FOREIGN EXCHANGE MARKET MOVEMENTS:
A NEW LOOK

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Abstract:

The literature relevant to the efficient market hypothesis in the foreign exchange market has been examined primarily from the premise that the exchange rates incorporate all available information regarding exchange rate expectations and that it should not be possible to predict one exchange rate as a function of another.

1. Introduction

In the foreign exchange markets, the forward rate has been considered an 'unbiased predictor' of the expected future spot rate, i.e., the forward rate incorporates all available information about exchange rate expectations (Chiang, 1988). Early researchers of the foreign exchange markets such as Kohlhagen (1975), Giddy and Dufey (1975), and Fama (1976) strongly supported the view that the exchange markets were efficient. More recent research seems to suggest otherwise. Levich (1985), Boothe and Longworth (1986), and Frankel (1988), all have had problems with the conclusions of the early researchers on exchange market efficiency and the 'unbiased forward rate hypothesis'. Yet, MacDonald and Taylor (1989), Coleman (1990), Lajaunie, McManus and Naka (1996) and Rapp and Sharma (1999) have found the currency markets to be not cointegrated and hence, at least weak form efficient.

Research in the domestic markets has taken a two-track approach: (a) looking at excess volatility in the capital markets and (b) what has been termed 'calendar based' anomalies present in the capital markets. LeRoy (1991) points out that if the capital markets are at least weak-form efficient and dividends follow a random walk[1], then the variance of the rate of return on stock cannot be greater than the variance of the dividend growth rate. Yet, empirical results do show the exact opposite. Again, through the 1980's, researchers have found increasing evidence of stock market behavior at odds with the efficient market theory. The 'January Effect', the 'Weekend Effect', the

[1] The importance of the random walk model in explaining financial asset price behavior should be noted. Because of its inherent simplicity, the random walk model has an intuitive appeal. In its simplest form, the random walk model suggests that the price of any financial asset moves through time as a random process with uncorrelated changes. Consequently, the best estimate of the one-period ahead asset price is the current asset price (Garbade, 1982).

'P/E anomaly' are but a few of these so-called 'calendar-based' anomalies, which have been found to exist in the stock markets. Even in the foreign exchange markets there is a 'January Effect'. Roll (1994) disagrees with the evidence, suggesting that the intertemporal pricing anomalies should be exploitable by using defined trading rules. The result is no better than a buy and hold strategy.

There are three efficient market hypotheses according to which market expectations may be formed and they are the Random Walk Hypothesis, the Unbiased Forward Rate Hypothesis and the Composite Efficiency Hypothesis. The Random Walk Hypothesis suggests that the best predictor of the expected future spot rate is the current spot rate. Frankel and Froot (1987) examine the three expectations models: extrapolative, adaptive and regressive expectations, which can be looked at as deviations from the Random Walk Hypothesis (Tucker, Madura and Chiang, 1991).

The theory of cointegration was essentially pioneered by Engle and Granger (1987) and improved upon with a more robust and powerful technique by Johansen (1988) and has been used to test the efficient market hypothesis in the currency markets. Evidence is mixed with Baillie and Bollerslev (1989) coming through with clear evidence of spot rates across seven different currencies being cointegrated. Diebold, Gardeazabal and Yilmaz (1994) find the evidence much weaker than earlier reported. Baillie and Bollerslev (1994) in their rejoinder, point out that the relationship can be shown to be fractionally integrated since the influence of shocks to the exchange markets may disappear over very long time spans.

A market is said to be efficient when prices fully reflect all available information (Fama, 1970). Hence, if markets are informationally efficient, then market participants cannot make unusual profits by taking advantage of all publicly available information. Efficient markets are important to macroeconomics, since price determined in such markets fully reflect the scarcity value of resources and lead to allocational efficiency. Many macroeconomic and international economic/finance models assume efficient markets. Additionally, exchange market efficiency, is important from the viewpoint of the individual investor, the exchange rate forecaster, the policy maker in the Central Bank, and of course, the theorist (Boothe & Longworth, 1986). Hence, we can look at the exchange market efficiency broadly from the micro and macro viewpoint. At the micro level, the individual investor's concern is the presence of unexploited profit opportunities. Consequently, the absence of such unexploited profit opportunities would be construed as market efficiency.

At the macro level, as suggested earlier, an efficient exchange market suggests the exchange rate as a price in macroeconomics. Consequently, exchange market efficiency in this context relates to whether this market has set the exchange rate, making optimal use of all available information (Boothe & Longworth, 1986).

Notwithstanding that there is widespread agreement amongst academics on the empirical rejection of the joint hypothesis of market efficiency and no risk premium (Boothe & Longworth, 1986), the efficient market hypothesis has not died a natural death with Roll (1994) providing a strong defense. He suggests that all prices cannot

always include all available information; to him this is an 'idealized version'. If this were true, there would be no necessity for security analysts or security analysis, since all information would already be incorporated in security prices and both the informed and the uninformed investor would be making the same selection. The efficient market hypothesis continues to remain important to the macro economy and to macro economists and will remain so in the foreseeable future.

The sheer size of the foreign exchange market, in excess of $550 trillion and steadily rising, suggests that if there is any market, which is efficient, this must be it. There are no barriers to entry, information is freely available and competition is unfettered, keeping prices in check and reducing profits to a bare minimum. It has also been suggested that central bank intervention in the foreign exchange markets may in part be responsible for what is perceived as market inefficiency. Yet, Levich (1985) comes through with a suggestion that at least in the long run, central bank sterilization policies are of 'limited importance'.

In this paper, the literature relevant to the efficient market hypothesis in the foreign exchange markets has been examined primarily from the premise that the exchange rates incorporate all available information regarding exchange rate expectations and that it should not be possible to predict one exchange rate as a function of another.

This paper is organized as follows. Section 2 examines efficiency in the foreign exchange markets, particularly the Random Walk hypothesis, and the Unbiased Forward Rate Hypothesis and Cointegration and market efficiency. Section 3 concludes and bibliography follows.

2. Efficiency in the Foreign Exchange Markets

The idea of market efficiency in the foreign exchange markets has been linked to the rationality of market expectations. This could be examined by seeing whether investors could systematically outperform the market (Tucker, Madura & Chiang, 1991). From Levitch (1985) and Fama (1991) we have:

$$E\left(\gamma_{t+1} - \gamma^{e}_{t+1} / I_t\right) = 0 \qquad (1)$$

where γ_{t+1} = asset return and γ^{e}_{t+1} = market expectations of these returns. If profit-making opportunities, i.e., systematic forecast errors exist, then market participants would exploit the situation and the resulting error becomes 'white noise'. Hence, for efficiency to exist, an optimal forecast of asset prices is consistent with rational expectations (Tucker, Madura and Chiang, 1991).

Extending the efficient market hypothesis to foreign exchange markets, we have:

$$E\left(SR_{t+1} - SR^{e}_{t+1} / I_t\right) = 0 \qquad (2)$$

where SR_{t+1} is the next period spot rate and SR^{e}_{t+1} is the estimated next period spot rate, given the information available during the same period, i.e., I_t. Of paramount importance then, is the optimal forecast such that residuals do not display serial correlation. There are three efficient market hypotheses according to which market expectations may be formed, and they are: (a) the Random Walk Hypothesis, (b) The Unbiased Forward Rate Hypothesis, and (c) the Composite Efficiency Hypothesis.

2 (i) The Random Walk Hypothesis

The Random Walk Hypothesis suggests that asset prices in the financial markets fluctuate randomly around their intrinsic value because news or information impacts the markets randomly; asset prices react to this unexpected information. Hence we can say that asset prices themselves also move randomly.

If the currency markets are efficient, then the best estimate of the one period ahead spot rate is the current spot rate, i.e., the current spot rate incorporates all past information (Mussa 1979, Meese & Rogoff 1983, Chiang 1986).

In view of the above, equation (2) can be written as:

$$E\left(SR_{t+1} - SR_t / I_t\right) = 0 \qquad (3)$$

Any perceived change between time t and t+1 is due to random shock e_{t+1} and market participants should notice no exploitable pattern from this random shock. In test form, equation (2) can be stated as:

$$SR_{t+1} = a_0 + a_1 SR_t + e_{t+1} \qquad (4)$$

As we have seen above, the Random Walk Hypothesis suggests that the best predictor of the expected future spot rate SR^{e}_{t+1} is the current spot rate. This is so since the probability of any exchange rate fluctuating either way is 50%. There are three expectation models, which will be reviewed shortly. Frankel and Froot (1987) tested the models using survey data to measure expectations. These expectations models can be looked at as deviations from the Random Walk Hypothesis (Tucker, Madura and Chiang, 1991).

It has been seen that if a currency starts falling in value in the financial markets, it continues doing so until a market correction is made, i.e., the expectation is that depreciation (appreciation) will lead to further depreciation (appreciation). This is termed extrapolative expectations. Mathematically:

$$SR^{e}_{t+1} = SR_t + \alpha(SR_t - SR_{t-1}) \qquad (5)$$

where α is a constant coefficient and $(SR_t - SR_{t-1})$ shows the recent change in exchange rates.

Such bandwagon expectations can be highly destabilizing with market participants unloading currencies they expect will lose value or vice versa. In such situations α is positive, but if the expectations are that movement will be in the opposite direction, α would be negative and speculative activities would actually be stabilizing. In such a scenario, equation (4) becomes:

$$SR^{e}_{t+1} = SR_t + (1-\alpha)SR_t + \alpha SR_{t-1} \quad (6)$$

This is known as the distributed lag expectations model, i.e., exchange rates are formed on the basis of current and lagged spot rates (Tucker, Madura and Chiang, 1991).

Adaptive expectation is another expectations model used to model currency price behavior. It is essentially an error learning process where market participants revise their expectations in view of previous errors made. A weighted average of the current and lagged expected rate is used to form expectations. Mathematically:

$$SR^{e}_{t+1} = (1-\gamma)SR_t + \gamma SR^{e}_{t} \quad (7)$$

where: $0 < \gamma < 1$ and SR^{e}_{t} = expected spot rate at time t given the information at time t-1. (Tucker, Madura and Chiang, 1991)

In regressive expectations, the assumption is that currencies tend to regress to their long run equilibrium value. Using this knowledge, market participants model expected currency prices as a weighted average of the current spot rate and the long run equilibrium rate. Mathematically:

$$SR^{e}_{t+1} = (1-\theta)SR_t + \theta SR^{'}_{t} \quad (8)$$

where $0 < \theta < 1$ and $SR^{'}_{t}$ = the long run equilibrium currency value. (Tucker, Madura and Chiang, 1991)

Frankel and Froot (1987) tested the three expectations models examined above, using survey data to measure market expectations. In test format, the model specifications were as follows:

<u>extrapolative expectations</u>

$$SR^{e}_{t+1} - SR_t = \alpha_0 + \alpha(SR_t - SR_{t-1}) \quad (9)$$

<u>adaptive expectations</u>

$$SR^{e}_{t+1} - SR_t = \lambda_0 + \gamma(SR^{e}_{t} - SR_t) \quad (10)$$

<u>regressive expectations</u>

$$SR^{e}_{t+1} - SR_t = \theta_0 + \theta(SR^{'}_{t} - SR_t) \quad (11)$$

Frankel and Froot (1987) tested for the restriction that α = 0 and γ = 0 and θ = 0 in each case. In extrapolative expectations, the estimated coefficients for α were found to be negative and statistically significant. Hence, Frankel and Froot (1987) concluded that the distributed lag expectations model was validated and that speculation was stabilizing.

In adaptive expectations, the estimated coefficient for γ was found to be positive and statistically significant, except over the 12-month horizon. This suggests that there is a positive relationship between present and past expectations. Hence, it has been suggested that expectations are inelastic and thus speculation is stabilizing.

In regressive expectations, the key is the long run equilibrium exchange rate, determined by real macroeconomic conditions such as interest rates, inflation, etc. It was seen that a substantial portion of the expected currency depreciation was explained by the long run equilibrium exchange rate. The estimated coefficients θ were all positive and statistically significant. The implication was that the market participants expected the exchange rate to regress to the long run equilibrium rate (Frankel & Froot, 1987).

Anomalies

Technical Analysts, as in the domestic financial markets, look for patterns in exchange rate behavior that may repeat themselves and may be used for forecasting, such that unusual profits may be made. Thus, if technical analysis succeeds, then efficient market hypothesis fails. Yet, no particularly useful trading rules have been unearthed in the foreign exchange markets (Tucker, Madura & Chiang, 1991). But interestingly enough, the so-called 'January Effect' has been found to exist in the currency markets, too. Also, 'trading day effects' and 'speculative bubbles' have been found which are inconsistent with the efficient market hypothesis.

As in the domestic markets, the foreign exchange markets also show a 'January Effect'. From 1980 through 1989, the dollar during January has appreciated against a basket of currencies, in all but two years, and this January performance has been faithfully followed throughout the year, in all years except one year, as reported by FINEX, the financial instrument division of the New York Cotton Exchange. A logical explanation put forward is that everything revolves around expectations. If the markets perceive that the dollar will appreciate against a certain currency (because of the January effect), they will typically act on it at the beginning of the year. In the process the dollar value is pushed up and it becomes a self-fulfilling prophecy. Yet, according to the efficient market theory, the markets should have recognized the phenomenon and speculative activities should have erased the effect (Tucker, Madura and Chiang, 1991).

'Trading day effects' were an interesting phenomenon examined by McFarland, Pettit and Sung (1982). They examined seven foreign currency markets and observed high dollar-denominated price changes on Mondays and Wednesdays, and low ones on

Thursdays and Fridays. Their possible explanation was that Wednesday-Thursday effects were due to settlement procedures in the foreign exchange markets and the Friday-Monday effects were due to an increase in dollar demand before the weekend.

Woo (1987) found 'speculative bubbles' in both French Franc/$ rate and the Deutsch Mark/$ rate. Woo found the former overvalued by 11 % and the latter by 12 % against the dollar. This kind of behavior is akin to the extrapolative expectations discussed earlier. If the market perception is that any exchange rate will rise, given favorable market fundamentals, then the expectation is that the exchange rate will continue to rise and in the process increasingly move away from its intrinsic value, until the bubble bursts.

2 (ii) The Unbiased Forward Rate Hypothesis

Many researchers have examined the efficient market hypothesis in the foreign exchange markets from the standpoint of the 'Unbiased Forward Rate Hypothesis'. The forward rate has been suggested as an unbiased predictor of the expected future spot rate. The assumption here is that transaction costs are minimal, investors are risk neutral, and all information is quickly absorbed in both markets; in such a situation efficient arbitrage activity will occur, culminating at the point where the forward rate is exactly equal to the expected future spot rate. Mathematically:

$$E\left(SR_{t+1} - FR_t / I_t\right) = 0 \qquad (12)$$

In test form equation (12) becomes:

$$SR_{t+1} = a_0 + a_2 FR_t + e_{t+1} \qquad (13)$$

Hence, forecast errors will equal zero on average. Any other result would negate the Unbiased Forward Rate Hypothesis (Tucker, Madura and Chiang, 1991, Giddy and Dufey, 1975). Combining the Random Walk and Unbiased Forward Rate Hypotheses, we obtain:

$$SR^{e}_{t+1} = \Psi SR_t + (1 - \Psi) FR_t \qquad (14)$$

In test form equation (14) becomes:

$$SR_{t+1} = a_0 + a_1 SR_t + a_2 FR_t + e_{t+1} \qquad (15)$$

Since the current spot rate includes all information regarding exchange rate movements up to the present and the forward rate includes all relevant future information, a weighted average of the two would provide the best estimate of the expected future spot rate. Tucker, Madura and Chiang (1991) suggest that this is the Composite Efficiency Hypothesis.

Empirical research has produced a mixed bag of results. Early researchers like Giddy and Dufey (1975), Kohlhagen (1975) and Fama (1976) found strong evidence

supporting the efficient market hypothesis. It should be noted that this was the early floating rate period and it was difficult to obtain sufficient numbers of observations to attain statistical significance. Notwithstanding, Kohlhagen (1975) came to the conclusion that one could not consistently outperform foreign exchange markets; any profit or loss through consistently taking long or short positions was purely random and the forward rate was an unbiased predictor of the expected future spot rate.

Later studies have disputed the earlier findings on exchange market efficiency. The Jurgenson Reports (1983) was the most comprehensive. It clearly states that there are better predictors of the expected future spot rate than the forward rate and that it was possible to consistently outperform the market. Other researchers like Levitch (1985), Boothe and Longworth (1986), Frankel (1988), and Hyat (2006) have also had problems with the conclusions of the early researchers. With substantially increased number of observations, they have come to the conclusion that forecast errors generated by using forward rates as unbiased predictors of the expected future spot rates, are not independent of latent variables, other asset prices, and risk factors (Tucker, Madura and Chiang, 1991).

Frankel (1981) tested sudden changes in interest rate differentials as a 'news' variable for three currencies and found only one currency statistically significant. In a follow-up article, Hoffman and Schlagenhauf (1985) found all test models as statistically insignificant with very low R^2. Hence, the 'news' variable does not appear to be a prime candidate in explaining forecast error in the foreign exchange markets.

As pointed out by Boothe and Longworth (1986), there seems to be a broad agreement amongst researchers on rejection of the joint hypothesis of market efficiency and no risk premium. The problem is which one of the individual hypotheses is responsible for the rejection. Maybe both are responsible. In other words, whenever the market forecast error is predictably different from zero, risk premium, market inefficiency or both could exist (Boothe and Longworth, 1986). Unfortunately, researchers have been singularly unsuccessful in devising a test to detect the presence of risk premium.

Using a latent variable model, Hansen and Hodrick (1980) found that three of the five currencies they considered were auto-correlated with their own lags. The other two currencies did lend support to the notion of existence of risk premium. Subsequently, Hodrick and Srivastava (1984) rejected the Hansen and Hodrick model on grounds of two very stringent assumptions, linearity and time invariant coefficients.

Notwithstanding substantial research, there is no conclusive evidence on the existence of a risk premium. But as Hodrick and Srivastava (1984) point out, there is still strong support within the academic community for the existence of a risk premium.

While most research on efficient markets in foreign exchange have essentially looked at the joint hypotheses of market efficiency and no risk premium, another school has emphasized unexploited profit opportunities as a method of testing market

efficiency. Bilson (1981), Hodrick and Srivastava (1984), and Bilson and Hsieh (1983) among others showed that there were unexploited profit opportunities available in the currency markets and speculation was profitable but highly risky.

Finally, Cumby and Obstfeld (1981) and Papadia (1981) examined speculative efficiency from the point of view of autocorrelation. They found autocorrelation to exist, which implies that past information may be used to improve forecasts made by forward rates and hence, is ground for rejection of the efficient market hypothesis.

2 (iii) Cointegration and Market Efficiency

Though initially applied to the money demand function, there are now extensive applications of cointegration in different fields of economics and finance; most notably it has been applied to the foreign exchange markets by Baillie and Bollerslev (1989) and Hakio and Rush (1989) among others. The main premise of the theory of cointegration is that even though two or more integrated time series are individually non-stationary, there may well be a linear combination of these time series, which is stationary. Stationarity implies that the underlying stochastic trends are time-invariant. If such a linear combination exists, we term the time series to be cointegrated, i.e., their underlying stochastic trends are linked.

The Johansen (1988) procedure is nothing but a multivariate generalization of the univariate Dickey-Fuller (1979, 1981) tests. The Johansen (Trace) statistics is extremely sensitive to the presence of deterministic regressors such as time trends or intercepts. In many instances, time series show a decided propensity to increase or decrease: in such cases a trend term may be added to the estimated model. Also, by manipulating the elements of the drift term, a constant may be added in the cointegrating vector or vectors without giving a deterministic time trend to the system (Enders 1995).

That deterministic regressors are extremely important should be evident from the controversy regarding cointegration, the foreign exchange markets, and the efficient market hypothesis. Baillie and Bollerslev (1989) conclude that foreign exchange markets are not efficient. They examined the spot rates of seven different currencies and applied both the Engle and Granger (1987) and the Johansen (1988) tests for cointegration. They clearly showed that the spot rates were cointegrated, i.e., the underlying stochastic processes of the spot rates were interlinked and were time invariant. Hence, a currency could be forecasted on the basis of the movement of another currency, which is against the tenets of the Efficient Markets Theory. Diebold, Gardeazabal and Yilmaz (1994) used the same data and came to a different conclusion that there was no cointegration. A deterministic regressor made all the difference! Diebold, Gardeazabal and Yilmaz (1994) introduced a drift term in the estimated model. Since there is no conclusive agreement amongst researchers about a drift term being present or otherwise, they felt a drift term did actually fit the data. Baillie and Bollerslev (1994) in their reply, agree that the inclusion of a deterministic regressor does change the picture; but they imply that the deviations from the cointegrating relationship may

well have long memory and disappear over a long time span. Accordingly, they suggest that this could be a fractionally integrated process.

3. Conclusion

Looking at future research, it appears that there will continue to be researchers looking for anomalies in both the domestic and foreign exchange markets. As stated earlier, this is a $550 trillion a year market and growing continuously. To put it in proper perspective the US GDP is about $14.2 trillion in 2009. Consequently, if this market was not efficient, we would have a difficult time finding one that is. All financial markets, including the foreign exchange market have no entry barriers and competition is unfettered, driving down prices. The sheer size of the market is such that it is almost impossible to influence prices. Certainly, from time to time, there is Central Bank intervention in the major currencies. The process is called 'leaning against the wind'. In other words, there may be short-term success in disciplining an unruly market, but long-term effects are almost non-existent. The underlying macroeconomic fundamentals will always assert itself in the long run.

It is important to look at financial markets, particularly foreign exchange market from a different perspective. If markets are always efficient some adjustment from inefficiency must occur. Perhaps the more relevant issue is 'does the market push the price in the right direction' rather than 'is the price always the efficient one'? From the point of view of Stiglitz and Grossman (1980) the Efficient Markets Hypothesis is an idealization that is unattainable and should be used as a benchmark to measure relative efficiency.

The next point to be thought about is how does one measure this relative efficiency? This could be the direction of future research. Another school assumes that the markets have long memory and that shocks to the system go away over a long period of time. Consequently, a longer period of data, preferably fifty years or more is necessary to adequately test the efficient market theory. This could be another direction of research. Intangibles, such as investor preferences, and financial technology, etc. have not been incorporated in models. We could start thinking in this direction, too.

Many have suggested that the Efficient Markets Hypothesis controversy should be settled in the markets itself. Here, Roll (1994) comes through with a spirited defense and agrees with Stiglitz and Grossman (1980) that the Efficient Markets Hypothesis in its present form is nothing but an 'idealized version'. All prices cannot include all available information known to everyone. Any abnormal profits accruing to an investor could be looked at as fair rewards for competitive advantage and/or superior financial technology, not necessarily market inefficiency. As for markets determining the outcome, Roll (1994) points out that with funds invested to take advantage of 'market anomalies', it was no better than a buy and hold strategy. The expected super profits never materialized.

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