries held on for a while to fixed exchange rate arrangements--as well as to all forms of restrictions on current and capital account transactions--made it both less pressing and less meaningful to use their data to test models that relied upon (or consisted of) PPP-based notions of the equilibrium exchange rate.

The situation started to change in the late 1980s. Since then, a growing number of studies has examined the time series properties of RER in various developing countries,

in many cases testing explicitly for some version of PPP. Table (7.4) contains basic information from 13 of those studies.

Specifically, the table contains information on the countries and time period covered by the studies, the measures of exchange rates and (relative) prices they used, the type of test of PPP they conducted, the precise PPP hypothesis they tested, and the results they obtained. To classify the tests employed in the studies we followed the demarcation of the various stages of tests of PPP proposed by Breuer, 1994 and Froot and Rogoff, 1995, namely: simple tests of PPP as the null hypothesis, univariate tests of the time series properties of the RER series, and cointegrating tests of PPP, both bivariate and trivariate .

The table captures some interesting features of empirical studies of RER and PPP in emerging economies. First, in terms of coverage, there is far more evidence available for Latin American economies than for developing countries in other parts of the world. Of the thirteen studies summarized in the table, eight focused solely or primarily on Latin American countries and the other three on East Asian economies. Only two studies (Edwards, 1989, and Bahmani-Oskooee, 1995) examined RER data from (a few) developing countries in other regions of the world. Second, the periods covered by the studies are quite short. The majority of studies conducted tests on data series that covered less than 30 years--and four of them did so on series that covered less than 15 years. Only three studies (Leñ and Oliva, 1992, Liu, 1992 and Montiel, 1997) used data series that covered 35 years or more. To overcome the "small sample problem" all studies but one used either quarterly or monthly data to test their hypotheses; this produced samples that ranged from 50 to 400 observations. Third, studies relied a bit more heavily on consumer price indices than on wholesale price indices to construct their measure of relative (domestic to foreign) prices. Three studies (Edwards, 1989, Seabra, 1995 and Devereux and Connolly, 1996) used a measure of relative prices that combined both the CPI (domestic prices) and the WPI (foreign prices). Also, in striking contrast with empirical tests on PPP for industrial countries, only seven of the studies in the table used a bilateral exchange rate vis-a-vis a major currency (typically the U.S. dollar) as the measure of the nominal exchange rate. The other six used a multilateral (trade-weighted) indicator--what the IMF calls the "nominal effective exchange rate."

Table 3 Empirical Studies of Real Exchange Rate Misalignment in LDCs

AUTHOR	COUNTRIES/PERIOD	FUNDAMENTALS	TECHNIQUE	COMMENTS
Edwards (1989)	Twelve countries -Brazil, Colombia, El Salvador, Greece, India, Israel, Malaysia, Philippines, South Africa, Sri Lanka, Thailand, Yugoslavia	Terms of trade, capital flows, import tariffs, government spending, productivity differentials (trend), excess domestic credit, nominal devaluation.	-Panel data; fixed-effect instrumental variables. -Dynamic adjustment equation that allows short-run effects of nominal variables, including the rate of devaluation. Long run RER only influenced by "real" fundamentals -Beveridge-Nelson technique used to calculate permanent and transitory components of fundamentals	-Equilibrium RER calculated -No attempt made to compute misalignment due to "benchmark" problem. -Compares estimated equilibrium RER with simple PPP extrapolations.
Contari, Cavallo and Khan (1990)	1962-84 Twenty-four countries, including: Argentina, Bolivia, Chile, Colombia, Jamaica, Peru, Uruguay, Cote d'Ivoire, Ethiopia, Mali, Somalia, Sudan & Zambia	Terms of trade, openness (inverse), net capital flows, excess domestic credit, GDP growth, foreign inflation, time trend.	-Pooled OLS estimation -Three-year moving average for some fundamentals as proxy for permanent component.	-Compute RER misalignment from three sources: degree of openness, sustainable capital inflows, and domestic credit creation (internal equilibrium). -Composite measure of RER misalignment used as regressor in equations of economic performance.
Chiura and Greenes (1993)	1960-83 Thirty-three countries from Sub-Saharan Africa	Terms of trade, capital inflows, openness (inverse), excess domestic credit, nominal devaluation, time trend.	-Instrumental variables estimation of pooled time-series and cross section data; includes country specific dummies (fixed-effect).	-Compute three measures of misalignment: one based on excess money creation and excess government borrowing; another one based on a measure of "sustainable" capital inflows, and a third one based on the black market premium. -Composite measures of RER misalignment used as regressor in equations of economic performance.
Eltadawi (1994)	Three countries -Chile, Ghana, and India	Terms of trade, capital inflows, openness, government spending, import tariffs, productivity differentials (trend), domestic credit, nominal devaluation.	-Cointegration and error correction models -Beveridge-Nelson technique used to calculate permanent component of some fundamentals; for other five-year moving average.	-Misalignment is calculated as the difference between the estimated "equilibrium" RER and the actual RER. -RER assumed to be, on average, in equilibrium during sample period.
Calvo, Reinhart and Végh (1995)	Three countries -Brazil, Chile and Colombia	Terms of trade, GDP per-capita, inflation tax	-Beveridge-Nelson technique to obtain permanent and transitory components of fundamentals. -Cointegration between permanent components of RER and fundamentals	-No estimate of equilibrium RER or of misalignment is provided. -Compare cyclical and permanent component of RER and fundamentals with predictions of an optimizing model.
Ades (1996)	1978-92 (quarterly) Twelve countries -Argentina, Brazil, Chile, Colombia, Ecuador, Indonesia, Mexico, The Philippines, Thailand, Turkey, South Africa and Venezuela. 1980:1-1996:4 (quarterly)	Long-run fundamentals: terms of trade, openness, capital inflows, government spending, foreign interest rate, technology (trend). Short-run determinants: transitory changes in terms of trade, monetary conditions relative to those abroad, risk premium, international reserves coverage	-Cointegration -Dynamic error correction model -Exponential moving-average procedure to obtain permanent and transitory components.	-Compares estimates of equilibrium RER with simple PPP extrapolations. -Stresses differences between long run and short run determinants of the equilibrium RER.
Soto (1996)	Chile 1978:1-1994:4 (quarterly)	Terms of trade, government spending, capital inflows, import tariffs, external debt, financial distortion index, interest rate differential	-Beveridge-Nelson decomposition of fundamentals. -Cointegration and error correction model. -Model of endogenous transition	-Tries to capture non-linear behavior of RER -Compares linear and non-linear models; concludes that linear models tend to over-react to shocks to fundamentals. -Misalignment is computed as the percentage difference between the actual and the equilibrium RER

Table 3 (Concluded). Empirical Studies of Real Exchange Rate Misalignment in LDCs

AUTHOR	COUNTRIES/PERIOD	FUNDAMENTALS	TECHNIQUE	COMMENTS
Montiel (1997)	Five countries -Indonesia, Malaysia, Philippines, Singapore and Thailand	Terms of trade, openness, government spending, public investment, foreign interest rate, foreign inflation, dependency ratio, time trend.	-Non-stationarity used as criterion to classify "fundamentals" as permanent -Cointegration (modified Johansen) -Error correction model	-Estimation procedure allows sum of residuals between actual and estimated RER to be different from zero. -Compares estimated with actual RER over sample and sub-samples using confidence intervals -Stresses the importance of capital flows for determining the equilibrium RER -Compares monetary model with "real" model; finds little improvement from the addition of "monetary fundamentals".
Warner (1997)	Mexico 1979:1-1997:4 (quarterly)	Crude oil price, government spending, import tariffs, interest rate on external debt, ratio of non-tradable to tradable prices, capital account balance, relative money supplies (Mexico vs US), relative GDP growth, interest rate differential.	-OLS, Stock and Watson, -Cointegration (Johansen)	
Soto (1997)	Chile 1960-97 (annual) 1978-97 (quarterly) 1986-97: (monthly)	Terms of trade, government spending, public investment, TFP, capital inflows, openness, import tariffs, interest rate differentials.	-Three methods for decomposing permanent and temporary components: Beveridge-Nelson, Hodrick- Prescott and moving average. -Cointegration -Error correction model	-Defines a "benchmark" case by computing a three- period moving average of normalized differences between permanent and temporary components of fundamentals. -Misalignment constructed as the difference between the RER and the linear combination of variables that proxy a "flex-price" RER.
Razin and Collins (1997)	Ninety-three countries (Penn World Tables data) 1975-92	Terms of trade, long-term capital inflows, resource balance, growth of output per worker, excess money growth. Short run stock to output, absorption and money supply.	-Panel data, fixed effect. -Error correction model	
Broner, Loayza and Lopez (1997)	Seven Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela) and the U.S. 1960-95	Ratio of relative prices of non-tradable to tradable goods (CPI/WPI); net foreign assets.	-OLS, GLS, and Instrumental Variables. -Gonzalo-Granger decomposition -Cointegration (Johansen)	-Misalignment constructed as the difference between actual RER and estimates from cointegrating vector.
Elbadawi and Soto (1997)	Seven countries -Cote d'Ivoire, Ghana, Kenya, Mali, India, Chile and Mexico 1960-93	Terms of trade, openness, long run capital inflows, government spending, public investment, foreign interest rate, country risk	-Newbold's version of Beveridge-Nelson technique. -Cointegration -Phillips-Loretan's error correction model	-Scale estimates of equilibrium RER by a scoring function, based on the distance of fundamentals to their sustainable level. -For Chile, they compare reduced form estimate of equilibrium RER with forward RER projections.
Halpern and Wyplosz (1997)	Six transition economies -Croatia, the Czech and Slovak Republics Hungary, Poland, and Slovenia. 1990-95 (Sample size varies depending on data availability).	Real aggregate producer wages, marginal productivity in tradable sector, unemployment, rate of exchange rate appreciation, interest rate differentials.	-Error correction model. -Fixed country effect in constant, and in constant and slope.	-Use three measures of RER: doubly deflated nominal exchange rate, ratio of nontraded to traded goods prices, and dollar wages.
Baffes, Elbadawi and O'Connell (1997)	Two countries -Cote d'Ivoire, Burkina Faso.	Terms of trade, openness, resource balance, investment share, foreign price level.	-Error correction model. -Three step procedure: order of integration, estimation (Engle-Granger, Johansen), calculation of equilibrium RER using Beveridge-Nelson.	-Both countries members of CFA zone.
Soto and Valdes (1998)	Chile 1977:1-1997:4 (quarterly)	Terms of trade, productivity differentials between tradable and non-tradable sectors, net foreign assets, public absorption.	-Three decomposition techniques: Beveridge-Nelson, Hodrick-Prescott, and Gonzalo-Granger. -Cointegrated VARs	-Use net foreign assets as proxy for terminal condition on foreign indebtedness; do not take into account "supply" effects. -No "benchmark" considerations.

Table 4 Empirical Studies of PPP in Developing Countries

Sample	No. of countries	Region	Period covered	No. of years	Data frequency	No. of observations	Exchange rate and prices	Price ratio: CPI	WPI	Mixed I/	Exchange rate: Bilateral US	Multilateral	Type of test	Univariate ("Stage 2")	DF, ADF	Phillips-Perron	Variance ratios	Other	Bivariate ("Stage 3")	Engle-Granger CI test	DF, ADF	Phillips-Perron	Other	Tivariate ("Stage 3")	Johansen-Juselius CI test	PPP version tested	Main findings	Stationarity	of real exchange rate	Mean reversion	Symmetry (of p & p*)	Proportionality (between p & e)
Edwards (1989)	32	broad coverage	1965-85	21	quarterly	[84]				X	X 2/	X	X	X	X	X			Box-Pierce Q						Absolute	Absolute	Absolute	RW rejected (19 of 32 cases)	not tested	slow (no formal test)	imposed	imposed
McNown & Wallace (1989)	4	Lat Am & Israel	1976-86	11	monthly	[89,126]		X	X	X	X	X	X	X	X				X						Absolute (w/intercept)	Absolute	found in 2 cases	found in 3 cases	not tested	not tested	imposed	no formal test
Abeyasinghe & Kok-Hong (1992)	1	East Asia	1975-90	15	quarterly	[63]		X	X	X	X 3/	X	X	X	X				Ljung-Box Q						Absolute	Absolute	found for US only	not tested	not tested	imposed	imposed	
Leon & Olive (1992)	12	Latin America	1957-91	35	monthly	[402, 418]		X	X	X	X	X	X	X	X				Ljung-Box Q						Relative	Relative	RW rejected	not tested	strong, long run 4/	imposed	imposed	
Liu (1992)	9	Latin America	1948-89	42	quarterly	[120,170]		X	X	X	X	X	X	X	X				X						Absolute (w/intercept)	Absolute (w/intercept)	not tested	bivariate: 3 yes, 2 no	not tested	not tested	imposed	no formal test
Gan (1994)	5	East Asia	1974-88	15	monthly	[154,174]		X	X	X	X	X	X	X	X				X						Absolute (w/intercept)	Absolute	not found	not found	on another RER	imposed	imposed	
Bahmani-Oskooee (1995)	22	broad coverage	1971-90	20	quarterly	[80]		X	X	X	X	X	X	X	X				X						Absolute	Absolute	found in 8 cases	not tested	not tested	imposed	imposed	
Calvo-Reinhart & Veiga (1995)	3	Latin America	1978-92	15	quarterly	[52]		X	X	X	X	X	X	X	X				X						Absolute	Absolute	not found	not tested	slow (Beveridge Nelson)	imposed	imposed	
Coos (1995)	1	Latin America	1964-91	27	monthly	[324]		X	X	X	X	X	X	X	X				X						Absolute (quasi)	Relative	not found	not tested	not tested	imposed	imposed	
Edwards (1995)	4	Latin America	1957-82	25	quarterly	[101]		X	X	X	X	X	X	X	X				Ljung-Box Q						Relative	Relative	found in 3 cases	not tested	not tested	imposed	not applicable	
Sabra (1995)	11	Latin America	1970-89	20	quarterly	[78]		X	X	X	X	X	X	X	X				X						Relative	Relative	not tested	bivariate: 8 yes	not tested	not tested	imposed	imposed
Devereux & Connolly (1996)	4	Latin America	1973-90	18	quarterly	[72]		X	X	X	X	X	X	X	X				X						Absolute	Absolute	rejected in levels	not tested	not tested	imposed	imposed	
Montiel (1997)	5	East Asia	1960-94	35	annual	[35]		X	X	X	X	X	X	X	X				X						Absolute	Absolute	rejected	not tested	not tested	imposed	imposed	

(apparent) (not apparent) (11 of 12 cases) (PP test) (1st diff stationary) (exc: Singapore) (not applicable) 6/ cases

Fourth, the majority of studies relied on some type of univariate test to examine the main properties of the RER--and the hypothesis.

Only four of the thirteen studies (McNown and Wallace, 1989, Liu, 1992, Gan, 1994 and Seabra, 1995) conducted bivariate cointegrating tests of PPP, and just two of those four also tested PPP using trivariate cointegrating techniques. And fifth, studies were generally unclear about the precise PPP hypothesis that was being tested. It could be argued, however, that the majority of them were testing for some variant of absolute PPP. Only three studies (León and Oliva, 1992, Edwards, 1995, and Seabra, 1995) made it clear that they were testing the hypothesis of relative PPP.

An obvious consequence of the predominance of univariate tests of PPP is that the bulk of the findings obtained by the studies in Table 7.4 revolves around the stationarity of various measures of the RER. By and large, the hypothesis that the RER is stationary in developing countries (and, thus, that some form of PPP condition holds in the long run) *does not* receive much support from these studies. In 40 out of 54 individual country tests of RER stationarity, the hypothesis that the RER series contained (at least) one unit root could not be rejected. Interestingly, however, the hypothesis that the RER series followed a random walk did not fare much better. In fact, Edwards, 1989 and León and Oliva, 1992 tested the random walk hypothesis for a combined total of 44 series, and rejected it in about 2/3 of the cases.

Results from the (few) studies that used cointegration tests were somewhat more supportive of the PPP hypotheses. The four studies that tested for bivariate cointegration between the nominal exchange rate and the ratio of domestic to foreign prices found that the residuals of the estimated regressions were stationary in about 50 percent of the cases (15 of 33). The two studies that conducted trivariate tests of cointegration (Liu, 1992 and Seabra, 1995) found even stronger evidence of an equilibrium relationship between the exchange rate and domestic and foreign prices (18 of 20 cases). Notably, all the support for PPP obtained from these stage-three tests stemmed from data on Latin American countries; in fact, Gan, 1994 did not find evidence of cointegration between the exchange rate and prices in any of the five East Asian countries in his sample.

Seeing what the studies in Table 7.4 have to offer, one gets the distinct feeling that our knowledge of the basic time series properties of RER in developing countries and, in particular, of the relevance of PPP as a long-run benchmark for the equilibrium RER in these economies is fairly rudimentary. The most serious shortcoming is, without question, the low power of the tests (especially of cointegration tests) to distinguish among alternative hypotheses in the short periods covered by the studies--a deficiency

that cannot be fixed by the common practice of increasing the number of observations through the use of quarterly or monthly data (Froot and Rogoff, 1995, Oh, 1996). But this is hardly the only problem.

The over-representation of Latin America in the sample of developing countries examined in the studies, the lack of clarity with regard to the variant of the PPP theory that is supposedly being tested, and the dearth of empirical work aimed at testing a well-defined PPP hypothesis using cointegrating techniques, both bivariate and trivariate, also contribute to the above feeling. The pervasive and severe data problems that one encounters in developing countries may well be at the root of these shortcomings, and it is quite possible that for many countries this constraint will not disappear for many years. But this does not alter the basic conclusion that the evidence on RER stationarity and long-run PPP contained in studies of individual developing countries does not enable us to discern which, if any, of the regularities of the long-run RER that have been found for industrial economies are also applicable to (or relevant for) the developing world.

7.5. The Use of the Parallel Market Rate as a Guide to Setting the Official Exchange Rate

Because parallel exchange rates continue to exist in important countries and because specific analytical issues in estimating the long-run equilibrium real exchange rate (LRER) that do not arise in the context of unified rates present themselves in this case, the implications of parallel rates merit separate attention.

The key question to be addressed in this context is the extent to which the free exchange rate in a parallel exchange market can provide guidance in identifying the long-run equilibrium real exchange rate (Hinkle & Montiel, 2001). In cases in which a parallel market for foreign exchange exists, it may appear natural to consider the

parallel exchange rate as a proxy for the "underlying" equilibrium real exchange rate that is, the rate that would tend to prevail over the long run in a unified exchange market. This interpretation suggests itself because the parallel exchange rate usually has the benefit of being determined in a free market and hence may not appear to be obviously contaminated by the distortionary effects of government policy.

Notwithstanding the appeal of a parallel market determined exchange rate as a guide to setting the official exchange rate, however, we will argue that various factors complicate the relationship between the parallel market rate and the long-run equilibrium real exchange rate. First, while the parallel market for foreign exchange may not itself be controlled by the government, conditions in that market are likely to be affected by government policy. Relative supplies and demands for foreign currency in the parallel market will be altered by the level of the official exchange rate, the extent to which exchange and trade controls are enforced, and the government's formula for rationing foreign exchange receipts to importers. Second, because the parallel exchange market represents an asset market as well as a trade-related market, the parallel market rate is likely to reflect expectations, political concerns, capital flight, and other speculative factors not directly associated with the equilibrium real exchange rate. Hence, only under a relatively narrow set of circumstances may the parallel market rate serve as a useful guide to determining the equilibrium value of the official exchange rate.

7.5.1. Essential Characteristics of Parallel Exchange Markets

This section sets out the essential characteristics of parallel exchange markets. It begins by defining more precisely what we mean by a parallel exchange market and describing its key features. The section then considers alternative ways in which governments have managed parallel markets, distinguishing broadly between the Latin American and African models. The section concludes with a review of trends in parallel markets in the 1990s.

7.5.1.1. Basic Concepts

A parallel foreign exchange market system is one in which transactions take place at more than one exchange rate and at least one of the prevailing rates is a freely floating, market-determined rate (the parallel exchange rate) (Kiguel and O'Connell, 1995).

Parallel market systems represent a subset of the broader category of multiple exchange rate regimes, which refer to any regimes in which two or more exchange rates are applied to the same currency.

Many developing countries have applied separate, fixed exchange rates to different types of transactions, but this practice is, in essence, equivalent to a single exchange rate coupled with different taxes or subsidies (depending on the transaction). By contrast, a parallel market for foreign exchange is distinguished by the fact that the parallel exchange rate is determined freely in the market. Usually, the official exchange rate in parallel market systems is pegged by the authorities at a particular fixed (or crawling) rate, although in principle the official rate could be floating as well. Additionally, it is frequently-although not always the case that the official exchange rate applies to current account transactions, while the parallel market rate, whether legal or illegal, applies to capital account transactions.

Parallel markets for foreign exchange can emerge only when the government imposes exchange controls, that is, restrictions on the volume of certain foreign exchange transactions or on the price at which such transactions are made. Trade barriers, quantitative restrictions, or high tariffs alone are not in themselves sufficient to give rise to a parallel exchange market. While such controls may affect the demand or supply of foreign currencies, they will not drive a wedge between exchange rates for different transactions as long as foreign exchange is freely available for all transactions at an official or market-determined exchange rate. A parallel market arises when the government limits the amount of foreign exchange that can be bought or sold for particular transactions, causing excess demand or supply to spill over into a parallel market, or authorizes that exchange rates for certain transactions be pegged and for other transactions be floating.

Parallel exchange rate systems may be legal or illegal. When the parallel market for foreign exchange is legal, it is often referred to as a dual exchange rate (DER) system. In these cases, most current account transactions take place at a pegged commercial rate, and capital account transactions at a market-determined financial rate. A number of countries have experimented with DER systems of varying duration. Some countries

maintained official dual exchange rates for long time periods, such as Belgium (from 1957 to 1990) and the Dominican Republic (until 1993).

The parallel market in these countries was used to insulate the rest of the economy from short-term capital flows. France (1971-74) and Italy (1973-74) adopted dual rates for a short period following the collapse of the Bretton Woods system as a transitory measure. Illegal parallel market systems emerge when private agents attempt to evade restrictions on the price or quantity of foreign exchange transactions.

Illegal parallel markets were the norm in most of Africa and South Asia, as well as in several Latin American countries, especially through the 1980s. The authorities, with some exceptions, generally tolerated the parallel markets. For example, the threat of enforcement and penalties was significant in Ghana before 1983, but these efforts fell by the wayside later on, and the coverage of the parallel market grew, as did the parallel premium (Kiguel and O'Connell, 1995). In Sudan, trading on the parallel market was a capital offense, and enforcement was attempted between 1970 and 1990. But even the threat of capital punishment did not totally wipe out the parallel market, though it may have been a factor in the very high premium observed in Sudan.

In principle, there is little difference, in terms of macroeconomic implications, between legal and illegal systems. In either case, free-market transactions in foreign exchange take place alongside controlled price transactions. In either legal or illegal systems, there are incentives for transactions to spill over or "leak" from one market into the other. These leakages may tend to undermine the dual exchange rate systems, depending upon how rigidly exchange controls are enforced.

7.5.1.2. Management of Parallel Markets

Parallel market systems emerge for different reasons in different countries. There is one legitimate rationale for a system in which current account transactions are conducted at a pegged rate and capital account transactions are conducted at a floating rate: to insulate domestic prices and economic activity from exchange rate fluctuations deriving from transitory shocks in the financial market.

In practice, the implementation of parallel market systems in developing countries rarely has been consistent with this rationale. In certain Latin American countries, dual

exchange rate systems were indeed adopted in response to strong, temporary capital outflows resulting from balance-of-payments crises in the 1980s. These did, to a certain extent, protect their economies from excessive, transitory depreciations of the exchange rate. There was very little rationing in the official market for trade transactions, as foreign exchange supply was usually enough to satisfy demand. On average, the premium of the parallel rate relative to the official rate was quite moderate in these cases-though there were occasional spikes when the premium was very high. But these spikes reflected temporary macroeconomic crises, not a drastic and persistent misalignment of the real exchange rate. However, these dual market arrangements were retained long after the financial crises had passed. Moreover, even after the crises had passed, the parallel rates continued to be more depreciated than the official rates. In a dual rate system designed to protect an economy from exchange rate variability-as opposed to a system designed to target the official rate at a level persistently more appreciated than the one that the market would set-the parallel rate would be expected to fluctuate both above and below the official rate.

In African countries, parallel markets were even less consistent with the one legitimate rationale for maintaining a dual rate system. In these countries, exchange controls were frequently tightened as progressive overvaluation of the official exchange rate led to excess demand for foreign exchange at the official rate. This tightening, in turn, led to the creation of parallel markets to evade exchange controls, even in the absence of strong capital account pressures. Hence, exchange controls were used to prop up persistently misaligned official exchange rates, not to insulate the domestic economy from transitory fluctuations. In the prototypical case, foreign exchange rationing grew more stringent over time as the official exchange rate became increasingly overvalued. Importers who lacked access to ever scarcer foreign exchange through the official channels turned to the parallel market to obtain foreign exchange for trade transactions. The parallel premium grew to very high levels, and stayed there, as the official rate became more and more overvalued. In Ghana, which is the textbook example of this phenomenon, the official exchange rate was so overvalued by the end of the 1980s that it became irrelevant for most transactions; even domestic prices and inflation reflected the parallel, not the official rate (Chhibber and Shaffik, 1991).

7.5.1.3 Parallel Markets in the 1990s

Although a great many countries have experimented with parallel exchange arrangements at various times, the incidence of such arrangements has been declining in the 1990s, since an increasing number of developing countries have sought to unify their exchange rates, often as part of a larger structural reform effort, which includes liberalization of the external accounts. The breakup of the former Soviet Union temporarily added a number of new countries that initially had parallel exchange markets. However, the trend among the new transition economies has also been toward unification (Halpern and Wyplosz 1997). Observers have identified various negative consequences of exchange controls and the parallel markets that they engender. A non exhaustive list would include, first, the fact that exchange controls allow the authorities to maintain a persistently misaligned official exchange rate perhaps coupled with inappropriate fiscal, monetary, and commercial policies-without losing all their international reserves, thereby distorting relative prices in the economy and inhibiting the growth of exports. Second, because parallel market regimes often involve the rationing of foreign exchange at subsidized rates to those with preferential access to the authorities, exchange controls encourage the development of rent seeking behavior among private entrepreneurs. Finally, the introduction of exchange controls, which by their nature are hard to enforce and profitable to evade, tends to promote a culture of law evasion among private entrepreneurs that may spill over into other areas such as tax compliance or adherence to other economic and financial regulations.

In response to these and other adverse effects of exchange controls, many countries have moved to dismantle exchange controls and unify their exchange markets. Parallel exchange rate arrangements are now found in developing countries only; Belgium, which was the last developed country with dual exchange rates, moved to a unified exchange rate in 1990. Some parallel markets were abandoned either because they were no longer needed (for example, when the crisis that led to them ended) or because they were no longer effective (for example, when rampant evasion of exchange controls undermined the dual exchange rate system). Argentina, Mexico, and Venezuela had legal dual rates that were expected to be temporary. All three created dual rates and then unified within the period 1980 to 1994, though a parallel market did re-emerge in Venezuela in 1994, as discussed above. Other Latin American countries moved to

multiple rates or unified within the same period. In the African and Asian countries, in contrast, parallel markets have tended to be more long lived. A few of these countries unified their exchange rates in the 1990s. Others (including Tanzania, Ghana, and India) moved to legalize their parallel markets as a transitional measure while easing restrictions on current account transactions-as a step on the path to unification of the exchange rate. In those cases, unification has been part of a larger structural reform effort aimed at liberalizing markets overall (Hinkle and Montiel, 2001).

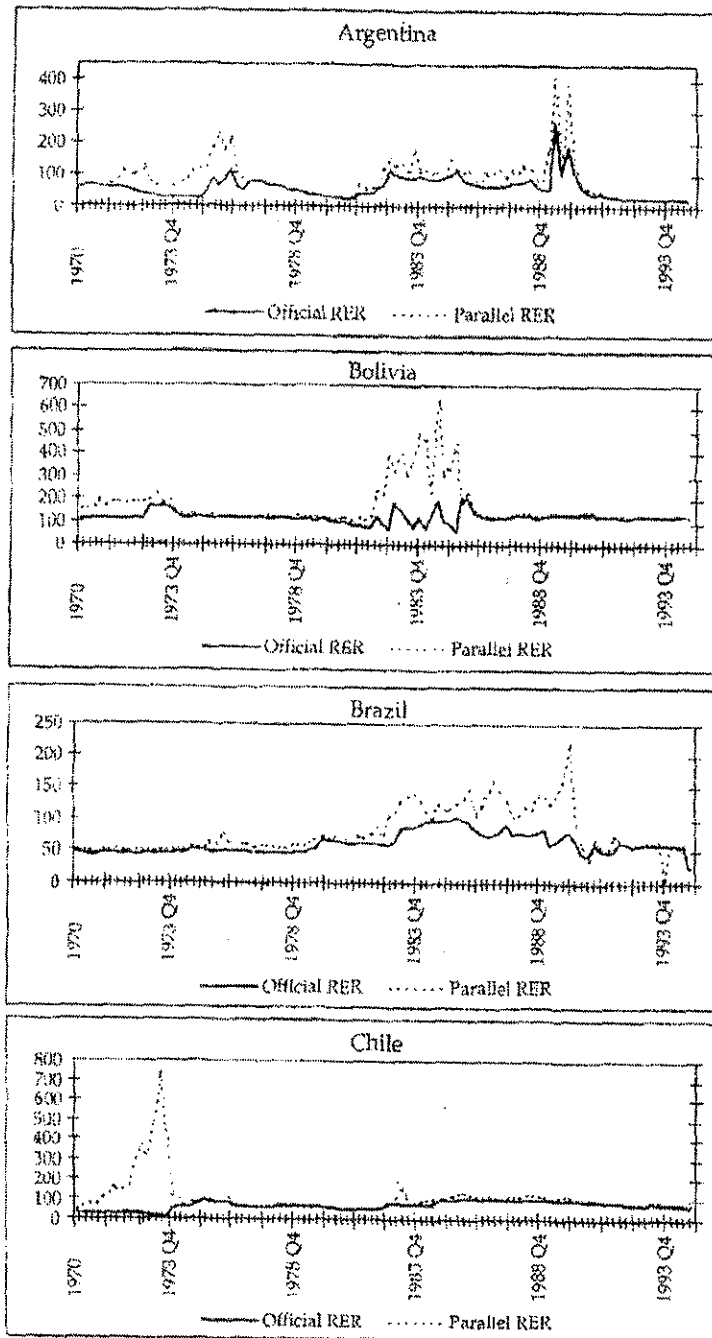
However, the trend toward unification has not been universal. Major exceptions remain-mostly in Africa, including Nigeria, Kenya, and Zambia. To assess the extent to which the survival of parallel markets has been more widespread, Hinkle and Montiel (2001) gathered data on the official and parallel exchange rates for a sample of 24 developing countries listed in table (7.5). The sample includes countries in which significant parallel markets existed for some time. It includes most of the more important developing countries outside Eastern and Central Europe and the former Soviet Union. The sample is otherwise fairly representative geographically, with 11 countries from Latin America, 10 from Africa, 2 from South Asia, and Turkey. Parallel exchange rates were still present in half of these countries at the end of 1994 (see table 7.5). The evolution over time of the official and parallel real exchange rates in the sample group of countries is shown in figure 7.4a & 7.4b. The level of the parallel premium has decreased, on average, in the countries that have retained parallel exchange rate arrangements. For a selected group of high-premium countries, Ghei, Kiguel, and O'Connell (1996) find that the median premium for the period 1990 to 1994 was 49 percent, compared with a figure of 100 per cent for the period 1980 to 1989. Similar trends have been observed for moderate and low-premium countries as well. As far as the sample chosen by (Montiel and Hinkle, 2001), they found lower premiums in 1994 relative to 1985 in many cases.

Overall, then, there are indications that developing countries are moving in the direction of unified exchange rates. The number of countries with significant parallel markets has declined, and the gap between the official and the parallel rate is steadily decreasing in most of the countries that still have parallel rates. Nonetheless, parallel exchange rates continue to exist in a significant number of developing countries around the world.

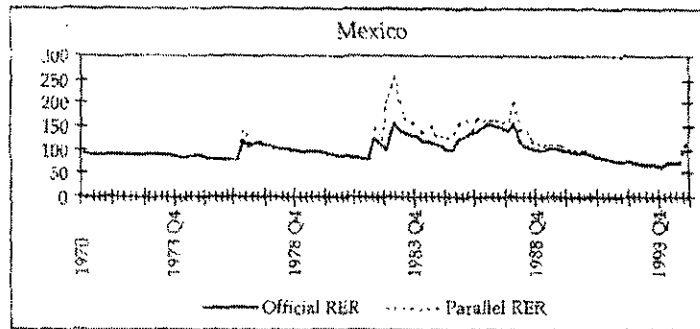
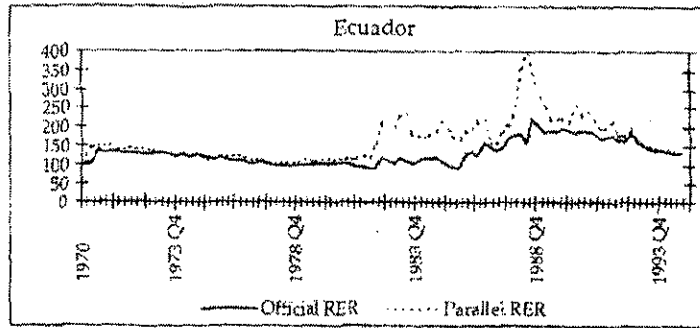
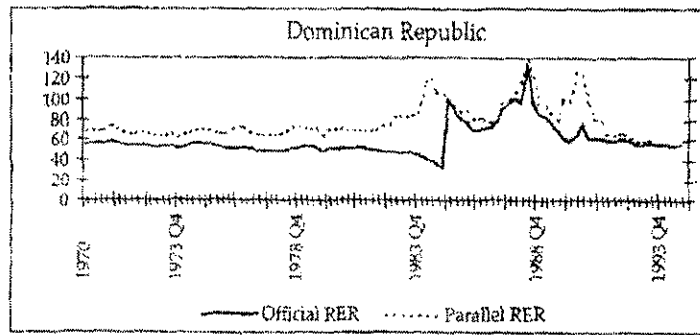
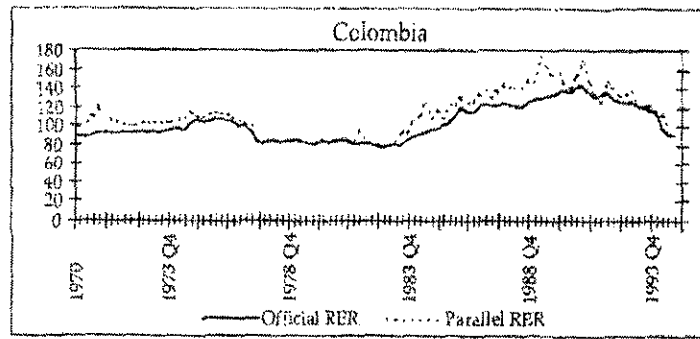
Table (7.4) Status of the parallel market & level of the parallel premium (%)

Country	YEAR			
	1980	1985	1990	1994
<i>Latin America and Turkey</i>				
Argentina	Unified	30.79	29.93	Unified
Bolivia	19.85	223.60	Unified	Unified
Brazil	8.90	30.12	14.28	Unified
Chile	6.03	25.39	16.78	8.67
Colombia	Unified	11.42	9.24	6.12
Dominican Rep	38.00	7.69	68.01	Unified
Ecuador	11.45	76.90	23.53	5.45
Mexico	Unified	28.46	7.41	Unified
Peru	36.25	29.53	104.80	Unified
Uruguay	Unified	9.41	10.93	16.51
Venezuela	Unified	104.00	Unified	4.73
Turkey	9.98	-7.17	Unified	Unified
<i>Africa and South Asia</i>				
Algeria	193.25	375.23	248.81	253.95
Egypt	7.77	122.90	89.47	Unified
Ethiopia	35.02	127.66	192.75	113.26
Ghana	485.92	143.48	9.84	Unified
Kenya	9.38	4.51	3.11	19.78
Malawi	92.27	49.51	17.51	14.62
Nigeria	67.67	306.22	19.40	231.87
Sudan	92.40	27.14	955.45	53.13
Tanzania	174.00	271.89	56.36	Unified
Zambia	70.27	65.39	279.56	-6.15
India	9.58	15.12	9.10	Unified
Pakistan	26.26	-0.67	8.72	Unified
<i>Parallel Markets</i>	19	24	21	12

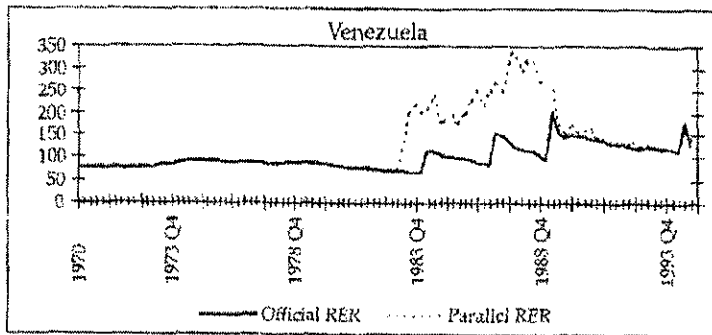
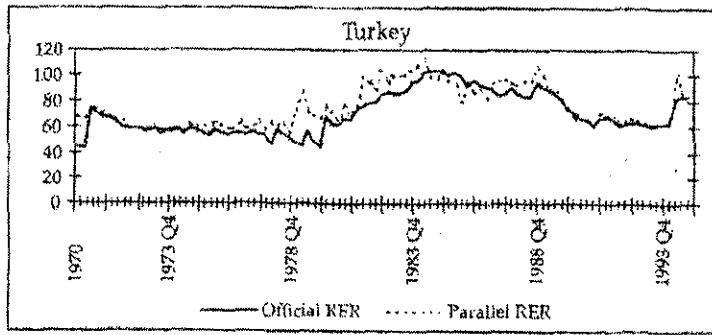
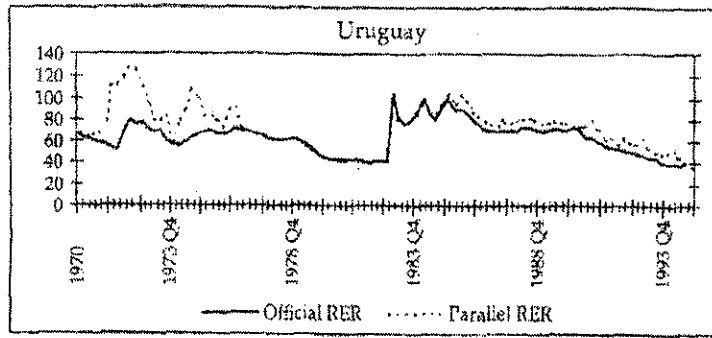
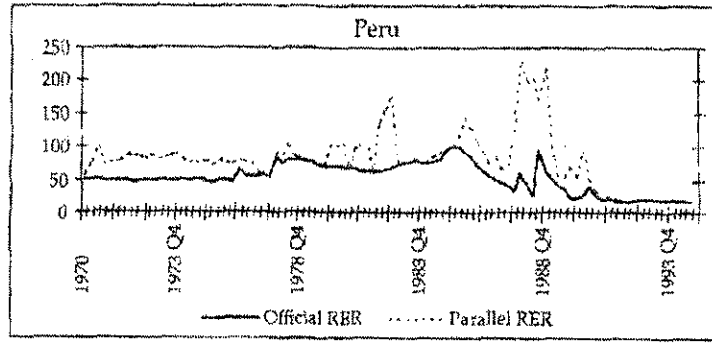
Figure 7.4a Latin America & Turkey : Official & parallel bilateral RER with the US Dollar, 1970-94 (First Quarter of 1985=100)



Note: Quarterly figures with year marking fourth quarter. An upward movement is a depreciation of the RER.

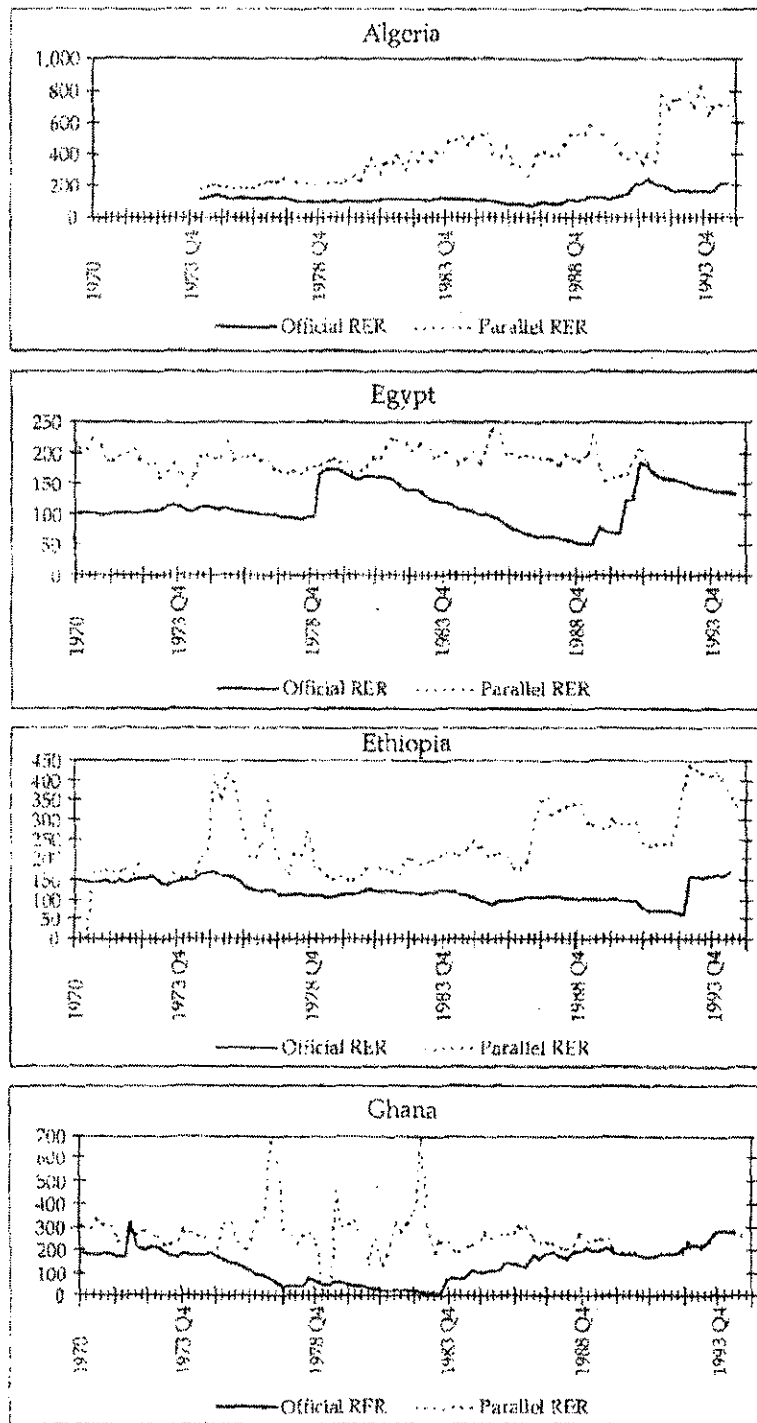


Note: Quarterly figures with year marking fourth quarter. An upward movement is a depreciation of the RER.

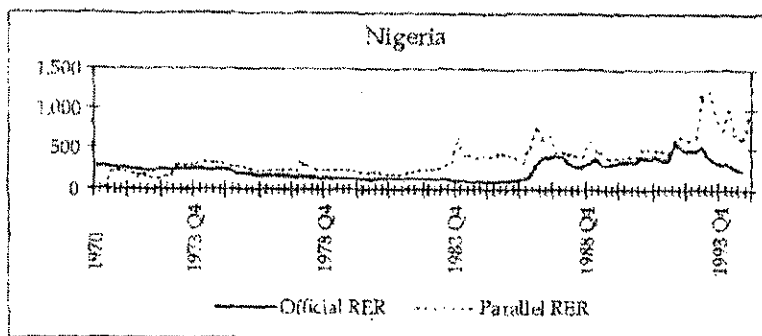
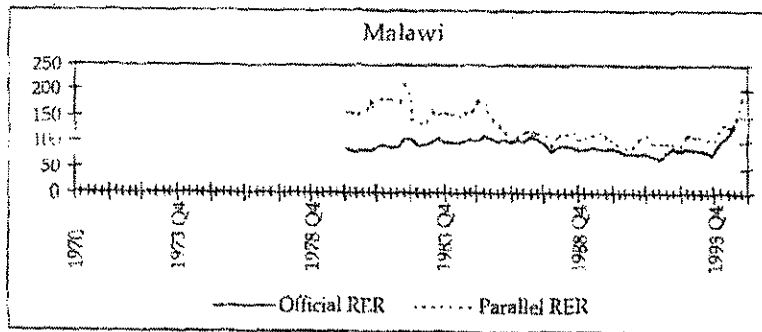
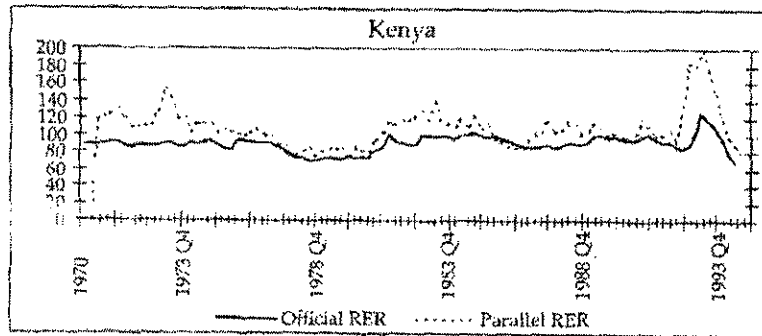
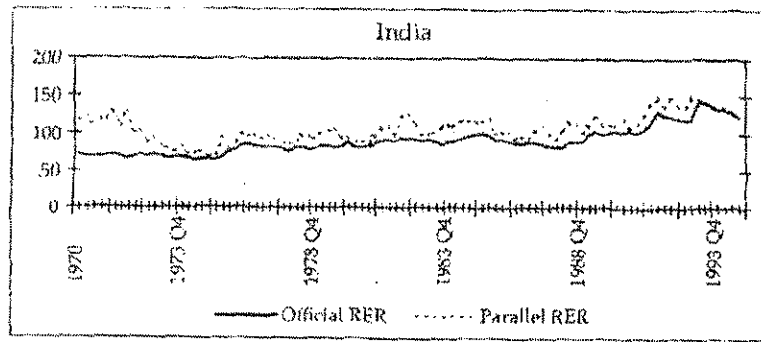


Note: Quarterly figures with year marking fourth quarter. An upward movement is a depreciation of the RER.

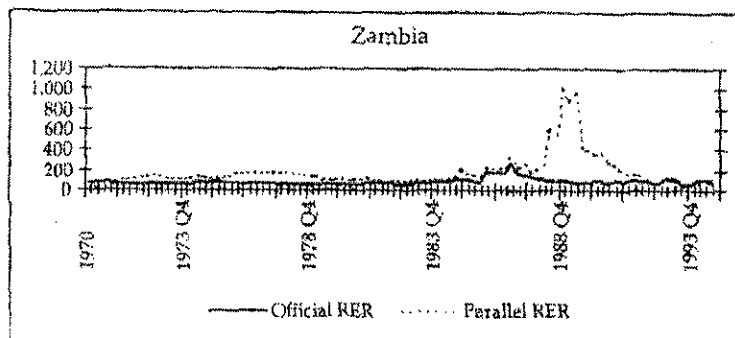
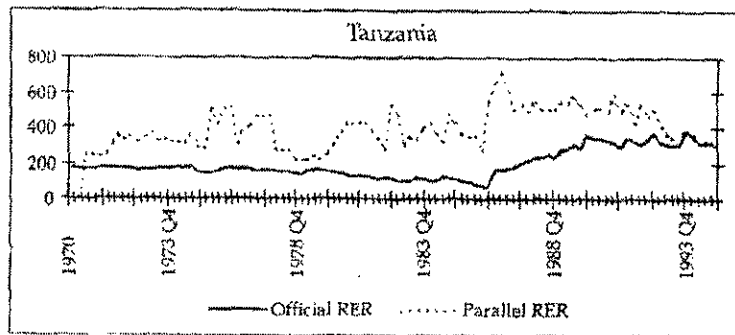
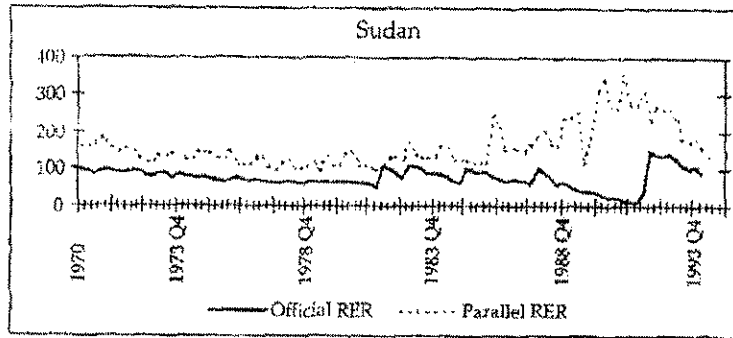
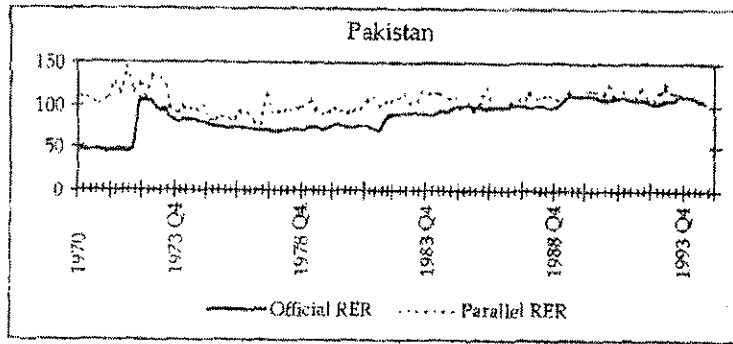
Figure 7.4b Africa & South Asia : Official & parallel bilateral RER with the US Dollar, 1970-94
 (First Quarter of 1985=100)



Note. Quarterly figures with year marking fourth quarter. An upward movement is a depreciation of the RER.



Note: Quarterly figures with year marking fourth quarter. An upward movement is a depreciation of the RER.



Note: Quarterly figures with year marking fourth quarter. An upward movement is a depreciation of the RER.

7.5.2. Trends in Official and Parallel Real Exchange Rates

From what have been said above, the theory suggests that the parallel exchange rate is likely to be more depreciated than the long-run equilibrium real exchange rate unless (a) macroeconomic factors inducing capital flight are not present, (b) exchange controls are poorly enforced, or (c) there are high import barriers that are well enforced. To evaluate these hypotheses, we would, ideally, compare the path of the parallel exchange rate in various countries to that of the long-run equilibrium real exchange rate in order to gauge the extent to which the parallel rate . On the basis of an optimizing model of the parallel market exchange rate, Montiel and Ostry (1994) come to much the same conclusion. They find that in the transition between steady-state equilibria in response to a productivity shock, the parallel market premium may move both above and below zero, and hence is "an unreliable indicator of the sign and magnitude of real exchange rate misalignment" may serve as a useful guide to determining the equilibrium exchange rate and, therefore, in setting the official rate.

Unfortunately, the equilibrium real exchange rate is a theoretical construct that must be estimated, not a directly measurable quantity for which data exist. Moreover, even in a unified market, the empirical estimation of the equilibrium real exchange rate is no easy task. Estimating the equilibrium rate is a highly involved process requiring strong assumptions about the operation of the current and capital accounts, as well as the estimation of stable trade and payments relationships over time.

Estimation of the long-run equilibrium real exchange rate for a wide set of countries, in order to compare those exchange rates to actual parallel rates, would go beyond the limited scope of this chapter. As a first step toward identifying where parallel market rates stand in relation to long-run equilibrium real exchange rates, however, it makes sense to compare levels of the parallel rate to levels of the official rate, averaged over long periods of time. This comparison may be informative, since over sufficiently long periods, the balance of payments must on average be at a sustainable level. Additionally, it may be useful to compare the level of the real official exchange rate during periods in which exchange controls are in effect-and hence parallel markets exist-to periods during which exchange markets are unified. Such comparisons may shed light on the factors that motivated the imposition of exchange controls, which in

turn may have implications for the relationship between the parallel and equilibrium real exchange rates.

A complicating factor in using averages of actual exchange rates as proxies for equilibrium exchange rates is that for most countries, the process of development and structural change will cause the long-run equilibrium real exchange rate to change over time. In that sense, a long-period average of actual real exchange rates may yield, at best, an average of long-run real equilibrium exchange rates over that period.

With this caveat in mind, however, we still believe that empirical comparisons of actual official and parallel exchange rates can yield useful insights.

First, as pointed by Montiel and Hinkle, 2001, the analysis will focus on averages of exchange rates across a large set of different countries. Therefore, even if long-run real equilibrium exchange rates follow particular trends in each individual country, the average long-run real equilibrium exchange rate for the sample as a whole may be more stationary. Second, the analysis focuses upon comparison of different types of exchange rates—official and parallel during regimes with and without exchange controls. Therefore, the results will be vulnerable to misinterpretation if the timing of exchange control periods in the sample coincide with particular movements in long-run equilibrium real exchange rates. Montiel and Hinkle, 2001 believe that exchange control periods are likely to coincide with systematic movements in *short-run* equilibrium real exchange rates, as a result of temporary shocks to capital flows or the terms of trade there is less cause to believe that exchange controls have been associated with particular trends in *long-run* equilibrium real exchange rates.

7.6. Summary and Conclusions

In the first part of this chapter we have discussed some of the most important exchange-rate related issues in developing economies. We have concentrated our discussion on three broadly defined issues: (A) the relative performance of alternative exchange rate regimes; (B) the long run behavior of real exchange rates, including whether there is any evidence suggesting that there is long-run convergence to PPP in developing economies; and (C) the assessment of situations of real exchange rate misalignment.

Throughout the analysis we have argued that, although, the field has experienced tremendous progress in the last few years, there are still a number of unresolved issues. In particular, we argue that the debate on the optimal exchange rate regime in developing countries has been hampered by the lack of genuine experiences with floating exchange rates. In fact, most exchange rate regimes classified as "floating" correspond to some kind of managed system. We have also argued that there are still major gaps in our understanding of the long run behavior of real exchange rates in the developing countries. In contrast with the case of the advanced nations, the time series available for the developing countries are relatively short and, in many cases, the quality of the data is suspect. Our analysis in section 7.4 dealt with alternative methods for assessing real exchange rate misalignment in developing countries. Here, as in the previous sections, we argued that in spite of evident progress in the last few years, existing models are still subject to a number of limitations.

The last section of this chapter this chapter dealt with the use of the parallel exchange rate as a guide to setting the official rate. The theoretical analysis indicated that when the emergence of a parallel exchange market is motivated by the overvaluation of the official exchange rate relative to the long-run equilibrium real exchange rate, the parallel market rate is likely, on average, to be more depreciated than the long-run equilibrium real exchange rate. The gap between the parallel rate and the long-run equilibrium rate is likely to be smaller to the extent that export receipt surrender requirements *are not* well enforced and to the extent that barriers to imports and other commercial policies that tend to appreciate the short-run equilibrium real exchange rate *are* well enforced. Moreover, our theoretical analysis indicated that even if the official exchange rate is set at its long-run equilibrium level, a parallel market may arise in order to meet the demands of residents seeking to augment their holdings of foreign assets.

In this chapter, we did not compare actual parallel exchange rates to estimates of the long-run equilibrium rate in different countries, owing to the difficulty of estimating equilibrium rates for a large sample. However, Hinkle and Montiel (2001) compared multiyear averages of real parallel rates to real official rates in a sample of 24 developing countries and made a number of empirical observations.

First, they found that for the sample as a whole, the real parallel market rate was generally more depreciated than the official exchange rate, even when the official rate was measured only during periods in which the exchange markets were unified. During periods in which the exchange market is unified and there are no exchange controls to bridge the gap between supplies and demands for foreign exchange, the official exchange rate is more likely to be close to the long-run equilibrium rate on average. Hence, these two observations constitute partial evidence that the parallel rate tends to be undervalued relative to the long run equilibrium exchange rate.

Second, they found important differences in the relationship between parallel and official exchange rates among different subsets of our country sample. In Latin America and in Turkey, the emergence of parallel exchange markets appears to have reflected a sharp depreciation of the short-run equilibrium exchange rate relative to its long-run value, *not* the appreciation of the official exchange rate from its long-run equilibrium value. In those countries, the parallel rate was clearly depreciated compared with the official exchange rate during periods in which the exchange markets were unified. However, the undervalued nature of the parallel rate does not appear to have reflected the overvaluation of the official exchange rate relative to the long-run equilibrium real exchange rate during periods of exchange controls, since the official exchange rate in this subset was on average more depreciated during the periods in which exchange controls were in effect than in the periods in which markets were unified.

Third, the findings show that the African and South Asian countries better fit the preconception that the emergence of parallel exchange markets reflects the overvaluation of the official exchange rate relative to its long-run equilibrium value. Among the few countries in this subset that experienced periods of unified exchange rates, the real official exchange rate clearly was more appreciated during periods in which exchange controls were in effect than in periods in which exchange markets were unified. This suggests that in contrast to the Latin America and Turkey case, the real appreciation of official exchange rates in Africa and South Asia, relative to long-run equilibrium values, was the main factor underlying the emergence of parallel markets.

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CHAPTER 8

The Algerian Exchange Rate System: A Cointegration Analysis

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The Algerian Exchange Rate System: A Cointegration Analysis

8.0 Abstract

Based on the theoretical background given in the previous chapter, we try in this chapter to study the exchange rate policy in Algeria by using a cointegration analysis. Unfortunately, we are not going to test the Efficient Markets Hypothesis of the Algerian Dinar. This is simply due to the lack of forward exchange rates. Nevertheless, we are going to look for other aspects of exchange rate in Algeria, mainly the parallel exchange rate. Thus the first part of this chapter examines the situation of exchange rate in Algeria by giving an historical review. Secondly, we will define the main factors behind the development of the parallel exchange rate market that lead to a situation of misalignment. Then, in the third part of this chapter, we show that the Algerian parallel exchange rate is more efficient than the official rate using a purchasing power parity approach. Section 4 gives the implications and recommendations. Evidence shows that authorities should take into account information provided by the parallel exchange rates in deciding the level of the appropriate official exchange rate.

8.1 Introduction

The breakdown of the Bretton Woods system of pegged exchange rates has since 1971 given developing countries a wider range of choices with regard to their exchange rate regimes that had previously existed. With the emergence of a variety of exchange rate regimes, increasing attention has been given to the rationale for choosing one type of regime over another and how variations in the nominal or real exchange rate affect the economies of these countries.

The issue of the choice of exchange rate regime has been an area of debate in international economics already in many years. In particular, with quest for high economic growth, developing countries have been interested to know whether to fix or float their exchange rate. In this regard, a number of economic factors have been found to determine the choice of exchange rate regime in these countries. An empirical study has not yet been conclusive as to what really are the factors that determine the adoption of exchange rate regimes in developing countries. Some authors tried to explain the adoption of exchange rate systems in developing countries from a social point of view, by 'learning from neighbors' (Khamfula, 1999). Quite amazing and puzzling is the tendency of some exchange rate regimes within a geographical region. For instance, by 1995 there had been a remarkable diffusion of managed float in Asian developing countries, an independent float in Central America and a crawling peg in South America, (IMF statistics). Does this tendency to adopt a similar type of exchange rate regime over time has anything to do with learning among regional neighbours?

In the case of the Algerian system, however, the answer could only be negative as far as the above 'learning from neighbours' doctrine is concerned. In fact, Algeria experienced different exchange rate systems, since 1962, that are totally different from those of neighbours. This is due probably to the different political system compared to other North African countries.

Another feature of the exchange rate regimes in the developing countries is the co-existence of a parallel or black market along with the official market for foreign exchange. This is the case of the Algerian exchange rate system. Several factors are responsible for the emergence of the black market for foreign currency. In the literature

some of the factors mentioned are; overvaluation of the currency, foreign exchange control, capital control, and trade restrictions (Agenor, 1992). In this literature on black market exchange rate, however, there are no discussions about whether these markets are efficient or not.

One of the factors that is responsible for the existence of black exchange rates is the overvaluation of the national currency. This situation is known as the misalignment of the exchange rate.

In chapter we try to investigate in the factors that are behind the development of the black market for foreign exchange that has led to a situation of misalignment. Then, in the next part of this chapter, we show that the Algerian parallel exchange rate is more efficient than the official rate using a purchasing power parity approach. Evidence shows that authorities should take into account information provided by the parallel exchange rates in deciding the level of the appropriate official exchange rate.

Consider rations are first given to an overview of the Algerian exchange rate policy.

8.2 the Algerian exchange rate policy

The objective of any exchange rate policy is the determination of the exchange rate of the national currency. The exchange rate is the price to which a national currency can be exchanged against another. The exchange rate that is frequently used is the bilateral rate which is listed by discount brokers in exchange rate markets or published by a financial newspaper. The bilateral exchange rate of the Dinar / US Dollar which was 4.94dinars to 1 US Dollar in 1974, has exceeded the value of 70 Dinars in 2000 and attended more than 83 Dinars in 2002.

To evaluate a currency on the foreign exchange market, by studying one or more bilateral exchange rates, can be misleading same manner as to consider the general price level by considering only the prices of one or several baskets of products. Just like any price index, the bilateral exchange rate of a particular currency can be combined in various ways In order to build an index of an effective exchange rate.

Before discussing the various theoretical approaches concerning the measurement of the exchange rate, we initially try to expose ,briefly, different time periods of the Algerian exchange rate policy.

The policies instituting the regulations of the national currency knew four principal phases:

From 1962 to 1970

After independence, Algeria was attached to the Franc zone. The currency was freely convertible and transferable. Unfortunately, and facing the risks generated by the massive capital flight and with the balance of payments disequilibria, the monetary authority instituted in 1963 exchange controls on all the operations with the rest of the world. This change was accompanied by various actions aiming at controlling the foreign trade; we can quote: the quotas system, the creation of the national office of trade, the control of all export and import operations.

These restrictions were followed in April 1964 by the creation of the national monetary unit, the 'Algerian Dinar', with a fixed value of 180 Mg of fine gold. Thus the Algerian Dinar (DA) replaced the new Franc (NF) at the parity of 1 DA = 1 NF.

For political reasons, Algeria decided to peg the value of its currency to a basket of currencies chosen according to its principal trade partners. The value of the Dinar is determined administratively according to the variations of the currencies composing the basket. The course of each currency is affected of a weighting coefficient giving the importance of the foreign trade expressed in the same currency.

The advantage of pegging the Dinar to a basket of currencies is to enable the stability of the effective nominal exchange rate, but urges a variability of bilateral rates relatively to the currencies that compose the basket. This will increase the exchange rate risk for the decision makers.

From 1971 to 1988

This stage is characterized by the application of a new management system for public enterprises, particularly with the Socialist Management of Enterprises (Gestion Socialiste des Entreprises), the General Statute of the Workers (Statut Général des Travailleurs) and the launching of the economic development plans. The objective being to stimulate the productive investment and to facilitate the of foreign trade operations. Many legal texts came to regulate the investment.

This period is marked by the total monopoly of the state on the economy. All the operations of production and marketing are entrusted to the offices of the state. The legal texts laid down the methods of access to the exchange market.

All the imports registered within the framework of the monopoly are subjected to what is called the GAI (Global Authorization of Importation); Any product not appearing in this framework requires a license of importation

The public and private enterprises cannot profit from the retrocession of the hard currencies generated by their activities with the rest of the world, except for the mixed investment companies whose amount of retrocession is fixed at 20%.

Thus since 1974 the access controls to the exchange market accompanied by policies of fixing of quotas of the imports gave rise to the parallel exchange market (parallel market, unofficial market or black market for foreign exchange). The table (8.1) shows the evolution of the Algerian Dinar in the official and parallel exchange market.

Table (8.1) Official exchange and parallel rates in Algeria

	1970	1974	1977	1980	1987
Official market	1.0	1.0	1.3	0.62	0.80
Parallel market	1.0	1.1	1.5	2.0	4.0

Source: Henni, A 1991 *Essai sur l'économie parallèle* Edition Enag

From 1988 to 1994

The events which shook Algeria in 1988, gave rise to an incipient rupture with the mode of socialist management.

Thus new reforms in economic and legal matter came to give a new breath to the Algerian economy, among which it is necessary to quote: the law on the autonomy of the enterprises (1988), the law on the currency and the credit (1990), the law on the prices.

The objective of these new reforms was to break with the monopoly of the State on the foreign trade, to rehabilitate the private enterprises, to gradually offer an autonomy of management to the public companies so they could operate a good

transition to the market economy, finally to ensure the autonomy of the Central Bank with regard to the Treasury.

The reforms recommend that the private enterprises can enter the official exchange market via the commercial chamber, the launching of a partial convertibility (current account) since 1991, and the realization of a total convertibility in 1993.

From 1994 to date

The access to the official exchange market is made possible by the IMF to all the economic operators (public or private) after the signature by Algeria in 1994 of a first agreement concerning rescheduling of part of its debt.

8.2 The origin of the Parallel Exchange market

The unofficial or parallel exchange market exists in the majority of developing countries. In some cases governments respond to balance of payments crisis by creating a legal parallel (or dual) foreign exchange market for financial transactions. The objective is to limit the short-term effects of a depreciation of the exchange rate on domestic prices while maintaining some degree of control over capital outflows and international reserves. In other cases, extensive controls on foreign exchange restrict access to official markets and lead to the emergence of an illegal parallel market. The illegal market then grows in importance as authorities respond to a deteriorating balance of payments by tightening and extending controls rather than reducing aggregate spending or devaluing the official exchange rate, or both (Kiguel and O'Connell, 1995). Clearly this is the case of the Algerian Dinar parallel market.

The causes which govern the emergence of this type of money market are similar for all the countries. For instance, the imposition of restrictions in the exchanges with rest of the world, the control of the capital movements with the rest of the world, the fixing of imports quotas and prohibition to import certain products, the inflation which the majority of developing countries knows and where the foreign currency is regarded as a blue-chip stock.

These are the causes which gave rise to the parallel exchange market of the Algerian Dinar. This market is considered as a free market, and the price of the foreign

currency is determined by the traditional practice of supply and demand . Contrary to the official exchange market, the parallel market is attached to only one currency: the French Franc. Nowadays, it is attached to the Euro for a parallel value of 107 DA/Euro compared to the official value of 86 DA/Euro.

A market is always constituted by supply and demand of unspecified goods. As far as the parallel exchange market is concerned, the restrictions imposed by the exchange rate policy, generated a demand for means of payment which is explained by the demand side by: capital transfers, invisible payments, some illegal imports (especially of consumption); and in the supply side by: transfers of the immigrants, imports invoicing, smuggling (trabendo), and the contribution of the foreign tourists.

The table (8.2) shows the evolution of the official exchange and parallel for the period 1970 – 1996.

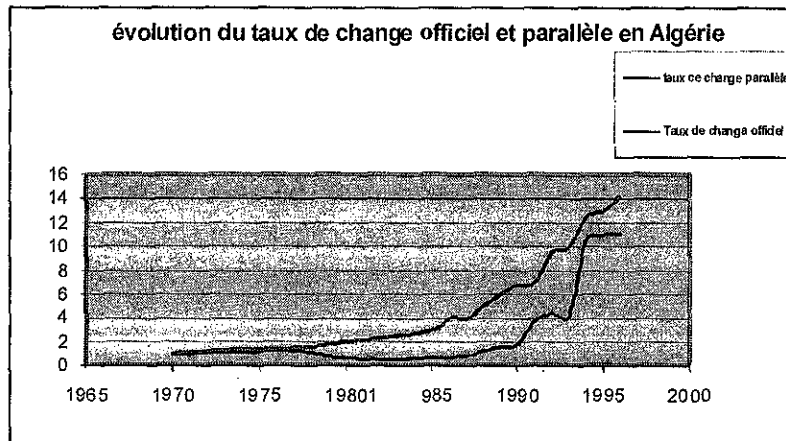
Table (8.2) Evolution of the parity of the Dinar compared to the F.F in the official and parallel exchange markets.

Year	1970	1971	1977	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
official rate	1	1.1	1.3	0.62	0.61	0.71	0.8	1.2	1.5	1.8	3.75	4.36	4.2	10.5	11	11.1
parallel rate	1	1.4	1.5	2	3	4	4	5	6	6.8	7	9.5	10	12.5	13	14.2
Level of the rebate	0	0.3	0.2	1.38	2.39	4.29	3.2	3.8	4.5	5	3.25	5.14	5.8	2	2	3.15
Variations of the parallel rate	100	110	150	200	300	400	400	500	600	680	700	950	1000	1250	1300	1420
Rate of inflation	-	-	-	-	10.5	12.4	7.4	5.9	9.3	16.7	20	31	31	35.5	30	-

Source: *Algerian review of economy and management*, May 1997, University of Oran.

Table (8.2) enables us to make the following observations: from 1970 to 1996 the parallel exchange market did not cease moving due to the high demand for hard currencies; the importance of the parallel exchange is increased in 1986 because of the economic crisis rising from the fall of the prices of the hydrocarbons which involved a fall of 56.5% of the export earnings for the same year; a strong correlation exists between the annual variation of the parallel exchange rate and the rate of inflation. These results, which go against the findings of Park (1995) and Morris (1995), confirm the work of Pinto (1991) by showing that a variation of parallel rate of exchange causes necessarily an increase in inflation.

The evolution of the official and parallel exchange rate is illustrated by the graph below which shows that the level of the rebate between the official exchange rate and the parallel exchange rate started to appear from the end of 1970 and has increased in 1993 with a rebate of 5.8.



8.3 The Dinar: What is the appropriate rate?

The very strong depreciation of the Dinar on the parallel market (currently more than 100 DA / 1 Euro against 72DA approximately / 1 Euro at the official market), and the extremely careful attitude of the monetary authorities towards a devaluation raises the question of the "true" value of the Algerian Dinar, or rather of its desirable rate.

The careful attitude of the authorities is explained by the fear of the impact of the devaluation of the Dinar on the prices and also on the situation of the enterprises already put at evil by the shortage of the provisioning. It is also explained by the implicit consideration that the parallel market is a marginal market for the fixing of exchange rate.

Several questions arise then: How can we explain the strong drift of the Algerian Dinar at the parallel market and what would be the appropriate rate for the Dinar in order to achieve a better convertibility at the official level and under which conditions?

Moreover, the creation of the economic and monetary Union (EMU) opened a new chapter in the debate on the choice of the modes of the exchange rate . It is a question of finding the mode which will serve best the interests of Algeria within the framework of the euro- Mediterranean partnership.

Algeria, which is experiencing a market economy transition, may strongly find it beneficial to adhere to the Euro zone, which will offer a certain number of economic advantages, mainly low risk premiums, interest rates and transaction costs. All the question is to know if there is an ideal exchange mode.

The studies carried out show however that the direct impact of the introduction to Euro will be positive but limited. In fact, the principal debate, in the short run, rests on the influence which this currency can or must have on the modes of exchange in the Mediterranean. An illustration of the plurality of the modes of exchange is exposed in the table (8.3):

Table (8.3) *Exchange rate regimes in the Mediterranean*

Country	Exchange Rate Regime	Basket or target Currency
Algeria	Managed Floating	US \$
Cyprus	Fixed anchor	Euro
Egypt	Managed Floating	US \$
Jordan	Fixed anchor	US \$
Lebanon	Managed Floating	US \$
Malta	Fixed Anchor	Euro
Morocco	Fixed Anchor	Basket of currencies
Syria	Fixed Anchor	US \$
Tunisia	Managed Floating	Basket of currencies
Turkey	Managed Floating	Rule of real exchange rate

Source *The IMF, World economic outlook, 10/1998*

8.4 The misalignment of exchange rates

Numerous authors have studied the theoretical relationship between exchange-rate management and international trade flows [Cushman (1983), Dixit (1989), Gagnon (1993), Hooper and Kohlhagen (1978)]. This relationship concerns both the impact of exchange rate changes and the impact of exchange-rate variability on trade. While there was a consensus on the impact of exchange rate changes on trade, the effect of variability was much more controversial (Reinhart & Reinhart, 2002). Variability is defined as fluctuations of exchange rate around its equilibrium level. Two types of fluctuations are considered. One type concerns frequent and non persistent fluctuations. This type of fluctuation is labelled volatility. The second concerns less frequent and more persistent swings: the exchange rate departs from its equilibrium level over several periods. This second type of variability is labelled misalignment. In developing countries (LDCs) real exchange rate (RER) misalignment is generally associated with a substantially overvalued RER with respect to its market clearing. This is often an outcome mismanagement of economic policies. This is the case of the Algerian Dinar.

Moreover, inconsistent policies increase the volatility of RER. Recent analyses of the damaging influence of RER variability on trade in LDCs are Medhora (1990), Paredes (1989), Grobar (1993) and Sekkat and Varoudakis (2000).

8.4.1 Theoretical Considerations

At the beginning, the macroeconomic literature abounded with models arbitrating between the pure fixed exchange and the pure flexible exchange. During the Nineties, the IMF has decided for the adjustable fixity on a currency or a basket of currencies in a time when perfect flexibility generally involves conflicts of economic policy. These achievements were lengthily analyzed by the new tendency of the political economy of the reforms (Edwards S., 1994). The IMF statistics confirm initially the retreat of the modes of fixed exchange - the number of currencies which was declared in fixed exchange regime or with limited flexibility moved back considerably, then symmetrically the managed float regime has increased.

The economic literature abounds of articles analyzing the exchange rate determination theories. The maladjustment of the traditional exchange rate theories (Purchasing power parity PPP, interest rate Parity, monetary models, portfolio

models) to the current situation of financial integration of the emergent economies, and the problems of validation which they meet lead towards the theories of long term real equilibrium exchange rate ..

Recently the debate is focused on the causes and the effects of the appreciation of the real exchange rates in developing countries . The points of view are opposed: the first is related to the " Misalignment view " for which the appreciation of the real rate generates a loss of competitiveness which is translated in its turn by a deterioration of the current balance; and the second, that of " fundamentalist ", considers that this appreciation translated by the exchanges on the level of the fundamental real sectors which are likely to involve a degradation of saving-investment equilibrium (Marouani A., 2000).

8.4.2 The real effective exchange Rate

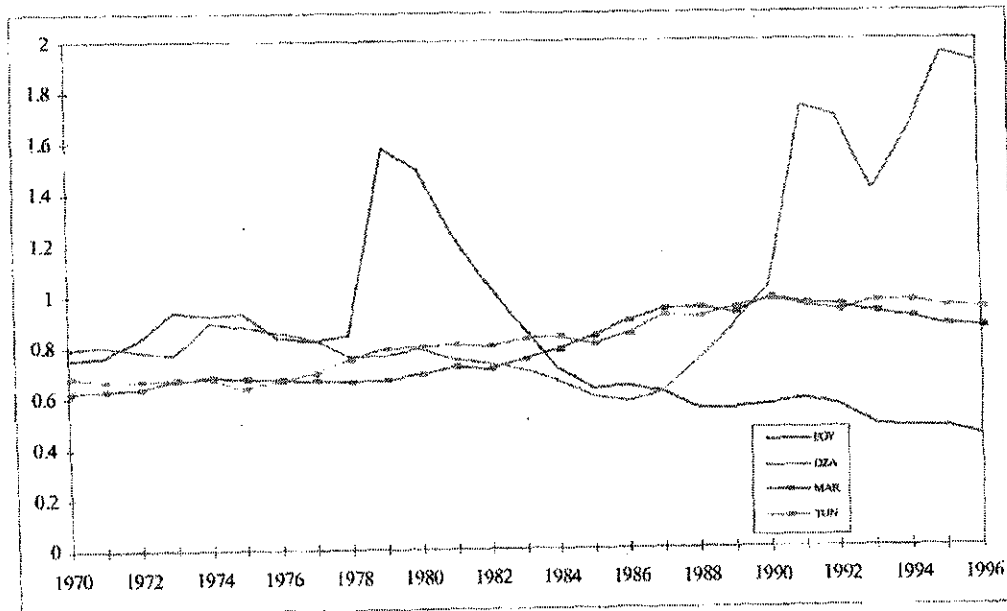
Theoretically, the real exchange rate is the relative price of the exchangeable goods compared to the non-exchangeable goods. Empirically, however, there is not a single method to measure the effective exchange rate. (Sekkat K. & Achy L, 2000) propose an index of real exchange rate " Real Effective Exchange Rate=REER " which takes into account the degree of competitiveness of the products of the countries of the Middle-East and North Africa (M.E.N.A) compared to the European products. The table (8.4) gives the results of the real effective exchange rate. The table shows that this rate knew significant movements during the last 16 years. We can note that the degree of variation is not the same one for all the countries. With a minimum of 74.3 and a maximum of 306 Algeria knows much more variation than Morocco or Tunisia. These latter shows a light stability in the real exchange rate. These contrasts find their explanation in the exchange rate reforms of undertaken by these two countries.

Table (8.4) Basic Statistics from the effective real exchange rate

	Algeria	Morocco	Tunisia
Average	134.2	82.2	75.2
Standard deviation	67.7	17.4	19.5
Minimum	74.3	61.3	65.9
Maximum	306.0	94	106.5

Source: K.Sekkat & Achy L, Femise, June 2000

As shown in Figure (8.2), among Northern African countries, Morocco and Tunisia exhibit a slight but steady trend of real effective rate depreciation. In the 1990s the RER seems to have been stabilised in the case of these two countries. On the contrary, Algeria and Egypt seem to have suffered from exchange-rate mismanagement. Algeria had a steadily appreciating real exchange rate from 1975 to 1986. Then it experienced a sharp real depreciation, followed by erratic RER movements over the 1990s, that increased the variability of the RER. Egypt experienced a sharp real depreciation following a devaluation in 1979, and then continuous real appreciation up to the 1990s.



Source: Sekkat K. & Varoudakis A. (1998)

Figure (8.2) Real Effective Exchange rate, North African Countries

8.4.3 The real exchange Rate and misalignment:

One simple and direct approach to estimating misalignment is the premium on parallel market (PMP) of exchange rate. The intuition behind is that the more overvalued the REER is, the tighter will be the control on foreign exchange and, as an outcome, the higher will be the PMP. Table (8.5) reports the (PMP) extent of parallel market premium expressed as a percentage of nominal official exchange rate against the US dollar. Except for Morocco and Tunisia where over the whole period the size of PMP was low, the three other countries experienced very high levels of PMP. This is specifically the case of Turkey where parallel market rate of Turkish Lira was more than seven times lower than its official rate during the period 1974-1979. This is also the case of Algeria where the black market of the Dinar was almost four times lower than its official rate during the period 1985-89 and two times lower during the period 1990-97. Thanks to exchange rate reforms undertaken in Turkey and Egypt, aiming at easing restrictions on foreign exchange holding by residents, the level of PMP in both countries has significantly decreased during the last period.

Table (8.5) Parallel Market Premium (PMP) (% of the official exchange rate)

Period	Algeria	Morocco	Tunisia
1970-1974	51	5	15
1974-1979	96	7	5
1979-1980	242	5	8
1985-1989	379	3	4
1990-1997	194	4	4

Source: K.Sekkat & Achy L, Femise, June 2000

Table (8.6), reports the implied rate of misalignment of MENA currencies with respect to European currencies. Real exchange rate is overvalued ($Mis > 0$) whenever it is below its "equilibrium value" and vice versa. According Sekkat & Achy (2000), during the period 1990-1997, all currencies were overvalued except the Moroccan dirham. The overvaluation is more pronounced for the Algerian Dinar, which experienced an overvaluation of 6.77%. The Tunisian Dinar and the Egyptian Pound have

experienced, roughly, 3% overvaluation. The Turkish Lira is closer to its equilibrium value.

Table (8.6) *Misalignment rate with respect Euro currencies*

Period	Algeria	Morocco	Tunisia
1970-1974	-9.14	2.54	-5.40
1974-1979	-1.10	0.73	0.56
1980-1979	-3.76	0.29	-2.47
1989-1985	2.12	-3.47	1.66
1997-1990	6.77	-0.16	3.33

Source: K.Sekkat & Achy L, *Femise*, June 2000

8.5 The parallel exchange rate: a test of efficiency

In our research, We will try to show at which point we will be able to apply the purchasing power parity (PPP) hypothesis in Algeria, by using initially the official exchange rate in the absolute version of the PPP, and next by using the parallel exchange rate to show which rate perform better. The PPP hypothesis is an important assumption in most models in international economics. Although its validity has at times failed to pass empirical tests, PPP does however, highlight the plausible factors that are behind exchange rate movements (Krugman and Obstfeld, 1997). It has also been used as a basis for assessing levels of exchange rates, and in comparing income levels between countries.

Although the PPP framework has certain limitations, there is no doubt that it is still appealing as a starting point for quantitative exercises regarding assessing the appropriate level for new parities of exchange rates (Isard, 1995). Thus, PPP can help policymakers to assess the appropriateness of exchange rate levels in Africa, or as Isard (1995) puts it, if used intelligently, along with other approaches to assessment, PPP calculations can have significant diagnostic value.

This continuing importance of PPP in economics merits further tests to establish its validity. As econometric methods undergo more development and refinement, better

techniques for undertaking empirical tests of PPP become available. This study employs one of the latest techniques, the Cointegration method (Engle & Granger, 1987), for testing PPP in Algeria.

This method is used to test the validity and the stability of the economic models as well in the short term as in the long term. A number of methods for testing for long-run PPP have evolved over time. However, of late, cointegration tests seem to have dominated the literature. Cointegration tests that have been done by most researchers have tended to offer support for long-run PPP, unlike traditional tests, which are criticised for having low power.

The statistical studies confirm the stability of the mathematical model of the purchasing power parity (absolute and relative version) (Frenkel, 1981). Cointegration methodology put the assumption that the variables used are unit root series (Dickey and Fuller, 1981).

In order to test the validity of the purchasing power parity theory (PPP), the best method consists in knowing if exchange rates and the prices are cointegrated. The work initially carried out by Taylor (1988) rejected this hypothesis for Germany, the United Kingdom, France, Canada, and Japan for the period 1973 to 1985. The results show that the exchange rates and the prices are not cointegrated, which implies the non validity of the PPP in the long term. The same results were found by (Jones, 1989).

As mentioned earlier, before proceeding to test for cointegration, it is necessary to determine the order of integration of the series of the logarithm of exchange rates (for both official and parallel market) and the logarithm of the price level. The results of our study are reported in the table (8.7) and (8.8). The selected period is 1970 to 1996. In fact we have used the statistics given by (Henni, 1991) and World Table Statistics (1998). In order to test for the unit roots in these three series, the Dickey-Fuller (DF) and the Augmented Dickey Fuller (ADF) are used. The results of the test are presented in table (8.7). For each of the variables concerned we are unable to reject the null hypothesis that the series are $I(1)$. In other words, all the variables are integrated to order $I(1)$.

After determining that the variables are of order $I(1)$, we now turn to examine whether they are cointegrated or not. The first step is to run a cointegration regression.

In the present analysis two cointegration regressions are set. In the first one, we regress the logarithm of the price level on the logarithm of the exchange rate and an error term. In the second equation we regress the logarithm of the exchange rate on the logarithm of the price level. The two regressions are presented in table (8.8). In testing for cointegration three tests were used, namely, Cointegration Regression Durbin Watson (CRDW), Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF).

Table (8.7) Unit root Tests for official and parallel exchange rates

VARIABLE	DF	ADF
PE _R	-1.21	-2.08
OE _R	-1.47	-2.22
CPI	-1.65	-1.98

DF and ADF stand for the Dickey-Fuller and Augmented Dickey-Fuller Tests ; PE_R : Parallel exchange rate. OE_R , Official exchange rate; CPI: Consumer price index ; The Null hypothesis is that series in question are I(1); Approximate critical values at the 5% level is -2.89, rejection (θ $\theta < -2.89$)

Table (8.8) Test of validity of PPP by using Co-integration

	Dependent Variable	Constant	S _t	P _t	DW	DF	ADF
Official exchange rate	S _t	5.36	-	1.42	-3.48	-4.12	-3.59
	P _t	1.79	-0.33	-	-3.88	-3.86	-4.48
Parallel exchange rate	S _t	1.25	-	-1.22	-2.11	-2.80	-3.12
	P _t	0.36	-0.85	-	-2.28	-1.98	-3.15

The Critical values for DF, ADF and DW are: -3.37, -3.17 and -3.86 respectively. The Null hypothesis is that series in question are I(0).

The results of the table (8.8) show that the hypothesis of the validity of the PPP by using the official exchange cannot be accepted. This hypothesis, on the other hand is valid by using a parallel exchange rate. This result shows that the long run purchasing power parity is accepted when using the parallel rate rather than the official exchange rate. We can argue that the unofficial exchange rate is more efficient than the official rate.

The parallel exchange rate is indeed much more close to the effective real exchange rate. As these markets are efficient, authorities should use the information provided by the black market rates in deciding the level of the official exchange rate. In

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CHAPTER 9

Conclusions and Recommendations

For further Work

9.1 Summary and Conclusions

The advent of flexible exchange rates in 1973 has led to a great amount of empirical research concerning the relation between the spot and forward exchange rates. The important issue here is whether or not the foreign exchange market can be regarded as an efficient market. In an efficient market, prices fully reflect all available information and it should not be possible for a market operator to make abnormal profits. Assuming rational expectations and risk neutrality on the part of the agents in the foreign exchange market, it can be shown that the forward rate is an unbiased predictor of the future spot rate. The Efficient Market Hypothesis (EMH) is very important for the construction of macroeconomic models and for testing monetarist theories concerning the asset approach to the exchange rate.

In the past two decades there have been many empirical studies both in support of and opposing the unbiased forward (UFH). The UFH argues that the forward rate "fully reflects" available information about the exchange rate expectations (Chiang, 1988). One view of market efficiency states that the current price fully reflects all available information. When this is applied to the foreign exchange market, it implies that 'economic agents' expectations about future

values of exchange rate determinants are fully reflected in the forward rates (Chiang, 1988). To test this hypothesis, the conventional method uses an Ordinary Least Squares (OLS) regression, with the spot rate as the dependent variable, while the one-period lagged forward rate as the independent variable. To support the UFH, the constant term would not differ from zero, the coefficient of the one-period lagged forward rate would not significantly differ from one, and the error term would not exhibit any serial correlation.

It is also useful to point out that a central concern for macroeconomic analysis, particularly from the viewpoints of policy prescription, is to understand and analyze the relationships that might exist among variables displaying non-stationarity over time. The co-integration methodology is generally used to capture and measure long run equilibrium relationships among these variables.

In the long run, the exchange rate is influenced by relative inflation, growth and interest rates and trade and investment flows between countries. Foreign exchange dealers therefore closely monitor announcements of new economic statistics on the major world economies. When economic releases are out of line with forecasts, dealers alter the rates they are quoting to reflect the implied change in their assessment of the currency's value.

Since changes within and between different governments often lead to changes in economic and financial policies, political developments can also affect the foreign exchange market. The market may therefore react to changes in public opinion polls or other 'news' items which have implications for future political developments. But expected news, whether economic or political, rarely moves exchange rates – the effect will already have been anticipated or "discounted". Unexpected news, such as a country changing the regime it favours for managing its currency, or unanticipated problems in a nation's economy, however, can lead to sudden and sharp exchange rate movements.

The goal of our research, and according to what have been said above, was to investigate the efficiency of the foreign exchange market and the role of the news in determining the short-term deviations of the exchange rate from its long run

equilibrium. Although, many tests have been used in the literature to test the validity of the EMH, we will have used the cointegration methodology and we have presented a new way of testing different aspects of market efficiency for exchange rates.

An other aspect of the study has looked on the effects of news on exchange rates. In fact we have tested the efficient markets hypothesis using a news format. We have used both monetary and portfolio models to determine the variables which affect directly the exchange rate behaviour.

Another aspect of our research has looked for the exchange rate policy in developing countries. The aim was to test the efficient Markets hypothesis. However, and due to the absence of forward rates in the majority of these countries, we have simply assessed the policy implications of these rates. Nevertheless, and the case of the Algerian exchange rate, we tested the efficiency of the parallel markets using a purchasing power parity approach.

After giving a research outline in the introductory chapter, the second chapter of thesis has provided a brief notes on cointegration methodology. It has shown that cointegration analysis provides of investigating the possible existence of equilibrium relationships and of estimating any such relationship if it exists. It also provides a computationally attractive way of incorporating long-run (levels) information into dynamic models. The testing, implications and problems were the main concern in the chapter. We have presented many examples using cointegration techniques, but the list is rather an illustrative but not exhaustive examples of cointegrated variables.

In the next chapter we have examined all the aspects of the EMH theoretically and empirically. As have been demonstrated, the available evidence would seem to question the efficiency of the forward market for foreign exchange. Researchers have been testing a joint hypothesis that agents are rational and that they know the expected equilibrium return. So, when rejecting the EMH, one cannot discern if this is due to the irrational information processing or rather it

last sixteen years. The poor performance of exchange rate models to explain exchange rate behaviour, concerning this high volatility and variability, has raised many questions about the reasons for this failure. To some extent this failure is due to the imperfect foresight of stances of monetary and fiscal policies and, of the consequences of those policies for inflation rates, interest rates, and other economic conditions. Another explanation that may have caused exchange rate movements, could be "news" that would not have been anticipated, since the new information plays a predominant role in determining the exchange rate pattern. In addition, the statistical tests that have been used indicated that the explanatory power of exchange rate models has been extremely poor during this period. In this chapter we have also given some elements of truth about relationships between exchange rates, national price levels and interest rates. Thus both implications and empirical validity of purchasing power parity (PPP) and interest rate parity assumptions are discussed.

Since the above concepts are based on a long-run equilibrium relationship, cointegration techniques have been used to detect this equilibrium. This was the main concern of chapter six. Many studies, as mentioned previously, have used the cointegration techniques in the context of exchange rate determination. We have been inspired merely by the pioneers MacDonald R. and Taylor M. Consequently, in this research the *UIP* is tested using the aforementioned method. Considerations are also given to the *PPP* and the problem of causality. As far as the "news" approach is concerned, this chapter has provided a description of the candidate models that can be used as a "news" term in the context of EMH framework. Where again, using the aforementioned technique, the variables that are cointegrated are detected within each model of exchange rate determination. If the model is not entirely cointegrated (i.e. not all the variables are cointegrated in the model), there must be at least one or two variables that could form a long-run relationship with the exchange rate. These variables, that are cointegrated reflect the news term and will be used in a news format.

As an answer to the questions raised in the previous chapter, chapter six 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 results have of the validity of uncovered interest parity (UIP). They y stated 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.

In another aspect of our research, most of the important exchange-rate related issues in developing were discussed in chapter seven. We have concentrated our discussion on three broadly defined issues: (A) the relative performance of alternative exchange rate regimes; (B) the long run behavior of real exchange rates, including whether there is any evidence suggesting that there is long-run convergence to PPP in developing economies; and (C) the assessment of situations of real exchange rate misalignment.

Throughout the analysis we have argued that, although, the field has experienced tremendous progress in the last few years, there are still a number of unresolved issues. In particular, we argue that the debate on the optimal exchange rate regime in developing countries has been hampered by the lack of genuine experiences with floating exchange rates. In fact, most exchange rate regimes classified as "floating" correspond to some kind of managed system. We have also

argued that there are still major gaps in our understanding of the long run behavior of real exchange rates in the developing countries. In contrast with the case of the advanced nations, the time series available for the developing countries are relatively short and, in many cases, the quality of the data is suspect. We have also dealt with alternative methods for assessing real exchange rate misalignment in developing countries. Here, we argued that in spite of evident progress in the last few years, existing models are still subject to a number of limitations.

The last section of this chapter this chapter dealt with the use of the parallel exchange rate as a guide to setting the official rate. The theoretical analysis indicated that when the emergence of a parallel exchange market is motivated by the overvaluation of the official exchange rate relative to the long-run equilibrium real exchange rate, the parallel market rate is likely, on average, to be more depreciated than the long-run equilibrium real exchange rate. The gap between the parallel rate and the long-run equilibrium rate is likely to be smaller to the extent that export receipt surrender requirements *are not* well enforced and to the extent that barriers to imports and other commercial policies that tend to appreciate the short-run equilibrium real exchange rate *are* well enforced. Moreover, our theoretical analysis indicated that even if the official exchange rate is set at its long-run equilibrium level, a parallel market may arise in order to meet the demands of residents seeking to augment their holdings of foreign assets.

In this context, empirical studies show that the real parallel market rate was generally more depreciated than the official exchange rate, even when the official rate was measured only during periods in which the exchange markets were unified. During periods in which the exchange market is unified and there are no exchange controls to bridge the gap between supplies and demands for foreign exchange, the official exchange rate is more likely to be close to the long-run equilibrium rate on average. Hence, these two observations constitute partial evidence that the parallel rate tends to be undervalued relative to the long run equilibrium exchange rate.

Empirical studies, also found important differences in the relationship between parallel and official exchange rates among different subsets country

In our research, we have shown that while rejecting the validity of the purchasing power parity hypothesis using official exchange rates, we, however, accept it using the parallel exchange rate. This result shows that black markets are generally efficient. The other result is that this test can show the degree of misalignment and how much the official exchange rate is overvalued.

Accordingly, we can propose the following recommendations: Authorities should consider gradually withdrawing foreign exchange control in combination with stabilization policies, and then unify the black market with official market for foreign exchange. Thus the black exchange rate could be used as an indicator for the determination of the appropriate exchange rate.

9.2 Considerations for further work

In their article entitled 'Reconsidering Cointegration in International Finance: Three Case Studies of Size Distortion in Finite Samples', Godbout M.J. and van Norden S. (1997) reconsidered several recently published but controversial results about the behaviour of exchange rates. In particular, they explored finite-sample problems in the application of cointegration tests and showed how these may have affected the conclusions of recent research. They also demonstrated how simple simulation methods may be used to check the robustness of cointegration tests in particular applied settings, and provides information on the potential sources of size distortion in these tests. Three case studies were presented. The first is the literature on cointegration and prediction of nominal spot exchange rates spawned by Baillie and Bollerslev (1989). The second is work on the long-run validity of the monetary model of exchange rate determination, particularly the contributions of MacDonald and Taylor (1993; 1994). The final case study looks at the evidence presented by Kasa (1992) on common stochastic trends in the international stock market. The results suggest that Baillie and Bollerslev's results are unaffected by finite-sample problems, but that the opposite is true for the other two case studies.

In fact, the above is just an illustrative example showing that cointegrated tests could be improved using new estimation methods. For instance, some authors

demonstrate the importance of NECM models (Non-linear Error Correctin Models) for studying partial adjustment problems in macroeconomics and the efficient market hypothesis in finance (Dufrénot and Mignon, 2002). Other studies use the so-called fractional cointegration which tests the rank order of cointegrating variables rather the simplest test (Tkacz, 2000). The near-cointegration is also a newly developed concept used to test equilibrium long run relationship. As far as the samples used in any estimation, recent methods used the Panel data for both unit root or cointegration tests.

Finally, cointegration techniques are not yet well explored in developing countries studies. Many economic aspects are unexploited. Future research on topics, such as: the demand for money, the causality problem, interest rate differentials, would be fruitful using this methodology.

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