Efficient Market Hypothesis (EMH)

The Case of India's Foreign Exchange Market

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Abstract

Efficient Market Hypothesis (EMH) propounded by the legendary finance professor Eugene F. Fama has come to be recognized as one of the most significant developments in the realm of finance theory. The enormous popularity of EMH may be vouched from the fact that the seminal paper -"*Efficient Capital Markets: Review of Theory and Empirical Work*" (Journal of Finance, Vol. 25, Issue 2) is counted one among the top cited papers of all time, as per the statistics available from Journal of Finance. While the ubiquity of EMH studies in respect of equity markets is appreciable, where academics have sought to examine the validity of the same in respect of diverse capital markets that include developed and developing economies;the lack of consensus emerging from empirical results make it difficult to lay any assertion on either acceptance or rejection of the theory. However, the gamut of research has certainly enhanced the richness of literature surrounding EMH.

In recent times with the proliferation of trading in commodity and foreign exchange markets, it is useful to examine the validity of EMH in respect of these markets as well. In emerging markets like India, where commodity and foreign exchange markets have been growing at a phenomenal pace, an examination of EMH in respect of these neo-markets becomes imperative. The present study seeks to explore the validity of this theory, particularly, in respect of foreign exchange markets. The recent episodes of extreme currency swings and the ominous need to trace the

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underlying fundamentals contributing to the above phenomenon necessitatesuch a study, which makes it even more relevant. The inferences derived from the same are expected to enrich the theory and literature surrounding application of EMH in foreign exchange markets.

The study begins with an introduction, which is followed by need for study that includes review of significant studies carried out on the above in Indian context. This is followed by a discussion on methodology describing the essential models, which is then empirically tested to draw appropriate inferences. The study ends with summary and conclusion.

Introduction

Notwithstanding the proliferation of studies surrounding the examination of market efficiency of different foreign exchange markets, the present study seeks to revisit the examination of foreign exchange market, in particular context of the pricing of exchange rate between US dollar (USD) and Indian rupee (INR). While similar studies have been performed in the past, there existcompelling reasons as cited below that warrant a re-examination of the same.

Much of the studies on foreign exchange markets have sought to employ the methodologies surrounding the examination of market efficiency in foreign exchange markets by resorting to the measures that are conventionally employed in the context of studies surrounding efficiency of equity markets. Without dismissing the merits of such studies, it is necessary to acknowledge the underlying difference in the characteristics exhibited by equity and foreign exchange markets. Investors typically participate in equity market operations with an objective of making capital gains in the long-term as well as profiteering in the short-term by engaging in speculation. In contrast, the participants of foreign exchange markets look for the benefits of hedging as well as speculative gains. Here, it is worth noting that the conventional methodologies – mean value of stock returns, normality distribution of stock market returns (skewness, kutosis, & Jarque-Bera test) autocorrelation, and variance ratio test (Chiang, Lee ,Su &Tzou 2010) seek to capture the possibility of making speculative gains from the 'underlying asset' only. Derivation of mean returns that are statistically significant positsevidence pointing towards market inefficiency. Such an inference though, is limited, as markets offer enough opportunities to make speculative gains by exploiting the arbitrage opportunities. Here, a marginal investor can take bets on both derivative (futures) and underlying assets (spot) to derive abnormal returns. It is therefore only prudent to consider the asset pricing behaviour of both the spot and futures while commenting upon the market efficiency. Validation of market efficiency by resorting to techniques that capture the underlying relationship between the two therefore carriesgreater merit. In respect of foreign exchange markets, investors are particularly interested in tracing the pricing behaviour of both spot and futures exchange rates. Futures market offer investors an opportunity to engage in both hedging as well as speculative gains.

The present study therefore revolves around capturing the underlying relationship between the spot and futures exchange rates to offer inferences on foreign exchange market efficiency. Here, we look at the USD/INR exchange rates for drawing the aforementioned inference. The fact that the country's major import and export activities are billed in USD provides enough impetus to look at the foreign market surrounding USD/INR. Also, as per the statistic available with NSE, the turnover of trade encompassing the USD/INR is manifold in comparison with GBP and Japanese YEN. The average daily traded volume for Futures contracts for USD-INR, GBP-INR, EUR-INR, and JPY-INR were 2268544, 13571, 57893, and 13492 respectively (NSE India).

Besides the trade factor triggering the choice of USD, the recent baits of wild swings witnessed in respect of USD-INR exchange rate generated heated discussion among policy makers, academia, and analysts on factors contributing to the same. While a discussion on exogenous factors contributing to the above phenomenon is beyond the scope of this study, it is certainly prudent to examine it in the light of efficiency of foreign exchange market surrounding the USD-INR. Even a slightest repudiationof an implicit hypothesis of foreign exchange market efficiency may help to provide some reasoning to the above development.

I. Need for the study

In the wake of the limitations of previous studies failing to capture the underlying relationship between the spot and futures pricesand at the same time employingthe conventional market efficiency tools that are relevant only in the context of equity markets; the present study overcomes these limitations by employing the powerful cointegration approach to examine the null hypothesis of market efficiency of foreign exchange market in the context of USD-INR. As a result, there exists a significant dearth of studies addressing the issue of foreign exchange

market efficiency by employing cointegration approach, and hence the study. In light of these limitations, we provide a review of limited, but significant studies focusing on the market efficiency in Indian foreign exchange market.

In a study seeking to examine the efficiency of foreign exchange market in India, the authors employ the conventional techniques surrounding the runs tests and variance ratio test to examine the efficiency hypothesis. The sample comprises of the exchange rates gathered during October 2003 – September 2004. The results provide an evidence of efficiency in the Indian foreign exchange market (Sarker & Gosh 2007). The inferences drawn on the basis of employment of conventional market efficiency tests need to be further examined.

In a study seeking to examine the efficiency of foreign exchange markets in SAARC countries, authors employ the conventional tests of market efficiency surrounding unit-root and variance ratio tests for drawing inferences. The study looks at returns from spot prices for all the SAARC countries over a period from 1985 – 2005. The authors conclude that the foreign exchange markets for all SAARC countries including India are weak form efficient(Noman & Ahmed 2008) . The failure of the study to capture the underlying relationship between underlying and derivative foreign exchange assets renders the results inconclusive.

In a study seeking to examine the weak form of market efficiency in Indian foreign exchange market, the author employs the conventional techniques surrounding variance ratio to examine the hypothesis. The study is based on the available monthly nominal effective exchange rate (NEER) data from April 1993 to June 2010. The results point to the absence of weak form efficiency in Indian foreign exchange markets(Kumar, 2011) . In the absence of the underlying relationship between the spot and futures exchange rates, the inferences derived from the study need a careful re-examination.

In another study seeking to examine the efficiency of foreign exchange market in India, the authors use the daily closing spot rates of USD/INR, EUR/INR, JPY/INR, and GBP/INR for the period of 10 years from 1999 to 2009. The study confirms the presence of weak and semi-strong forms of efficiency in respect of the above exchange markets (Yuvaraj, Jayapal & Sathya 2012) . While the study employs the powerful cointegration test, the absence of consideration of futures exchange rates for the same does lend the study inconclusive.

In a study seeking to examine the efficiency of foreign exchange markets of the four major South Asian countries of India, Pakistan, Bangladesh, and Srilanka, the authors employ a combination of tests including the Augmented Dickey Fuller (ADF), Phillips Perron, and Granger Causality tests. The study uses the average spot rates over a period from January 1995 through December 2010. The study points out to presence of weak-form of efficiency in foreign exchange markets for all countries including India (Choudhry & Javid 2012). Again, the failure to establish the relationship between spot and futures exchange rates renders the results inconclusive.

A review of the above studies point out to the inherent limitations in the absence of the consideration of relationship surrounding the underlying and derived exchange rates. We therefore make an attempt to examine the hypothesis surrounding the efficiency of foreign exchange market in the context of USD-INR by employing the robust cointegration regression approach using both spot and futures exchange rates.

II. Modelling the Foreign Exchange Market efficiency

As argued earlier, it is necessary to capture the underlying relationship between the spot and futures prices in order to draw appropriate inferences in respect of the existence of market efficiency surrounding the USD-INR foreign exchange market.We therefore employ the powerful cointegration regression approach by developing a joint hypothesis that seeks to examine the existence of efficiency evidenced by both long-term and short-term equilibrium in the foreign exchange market.

The long-run equilibrium model is expressed as given below(UK polo 1995)

$$S_t = \beta F_{t-1} + \mu_t \qquad\qquad Eq.1$$

where

S_t = spot rate

F_{t-1-} = 12-month futures rate

μ_t = error term

In this context, the foreign exchange market is said to be efficient if the necessary and sufficient condition of a vector $(\alpha,\beta) = (0,1)$ is satisfied. Since both the spot and futures data are arranged in time series, it is necessary to test for their

stationarity by conducting the unit root tests. This assumes significance as any attempt towards establishing relationship between variables, when they are non-stationery, produces spurious regression results resulting in high R2value that has virtually no significance (Gujarati & Sangeetha 2007). Consequently, an incidence of presence of unit roots implies the data is non-stationery

To ascertain the efficiency of foreign exchange market in the context of USD-INR, we use the daily spot and 12-month futures prices over a period from December 2008 to December 2012 giving a sample size of 960, retrieved from the NSE. A 12-

month futures price has been used as the risk arising out of volatility and margin call tends to get lowered when the maturity of the futures is extended. The data is long enough to capture the movements of spot and futures prices mirroring varied economic sentiments.

Testing for ascertaining the stationery status of the data is conducted using the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) unit root tests(Dickey & Fuller 1981) . The tests have been conducted on both original and differenced values. The results of the tests are reflected below. Failure to reject a null of unit-roots confirms that the data is non-stationery.

Table I – DF & ADF Unit-root tests

Null: Presence of unit-roots				
Variables	DF level	First difference	ADF	First difference
Spot	-0.636887	- 2.821990*	-0.58854	- 30.56208*
Futures	-1.065671	- 1.841958** *	- 1.0358	- 31.69469*

(DF critical values at 1%, 5%, and 10% are -2.56, -1.94, and -1.61; ADF critical values at 1%, 5%, and 10% are -3.4369, -2.8643, and -2.5683 respectively ; *Significant at 1 %, ** *Significant at 10%)

Comparing the observed t-statistic values with critical values, it is clear that the spot and futures data have unit-roots, that is, they are non-stationeryI(1), while in respect of the first differenced values, the null is rejected and it is inferred that the data therein is stationeryI(0).

Now that it is established that the data in respect of spot and

futures are non-stationery, we need to test for the cointegration to establish the null of long-term equilibrium. Consequently, we employ the robust cointegration tests of (Engle-Granger-1987) and (Phillips-Ouliaris-1990) . The results of the same are established below.

Table II – Engle-Granger and Phillips-Ouliaris Cointegration test results

Null: Series are not cointegrated				
Dependent	Engle-Granger		Phillips-Ouliaris	
	z-statistic	p-value	z-statistic	p-value
Spot	- 19.6972	0.0587** *	-41.41981	0.0005*
Futures	- 20.8857	0.0459**	-42.7295	0.0004*

(*Significant at 1%, **Significant at 5%, ** *Significant at 10%)

The Engle-Granger cointegration test is believed to be more robust than Phillips-Ouliaris (Dutt & Gosh 1995). From the values above, while there is an emphatic rejection of the null of no cointegration when considering the Phillips-Ouliaris test results, the rejection under (Engle-Granger-1995) is valid only at 10% level of significance. While statistically, there appears to be a case of cointegration, it becomes necessary to establish the relationship between spot and futures prices by running a cointegration regression. Here, the observed value of

cointegration regression Durbin-Watson (CRDW) would stand as an overwhelming testimony to null that variables are not cointegrated. Besides the CRDW, testing for the absence of unit-roots in the residuals produced from cointegration regression serves as an important and a necessary condition to justify the cointegration between variables.

The results from the cointegration regression may be observed from Table III given below.

Table III – Long-run cointegration regression results

Null: Variables are not cointegrated (Dependent: Spot)		
Variables	Parameter estimates	p-values
Intercept	1.333381 (1.603905)	0.1091 (insignificant)
Futures price	0.952347 (56.94526)	0.0000 (significant)

Table IV – Long run cointegration regression statistical parameters

Statistical parameters	Parameter estimates
R^2	0.955007
Durbin-Watson	0.156940
DF (residual)	-2.9860*
ADF (residual)	-2.9828**

(*Significant at 1%, **S ignificant at 5%)

2The data on spot and futures for USD-INR was retrieved from http://nseindia.com/products/contents/derivatives/currency/historical_contracts_cd.htm

The results observed from Table III and IV are quite revealing, which have been derived from the fully-modified OLS (FMOLS) method. Considering the CRDW value, there appears to be a rather weak case for an existence of long-term equilibrium. While the DF test statistic presents an overwhelming case for rejection of null on presence of unit-roots at 1% level of significance, the ADF test statistic confirms the same at 5% significance level.

From the above results, we therefore infer that while there is an exhibition of long-term equilibrium between the spot and futures prices, the power of the evidence is rather weak (the implied inference of the same is revisited towards the end).

Any assertion on the existence of market efficiency is incomplete without considering the error correction model which seeks to test for the existence of short-term equilibrium between the underlying variables. The model is expressed as follows.

$$\Delta s_t = \Delta F_{t-1} + EC_{t-1} \qquad \text{Eq. 2}$$

where

$S\Delta_t$ = First-differenced spot prices

$F-\Delta_{t-1}$ = First-differenced futures prices

EC_{t-1} = Error correction term (residuals derived from the cointegration regression)

The results of the above regression are presented below. A necessary condition for establishing short-term equilibrium between the underlying variables is reflected by the coefficient represented by error correction term (EC_{t-1}). Looking at the tables given below (V and VI), it is clear that the possibility of earning no-excess returns (alternatively '0' excess returns) is virtually non-existent. This establishes a case for an absence of short-term equilibrium between the spot and future prices.

From the above results obtained from long-term cointegration and short-term error correction models, we fail to accept the null of efficiency in the foreign exchange market in the context of USD-INR.

Table V: Regression results from Error correction model

(Dependent: EC_{t}Spot)		
Variables	**Parameter estimates**	**p-values**
Intercept	0.004 (0.515)	0.607 (insignificant)
EC_{t}Futures	0.520 (18.595)	0.0000 (significant)
EC_{t-1}	0.128	0.0000 (significant)

Table VI: Regression Statistical parameters from Error correction model

Statistical parameters	**Parameter estimates**
R^2	0.517
SER	0.2421143
Durbin-Watson	2.425

3-Here, we work with the original values of spot and futures prices resulting in a very high R2 value. This is unlike to studies that predominantly employ return functions to capture the underlying relationship between variables. One very obvious limitation of working with returns is that the relationship is rather poorly captured reflecting in atrociously poor R2 values .

4-A CRDW that is non-zero is considered as a case for rejection of null underlying 'no-cointegration' . However, iinterpretation of CRDW values needs caution as the value is relevant for a given number of regressors and the sample size. As the sample size becomes large, the CRDW is pushed closer to '0'. Given the very large sample size in this study, the inference arising out of the same is therefore limited.

I. Summary & Conclusion

In this study, we make an attempt to understand the efficiency of foreign exchange market in India in the context of USD-INR. The inferences are derived by employing the robust cointegration regression and error correction models to evaluate the existence of long-term and short-term equilibrium respectively. The results of cointegration provide weak evidence on the existence of long-term equilibrium, exhibited by weak CRDW and ADF test-statistic values. The results obtained from the error correction model emphatically reject the possibility of an investor making '0' excess returns, positing towards short-term disequilibrium between the spot and futures prices. The results from the twin models present strong evidence towards not accepting the null of market efficiency.

An observation positingtowards the absence of efficiency in the Indian foreign exchange markets is not entirely inconsistent with observations made in similar studies. However, much of the previous studies have employed the traditional market efficiency tools to derive these results. Even where the studies have employed the robust cointegration technique, the failure to explicitly consider the futures prices presents a strong case for undertaking the present study. Hence, in this paper, an attempt was made to employ the cointegration procedure by explicitly considering both spot and futures prices for drawing inferences on the existence of market efficiency surrounding the USD-INR foreign exchange market.

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5-In a study published by the Reserve Bank of India, the evidence towards the absence of efficiency in India's foreign exchange markets is established. The reason for the intervention of RBI through its open-market operations to correct the temporary disequilibrium in the forex market is cited as a valid justification towards the existence of market inefficiency (Reserve Bank of India, 2010)