STUDY ON WEAK-FORM EFFICIENCY OF FOREIGN EXCHANGE MARKETS OF DEVELOPING ECONOMIES: SOME INDIA EVIDENCE

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ABSTRACT

This paper examines the empirical validity of the weak-form Efficient Market Hypothesis (EMH) for the foreign exchange market of India, using a battery of (univariate and panel) unit root tests, including those that allow for structural breaks. Monthly exchange rates for three major currencies (China, Indonesia and US) vis the Indian rupee are considered in the empirical analysis. The results indicate that the three exchange rates studied follow a random walk, thus supporting the validity of the weak-form EMH. These results have strong implications for the participant’s of the foreign exchange market of India and government policy makers.

Keywords: Efficient Market Hypothesis, Exchange Rates, Unit Root Tests, Panel Data, Structural Breaks.

INTRODUCTION

The efficient market hypothesis (EMH) of Fama (1970) asserts that in an efficient market, prices always fully reflect all available information. EMH has three forms: weak, semi-strong and strong, which depend on the different degrees of information content. When a market is weak-form
efficient, its prices reflect all the information available in the past prices or returns. The semi-strong form has the prices of financial assets instantly reflecting publicly available information. Lastly, in a strong-form efficient market, prices of financial assets even reflect inside information. Accordingly, in a weak-form efficient market, participants cannot exploit past prices or returns of a financial asset to consistently bear the market.

The publication of Fama's seminal work, foreign exchange markets especially in developed countries, have been extensively tested for efficiency using different econometric techniques (Cumby and Obstfeld 1984; Edwards 1983; Hakkio and Rush 1989; Serletis and King 1997; Singh 1997; Taylor 1988; Taylor and MacDonald 1989). In today’s research work, there have been several studies which provide mixed evidence in this area using data from developing countries (Los 1999; Masih and Masih 1996; Sarwa 1997).

The efficiency of a foreign exchange market has policy implications of enormous importance (Pilbeam 1992). If a foreign exchange market is inefficient in the weak form, a model that predicts exchange rate movements can be developed based on past price or return. Therefore, an inefficient foreign exchange market provides opportunities for profitable foreign exchange transactions. In an inefficient foreign exchange market, government responsibilities can determine the best way to influence exchange rates, reduce exchange rate volatility and evaluate the consequences of different economic policies. Alternatively, an efficient foreign exchange market needs minimum government intervention and its participants cannot make abnormal gains from foreign exchange transactions.

The objective of this research work is to test for the weak-form efficiency of the Indian foreign exchange market during the recent floating exchange rate regime. To the best of our knowledge, Wickremasinghe (2005a) is the only empirical study to date that has used the unit root tests to examine weak-form EMH. This study, however, did not use the unit root tests that accommodate possible structural breaks or outliers in the exchange rates. Exchange rates, like many other financial prices, are subject to market conditions which can bring about structural breaks and outliers, and these are well known to exert adverse effects on the power of the unit root tests (see, for example, Perron 1989). It is possible that more robust inferential outcomes can be expected from the unit root tests which accommodate the possible presence of outliers and structural breaks. Further, there have been a few currency crises in the 1990s (the Asian currency crisis in 1997 and the UK pound crisis in 1992) that might have affected the behaviour of the exchange rates of India. In view of these, a study examining the efficiency of foreign exchange markets cannot ignore the presence of structural breaks in the exchange rates.

In this research work, the researcher start with Univariate and Panel Unit root tests that do not accommodate structural breaks. The univariate unit root tests with out structural breaks adopted in this paper include those developed by Elliot, Rothenberg and Stock (1996) and Ng and Perron (2001). The panel unit root test without structural breaks adopted included those developed by Breitung (2000), Hadri (2000), Levin, Lin and Chu (2002). Then we use two recently developed unit root tests proposed by Lee and Strazicich (2003) and Westerland (2006) which take account of structural breaks.

OVERVIEW OF LITERATURE

EFFICIENT MARKET HYPOTHESIS (EMH)

As we have indicated, EMH has three forms (Fama 1970): weak, semi-strong and strong. Each version reflects a different degree of information in the prices of financial assets. The weak version of EMH asserts that the prices of financial assets reflect all the information contained in past prices. Therefore, no market participant can use past data on the prices of financial assets to predict the future values of such assets. In other words, the prices of financial assets behave randomly, with or without any identifiable pattern.

On the other hand, the semi-strong version of EMH says that the prices of financial assets reflect all publicly available information. In the case of exchange rates, publicly available information would include data releases on interest rates, exchange rates and inflation rates for other currencies as well as for other macroeconomic variables. Since exchange rates are expected to rapidly adjust to releases of such data, no market participant can use publicly available data to predict exchange rate movements.

The strong form of EMH indicates that the prices of financial assets reflect inside data, in addition to the information contained in past prices and publicly available data. Therefore a market participant with inside data cannot use his or her knowledge to predict future values of exchange rates. This version of EMH encompasses both the weak and semi-strong versions.

EMPIRICAL TESTS OF EMH

Since the publication of Fama's seminal work on EMH, foreign exchange markets, especially those in developed countries, have been extensively subjected to tests of efficiency using different econometric techniques. These techniques are mainly aimed at determining whether (a) a spot exchange rate for a currency behaves as a random walk, (b) the forward rate for a currency is an unbiased predictor of the future spot exchange rate for that currency, and (c) there are cointegrating relationships among several currencies. The first type of tests can be categorised as weak-form efficiency tests whereas the second and third type of tests can be categorised as semi-strong form efficiency tests. Empirical studies using these different methodologies have provided mixed evidence.

ECONOMETRIC METHODOLOGY AND DATA

The econometric methodologies adopted in this research work are more powerful and robust than those employed in the previous studies. Elliot et al (1996) says that when a time series has an unknown mean or linear trend and the sample size is small, the conventional unit root tests such as the augmented Dickey-Fuller test (ADF-Test) suffers from low power. To overcome this problem, they proposed a point optimal test, which substantially improves the power when an unknown mean or trend is present in a time series. Ng and Perron (2001) also noted that the ADF test suffers from low power, especially when the moving-average polynomial of the first differenced series has a large negative root. In response to this, Ng and Perron (2001) proposed new tests with improved small sample properties.

Another way of improving the power of unit root testing is the use of panel data. By pooling the observations from different cross-sectional units, the test can find out a larger number of sample sizes, which can give improve to aligner power (see, for example, Maddala and Wu 1999). In this research work, we also use a number of panel unit root tests. Lastly, it is well known that the presence of structural breaks can alter the outcome of the unit root test (see Perron 1989)- We also use recent unit root tests that can accommodate the presence of structural breaks or outliers, which can improve the power of the test when unknown breaks are present in the data. In the following section, we provide a brief discussion of these new tests.
UNIT ROOT TESTS WITHOUT STRUCTURAL BREAKS

NORMALITY TEST

In statistics, normality tests are used to determine whether a data set is well-modeled by a normal distribution or not, or to compute how likely an underlying random variable is to be normally distributed.

More precisely, they are a form of model selection, and can be interpreted in several ways, depending on one's interpretations of probability:-

In descriptive statistics terms, one measures a goodness of fit of a normal model to the data – if the fit is poor then the data are not well modeled in that respect by a normal distribution, without making a judgment on any underlying variable.

In statistical hypothesis testing, data are tested against the null hypothesis that it is normally distributed.

In Bayesian statistics, one does not "test normality" per se, but rather computes the likelihood that the data come from a normal distribution with given parameters $\mu,\sigma$ (for all $\mu,\sigma$), and compares that with the likelihood that the data come from other distributions under consideration, most simply using a Bayes factor (giving the relatively likelihood of seeing the data given different models), or more finely taking a prior distribution on possible models and parameters and computing a posterior distribution given the computed likelihoods.

Here the research adopted for types of test to find normality of data. They are explained below:-

SHAPIRO-WILK TEST

The Shapiro-Wilk test, proposed in 1965, calculates a $W$ statistic that tests whether a random sample, $x_1, x_2, ..., x_n$ comes from (specifically) a normal distribution. Small values of $W$ are evidence of departure from normality and percentage points for the $W$ statistic, obtained via Monte Carlo simulations, were reproduced by Pearson and Hartley. This test has done very well in comparison studies with other goodness of fit tests.

The $W$ statistic is calculated as follows:

$$W = \frac{\left[ \sum_{i=1}^{n} a_i x_{(i)} \right]^2}{\sum_{i=1}^{n} (x_{(i)} - \bar{x})^2}$$

where the $x_{(i)}$ are the ordered sample values ($x_{(1)}$ is the smallest) and the $a_i$ are constants generated from the means, variances and covariances of the order statistics of a sample of size $n$ from a normal distribution. The test rejects the hypothesis of normality when the p-value is less than or equal to 0.05.

LILLIEFORS TEST

It is used to test the null hypothesis that data come from a normally distributed population, when the null hypothesis does not specify which normal distribution; i.e., it does not specify the expected value and variance of the distribution.
JARQUE-BERA TEST

In statistics, the Jarque–Bera test is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution. The test is named after Carlos Jarque and Anil K. Bera. The test statistic $JB$ is defined as

$$JB = \frac{n}{6} \left( S^2 + \frac{1}{4} (K - 3)^2 \right)$$

where $n$ is the number of observations (or degrees of freedom in general); $S$ is the sample skewness, and $K$ is the sample kurtosis:

$$S = \frac{\hat{\mu}_3}{\hat{\sigma}^3} = \frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^3 \left( \frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2 \right)^{3/2}$$

$$K = \frac{\hat{\mu}_4}{\hat{\sigma}^4} = \frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^4 \left( \frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2 \right)^2,$$

where $\hat{\mu}_3$ and $\hat{\mu}_4$ are the estimates of third and fourth central moments, respectively, $\bar{x}$ is the sample mean, and $\hat{\sigma}^2$ is the estimate of the second central moment, the variance.

If the data come from a normal distribution, the $JB$ statistic asymptotically has a chi-squared distribution with two degrees of freedom, so the statistic can be used to test the hypothesis that the data are from a normal distribution. The null hypothesis is a joint hypothesis of the skewness being zero and the excess kurtosis being zero. Samples from a normal distribution have an expected skewness of 0 and an expected excess kurtosis of 0 (which is the same as a kurtosis of 3).

VAR (VECTOR AUTO REGRESSION)

A VAR model describes the evolution of a set of $k$ variables (called endogenous variables) over the same sample period ($t = 1, ..., T$) as a linear function of only their past values. The variables are collected in a $k \times 1$ vector $y_t$, which has as the $i$-th element, $y_{it}$, the time $t$ observation of the $i$-th variable. For example, if the $i$-th variable is GDP, then $y_{it}$ is the value of GDP at time $t$.

A $p$-th order VAR, denoted VAR($p$), is

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + e_t,$$

where the $l$-periods back observation $y_{t-l}$ is called the $l$-th lag of $y$, $c$ is a $k \times 1$ vector of constants (intercepts), $A_i$ is a time-invariant $k \times k$ matrix and $e_t$ is a $k \times 1$ vector of error terms satisfying

1. $E(e_t) = 0$ — every error term has mean zero;
2. $E(e_t e'_t) = \Omega$ — the contemporaneous covariance matrix of error terms is $\Omega$ (a $k \times k$ positive-semidefinite matrix);
3. $E(e_t e_{t-k}) = 0$ for any non-zero $k$ — there is no correlation across time; in particular, no serial correlation in individual error terms. See Hatemi-J (2004) for multivariate tests for autocorrelation in the VAR models.

A $p$th-order VAR is also called a VAR with $p$ lags. The process of choosing the maximum lag $p$ in the VAR model requires special attention because inference is dependent on correctness of the selected lag order

**LAG**

The number of data points that a filter, such as a moving average, follows or trails the input price data

**STATIONARY ROOT TEST**

**UNIT ROOT TEST**

In statistics, a unit root test tests whether a time series variable is non-stationary using an autoregressive model. A well-known test that is valid in large samples is the augmented Dickey–Fuller test. The optimal finite sample tests for a unit root in autoregressive models were developed by John Denis Sargan and Alok Bhargava. Another test is the Phillips–Perron test. These tests use the existence of a unit root as the null hypothesis

**AUGMENTED DICK-FULLER TEST**

In statistics and econometrics, an augmented Dickey–Fuller test (ADF) is a test for a unit root in a time series sample. It is an augmented version of the Dickey–Fuller test for a larger and more complicated set of time series models. The augmented Dickey–Fuller (ADF) statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence.

**TEST BASED ON INDIVIDUAL TIME SERIES**

**DICKEY-FULLER TEST**

This test is a more powerful test than the Dickey-Fuller type tests. In the augmented Dickey-Fuller (ADF) (1979, 1981) test regression, either a constant or a constant and a linear time trend is included to take account of the deterministic components of the data. Elliot, Rothenberg and Stock (ERS) (1996), however, propose a modification to the ADF regression in which data are de-trended before the unit root test is conducted. This de-trending is done by taking the explanatory variables out of the data (see, Elliot, Rothenberg and Stock 1996 for details). Then the following equation is estimated to test for a unit root the variable:

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \gamma_1 \Delta y_{t-1} + \ldots + \gamma_k \Delta y_{t-k} + u_t$$

where $A$ is the difference operator, $y_t$ is the generalised least squares de-trended value of the variable, $a$, and $\alpha$ are the coefficients to be estimated and $u_t$ is the independently and identically distributed error term. As in the case of the ADF test, the test for a unit root of the variable $a$ is performed by testing whether the coefficient of the AR(1) term, in this case $a_0$ in Equation (1) is
zero against whether it is less than zero. In making inferences, critical values tabulated in Elliot, Rothenberg and Stock are used.

NG-PERRON TESTS

Ng and Perron (2001) constructed four unit root test statistics that are calculated using generalised least squares (GLS) de-trended data for a variable. Compared to the widely-used Dickey-Fuller (DF) and Phillips-Perron (PP) unit root tests, these have better power and size properties. The first unit root test statistic developed by Ng and Perron calculates the Elliot, Rothenberg, and Stock (ERS) point optimal statistic for GLS de-trended data as follows:

$$MPdt = \begin{cases} 
(c_k^2 - cT^{-1} (y^d_T)^2)/f_0 & \text{if } x_t = 1 \\
(c_k^2 + (1-c)T^{-1} (y^d_T)^2)/f_0 & \text{if } x_t = \begin{bmatrix} 1, & t \end{bmatrix}
\end{cases}$$

Frequency spectrum term, and $y^d_T$ is the generalised least squares (GLS) de-trended value of the variable.

The other three statistics, $M_Z$, $M_Z$ and $M_S$ are the enhancements of the Phillips-Perron (PP) test statistics which correct for size distortions when residuals are negatively correlated.

All four test statistics above are based on a specification for $x_t$ and a method for estimating $f_0$, the zero frequency spectrum term. The specification for $x_t$ can take one of two forms. That is, a constant or a constant and a linear trend. The consistent estimate of the residual spectrum at frequency zero is obtained on the basis of auto-regressive (AR) spectral regression (GLS-de-trended).

PANEL UNIT ROOT TESTS

According to recent literature, panel-based unit root tests are more powerful than those based on individual time series. In this article, we apply six recently developed unit root tests to a panel of four individual exchange rate series, in addition to unit root tests for individual exchange rate series. The panel unit root tests applied in this article are those developed by Breitung (2000), Hadri (2000), Im, Pesaran and Shin (IPS) (2003) Levin, Lin and Chu (LLC) (2002) and Maddaia and Wu (1999).

Consider the following AR(1) process for a panel of time series data:

$$Y_{it} = p_i Y_{it-1} + X_{it} \delta_i + \sum_{it}$$

where $i = 1, 2, TV$ cross-sections and $t= 1, 2, T_i$ time periods. The $X_{it}$, denote the exogenous variables including any fixed effects or individual trends, $p_i$ are the auto-regressive coefficients and the $\sum_{it}$ are assumed to be mutually independent idiosyncratic errors. A unit root is present in the panel of time series if $|p_i| = 1$. In a test for a unit root, normally, there are two assumptions regarding $p_i$. First, we can assume that $p_i = p$ for all cross-sections. The panel unit root tests in which this assumption is made are known as tests with common unit root processes. Second, we can assume that $p_i$ vary freely across cross-sections. The panel unit root tests in which this assumption is made are known as tests with individual unit root processes. Breitung (2000), Hadri (2000) and Levin, Lin

and Chu (2002) make the first assumption in their unit root tests. Im, Pesaran and Shin (2003) and Maddala and Wu (1999) make the second assumption in their Fisher-ADF and Fisher-PP unit root tests. Each of these tests is briefly discussed below.

DATA AND EMPIRICAL RESULTS

The data used in this study consist of the monthly average exchange rates of the Indian rupee with the currencies of three countries. The three exchange rates used were the China, Indonesia and the US. The choice of these exchange rates was determined by their availability in published sources. All the data were obtained on a monthly basis for the period January 2000 to October 2013 from the Monthly Bulletins of the Central Bank of India.

Table 1: Descriptive Exchange Rate

<table>
<thead>
<tr>
<th></th>
<th>CHINA</th>
<th>USD</th>
<th>INDONESIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.157425</td>
<td>0.022697</td>
<td>0.19935</td>
</tr>
<tr>
<td>Median</td>
<td>0.171548</td>
<td>0.021538</td>
<td>0.19813</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.0960090</td>
<td>0.015683</td>
<td>0.16605</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.190471</td>
<td>0.19202</td>
<td>0.24051</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>0.0287870</td>
<td>0.015345</td>
<td>0.18198</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.744647</td>
<td>0.95982</td>
<td>0.38824</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.774001</td>
<td>0.95361</td>
<td>-0.61057</td>
</tr>
</tbody>
</table>

A look at the median and maximum exchange rate returns shows that the median return for the Indonesia is highest compared to that of the other three currencies. As far as minimum returns are concerned, all the currencies considered have negative returns. This indicates that all three currencies have depreciated during certain months in the sample period. The standard deviations of returns for the Indian rupee, the USD and Indonesia are more or less similar. However, when these standard deviations are compared with means, the Indian rupee emerges as the most volatile currency as it has the highest coefficient of variation.

Table 2: Normality Test

<table>
<thead>
<tr>
<th>Exchange Rate</th>
<th>Doornik-Hansen test</th>
<th>Shapiro-Wilk W</th>
<th>Lilliefors test</th>
<th>Jarque-Bera test</th>
<th>Maximum Lag length</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>77.0787</td>
<td>1.83053e-017</td>
<td>0.870943</td>
<td>3.21048e-011</td>
<td>0.216864</td>
</tr>
<tr>
<td>USD</td>
<td>11161.7</td>
<td>0</td>
<td>0.168715</td>
<td>1.83555e-027</td>
<td>0.418815</td>
</tr>
<tr>
<td>Indonesia</td>
<td>13.4448</td>
<td>0.00120365</td>
<td>0.970833</td>
<td>0.00868247</td>
<td>0.062159</td>
</tr>
</tbody>
</table>

Table visualizes the test of univariate normality for the country currency based on three different types of test namely Doornik-Hansen test, Shapiro-Wilk test, Lilliefors test, Jarque-Bera test. The results were performed for the selected country currency. As for as analysis the country
currency follows the normality at 1% level. Hence, we can conclude that the country currency had followed the normal distribution.

Table 3: Univariate Unit Root Test Results for Exchange Rates

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Indonesia</th>
<th>USD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exchange Rate</td>
<td>First Difference</td>
<td>Exchange Rate</td>
</tr>
<tr>
<td>ADF</td>
<td>-0.141583</td>
<td>-9.054779</td>
<td>-3.162148</td>
</tr>
<tr>
<td>DF-GLS</td>
<td>0.923832</td>
<td>-9.055342</td>
<td>-1.361705</td>
</tr>
<tr>
<td>PP</td>
<td>-0.013438</td>
<td>-8.958934</td>
<td>-2.963176</td>
</tr>
<tr>
<td>KPSS</td>
<td>1.379217</td>
<td>0.162884</td>
<td>0.292404</td>
</tr>
<tr>
<td>ERS</td>
<td>46.34160</td>
<td>0.320751</td>
<td>5.713117</td>
</tr>
<tr>
<td>Mzt</td>
<td>0.95760</td>
<td>-6.18289</td>
<td>-1.33844</td>
</tr>
<tr>
<td>MSB</td>
<td>0.68765</td>
<td>0.08084</td>
<td>0.34688</td>
</tr>
<tr>
<td>MPT</td>
<td>39.2984</td>
<td>0.32297</td>
<td>6.39330</td>
</tr>
</tbody>
</table>

The table exhibits the results of the Augmented Dicky-fuller test (or) unit root test, DFL, KPSS, PP, ERS test which helps to find out the stationerity for the selected country currency. All the test confirms that the selected country currency are stationery over a period of time at 5% significant level.

The Ng-Perron modified unit root test says the Mza test for the selected currency reject the null hypothesis at 5% significant level. These results are consistent when a constant and both a constant and a linear time trend are considered as deterministic components. The Mzt test results reported the Indian rupee and the US dollar exchange rate are random walks when a constant and a linear trend are considered as deterministic components. The China exchange rates are stationary only when a constant is included as a deterministic components. The Indonesia exchange rate follows a random walk only when a constant is considered as the deterministic component. These results support the weak form of EMH. The results of the MsB test are also consistent with the above results.

Table 4: Unit Root Test

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Indonesia</th>
<th>USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levin, Lin &amp; Chu t</td>
<td>-16.086</td>
<td>-19.1049</td>
<td>-0.66077</td>
</tr>
<tr>
<td>ADF-Fisher Chi-Square</td>
<td>93.4194</td>
<td>91.4686</td>
<td>5.90838</td>
</tr>
<tr>
<td>ADF-Choi Z-Stat</td>
<td>-9.33232</td>
<td>-9.22840</td>
<td>-1.62463</td>
</tr>
<tr>
<td>PP-Fisher</td>
<td>93.4837</td>
<td>91.4682</td>
<td>6.41635</td>
</tr>
</tbody>
</table>

The results reported in Panel A for the levels of exchange rates indicate that the null hypothesis of a unit root test is rejected under the Levin, Lin and Chu-t test ADF-Fisher Chi-square test. This result is inconsistent with EMH. Under the PP-Fisher Chi-square test the null hypothesis of a unit root is not rejected. The results for the first differences of exchange rates when an individual constant is considered as a deterministic component are reported in the above table. According to the results, the panel of three exchange rates are stationary. Such results are consistent with EMH.

The results from Table 5 present the results of the multi-break unit root test of Westerlund (2006). Paying attention to the univariate case, the TB statistics indicate acceptance of the unit root hypothesis for all exchange rates at the 5 per cent level of significance. The China has experienced nine outliers or breaks, while the Indonesia has experienced seven, according to the outlier detection procedure proposed by Westerlund (2006). Only a small number of outliers are identified for the US currency. The panel unit root test also supports the presence of unit roots. The result remains unchanged with the bootstrap inference, which suggests that the test outcome is robust to a relatively small number of cross-sectional units which may be contemporaneously correlated.

<table>
<thead>
<tr>
<th>Chi-square</th>
<th>Levin, Lin &amp; Chu</th>
<th>ADF-Fisher Chi-Square</th>
<th>ADF-Choi Z-Stat</th>
<th>PP-Choi Z-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>-9.33573</td>
<td>-29.305</td>
<td>85.7102</td>
<td>-8.91474</td>
<td>-3.71902</td>
</tr>
<tr>
<td>-9.22838</td>
<td>-34.2135</td>
<td>85.1467</td>
<td>-8.88346</td>
<td>-3.71902</td>
</tr>
<tr>
<td>-1.74571</td>
<td>-13.8570</td>
<td>79.8503</td>
<td>-8.58407</td>
<td>-8.54255</td>
</tr>
<tr>
<td>-5.69735</td>
<td>-22.8918</td>
<td>156.561</td>
<td>-12.2352</td>
<td>-3.71902</td>
</tr>
<tr>
<td>0.59468</td>
<td>-13.2183</td>
<td>-24.8416</td>
<td>-26.6442</td>
<td>0.14206</td>
</tr>
</tbody>
</table>

**Table 5: Results from Two-break LM Unit Root Test**

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>TB</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>17.68887</td>
<td>2003:8,2011:11</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>28.19896</td>
<td>2004:12, 2011:09</td>
<td></td>
</tr>
</tbody>
</table>

The Lee and Strazich (2003) test and the Westerlund (2006) test identify a number of statistically significant break points or outliers. It appears that some of these occurred around the UK pound crisis in 1992 and the Asian crisis in 1997. For example, the Westerlund test identifies two break points for the UK pound in 1992, and one break point for the Indian rupee in 1997. According to a report compiled by the Trade Compliance Centre of the US Department of Commerces International Trade Administration (1999), the Asian currency crisis has not taken a heavy toll on the Indian economy. This was partly due to continued exchange controls on the capital account and relatively low exposure to short-term foreign debt. Additionally, there is no evidence that the other currency crises have had an impact on the Sri Lankan economy. However, we believe that different policy regimes that have existed in relation to exchange rate determination in India have introduced structural changes in the exchange rates during the sample period. We leave this line of research for future work.

CONCLUSIONS

This article examined the validity of the weak-form efficient market hypothesis for the foreign exchange market of India during the floating exchange rate period. Our analysis used the exchange rates for the three main currencies (China, US and Indonesia) vis-a-vis the Indian rupee that are traded in the foreign exchange market of India.

The empirical analysis in this article was performed using unit root tests with and without structural breaks. The results of the univariate tests without structural breaks indicate that the China, US and Indonesia currency exchange rates behave as random-walks. These results are consistent with the weak form of EMH. The random walk behaviour of the china exchange rates is not as strong as that of the other currencies. The panel unit root tests without structural breaks also, except in a very few cases, provide support for the validity of the weak form of EMH.

As the time series plots for exchange rates indicate the presence of possible structural breaks and outliers in the exchange rate data, we also performed the unit root tests proposed by Lee and Strazich (2003) and Westerlund (2006) that allow for structural breaks. To tackle the problems associated with possible cross-sectional dependence and a small number of cross-sectional units, we also conducted the bootstrap inference following the procedure proposed by Westerlund (2006). The results of these tests provide evidence that all four exchange rates examined follow random walks consistent with the weak version of EMH.

The exchange rate of a currency is a major economic policy variable. As such, its behaviour is very important for the policy makers of any country. When a foreign exchange market is efficient, the ability of government authorities to influence the movement of exchange rates is restricted as the exchange rates are not predictable. The results of this study have important policy implications, as they indicate that the foreign exchange market of India is weak-form efficient. That is, the government cannot make informed decisions on exchange rates, take actions to reduce exchange rate volatility and evaluate the consequences of various economic policies for exchange rates. An efficient foreign exchange market is essential to facilitate international trade and inflow of foreign investments to a developing country such as India. The prices of assets determined in an efficient market serve as aggregators of information. Therefore, such prices will provide sufficient information for efficient allocation of resources in the economy.

Participants in the foreign exchange market such as investors and multinational firms are interested in making gains or protecting their investments. They can achieve these objectives only when the exchange rates behave in a predictable manner. According to the results of this study, investors (speculators) cannot devise various trading rules or techniques to make abnormal profits from transactions in the foreign exchange market.
As far as managers of multinational firms are concerned, an efficient market indicates that the need to actively select currency and the timing of transactions is less important. Further, managers cannot gain from any hedging policies to avoid the effects of exchange rate risks. Rather, they could minimise decisions on the currency composition of their balance sheet and focus on other objectives of the firm.

**REFERENCE**


