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EFFICIENCY OF FOREIGN EXCHANGE MARKET OF SRI LANKA: SOME EMPIRICAL EVIDENCE

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ABSTRACT. The purpose of this paper is to examine the validity of the weak and semi-strong form efficiencies of the foreign exchange market (FX) of Sri Lanka. This study departs from previous Sri Lankan studies by examining structural changes in the time series via unit roots tests as well as a cointegration test, developed by Saikkonen and Lütkepohl (2000a, 2000b, 2000c). The data comprised end of month exchange rates for the Japanese yen, British pound, Indian rupee, and the US dollar in terms of the Sri Lankan rupee for the period January 1995 to September 2013. The findings indicate that the Sri Lankan FX market is consistent with both the weak and semi-strong versions of the efficient market hypothesis. These results, which have important implications for the participants of the FX market of Sri Lanka, suggest that participants cannot devise modeling techniques which would result in abnormal gains. The implication for Government authorities is that they can only exert a minimal influence on exchange rates. This is the first study that employs the statistical techniques mentioned above to investigate the validity of the weak and semi-strong form efficiencies of the Sri Lankan FX market.

JEL codes: F31; G14

Keywords: efficient market hypothesis; Sri Lanka; structural breaks; cointegration

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1. Introduction

Fama (1970) identified three versions of the efficient market hypothesis (EMH). These three versions are known as (i) weak-form efficiency, (ii) semi-strong form efficiency and (iii) strong-form efficiency. According to the weak-form efficiency current foreign exchange rates reflect information available in past exchange rates. Therefore, current foreign exchange rates instantly adjust to reflect past information contained in the exchange rates. This means, a participant in the foreign exchange market cannot make use of past exchange rates to predict future exchange rates. Therefore, it is impossible for a participant in the foreign exchange market to make gains from foreign exchange transactions on a consistent basis.

The semi-strong form of the efficient market hypothesis (EMH) implies that foreign exchange rates reflect not only the information in past exchange rates but also the information in other exchange rates and other publicly available information such as macroeconomic variables. Therefore, a speculator or an arbitrageur in the foreign exchange market cannot use exchange rates other than the one we are concerned with and other publicly available information to predict future values of an exchange rate. Consequently, a speculator or an arbitrageur is unable to devise any trading rule to make abnormal gains from foreign exchange transactions on a consistent basis.

When a foreign exchange market is strong form efficiency it reflects both information contained in past exchange rates and publicly available information. In addition, it reflects inside information of a foreign exchange market. This implies that even a central bank official or other insider of the foreign exchange market cannot make abnormal gains in the foreign exchange market on a consistent basis on the basis of information available to them.

According to Pilbeam (1992), the efficiency or inefficiency of a foreign exchange market has policy implications of importance. An inefficient foreign exchange market allows participants to develop a model that best predicts exchange rate movements. Therefore, participants of an inefficient foreign exchange market are able to engage in profitable foreign exchange transactions. An inefficient foreign exchange market also allows government authorities to determine the best way to influence exchange rates in order to reduce exchange rate volatility and provide an opportunity to evaluate the consequences of different economic policies. In contrast, government authorities need minimal intervention in an efficient foreign exchange market. Further the participants of an inefficient foreign exchange market are unable to make abnormal gains from foreign exchange transactions on a continuous basis.

The objective of the current study is to test the validity of both the weak and semi-strong versions of the EMH to the foreign exchange market during

the floating exchange rate regime using data from a more recent sample period and examine how results are sensitive to different econometric techniques.

The paper is organized as follows. Section two provides an overview of the empirical literature, Section three provides an overview of the foreign exchange market of Sri Lanka. Section four outlines the methodology and data, empirical results are analyzed in Section five and the last section offers conclusions and policy implications.

2. Review of Literature

Fama's original paper on the EMH received enormous attention from academics, particularly, those of the developed countries. This resulted in a plethora of studies on efficiency of foreign exchange markets in these countries using different analytical tools. Traditionally, researchers have applied three main approaches to test the efficiency of foreign exchange markets. The focus of these approaches was mainly on whether (a) a spot exchange rate for a currency behaves as a random walk or whether the foreign exchange market is weak-form efficient (b) the forward rate for a currency is an unbiased predictor of the future spot exchange rate for that currency or whether the foreign exchange market is semi-strong form efficient and (c) there are cointegrating relationships among several currencies or whether the foreign exchange market is semi-strong form efficient. Studies using the above approaches have been conducted using linear techniques.

The first type of tests employed such techniques as the autocorrelation test, the Ljung-Box Q-statistic, variance ratio tests, technical trading rules and runs tests. For example, Almudhaf (2014) used a variance ratio test and Wickremasinghe (2007) employed an autocorrelation test, Box-Pierce statistic, and cross-correlation test to test weak-form efficiency. In addition, developments in techniques for testing unit root tests provided another methodology to examine the random walk properties of exchange rates (see, Azad (2009) and Wickremasinghe and Kim (2008)). The second type of tests were performed using the ordinary least squares regression method, particularly before the development of cointegration techniques (see, Frankel (1980, 1982), Edwards (1983), Boothe and Longworth (1986) and Taylor (1988)). After the latter half of the 1980s, there was a significant change in the methodologies employed to test the efficiency of foreign exchange markets and this was due to the development of the bivariate cointegration techniques of Engle and Granger (1987) and the multivariate cointegration techniques of Johansen (1988) and Johansen and Juselius (1990). These techniques were used by researchers to examine the unbiasedness of the forward rate as a predictor of the future spot rate (see, for example, Norrbin and Reffert (1996), Wesso (1999) and Barnhart et al. (1999)). In addition, several studies

employed cointegration tests to see whether there are long-run co-movements among several exchange rates. Among others, Ruiz (2009), Ahmad et al. (2012), Sanchez-Fung (1999), Speight and McMillan (2001) and Jeon and Seo (2003) employed this methodology in their studies on the efficiency of foreign exchange markets.

In addition to the above studies using traditional approaches, recent papers have employed non-linear techniques, equilibrium exchange models, techniques to examine whether markets efficiency improves over time and newly developed exchange rate models. Some of the studies using the above approaches are discussed below:

Giannellis and Papadopoulos (2009) employed an equilibrium exchange rate model to test the efficiency of foreign exchange markets of developing countries. They argued that if the foreign exchange market is efficient the actual exchange rate will not deviate significantly from its equilibrium rate. In other words, the misalignment rate of a currency should be stationary. In line with this argument, they used Clark and MacDonald's (1998) behavioral equilibrium exchange rate model to estimate the equilibrium rate for each currency. They used both linear and nonlinear models to test if the misalignment rates are stationary. Logistic smooth transition (LSTAR) model which is a nonlinear model found no evidence of nonlinear adjustment in the misalignment series consistent with foreign exchange market efficiency. Linear unit root tests found that the Poland/ Euro foreign exchange market is efficient, the Czech/Euro foreign exchange market is inefficient, while the Slovak/Euro foreign exchange market is quasi-efficient.

Rejichi and Aloui (2012) tested the evolving efficiency of MENA stock markets employing Hurst exponents using a rolling sample with a time window of 4 years. They used daily data in their study from January 1997 to December 2007 in their analysis. They reported that all MENA stock returns exhibit long-range memory and certain markets are becoming more efficient. Further, they found a statistically significant correlation between the measure of long-range dependence and average trading costs, market capitalization and anti-self-dealing index. These results indicate that these variables play a role in explaining the differences in the stage of inefficiency. Their ranking of stock markets by efficiency with their measures of long-range dependence showed that the foreign exchange markets of Israel, Turkey and Egypt are the least efficient markets in the region.

Ahmad et al. (2012) examined within-country and cross-country efficiency of the Asia-Pacific region's currency markets. In addition to using the Johansen cointegration technique, Ahmad et al. used a recently developed exchange rate model by Pilbeam and Olmo (2011) in their analysis. They reported results in favor of the market efficiency for the above markets. Further, their results found that the free-float currency markets are more

resilient than managed-float currency markets among 12 Asia-Pacific economies. From the across-country perspective, the foreign exchange markets are mostly efficient and the results show that the 1997–1998 Asian financial crisis was a more disturbing event than the 2008–2009 global financial crisis in the region.

To the author's knowledge, there have been three empirical studies (Wickremasinghe, 2005, Wickremasinghe, 2007 and Wickremasinghe and Kim, 2008) on the efficiency of foreign exchange market of Sri Lanka. Wickremasinghe (2005) used Engle and Granger and Johansen co-integration techniques, Granger causality tests and variance decomposition analysis in his investigation of the efficiency of the foreign exchange market of Sri Lanka. He used average monthly nominal spot exchange rates for Japanese yen, the UK pound, the US dollar, French franc, Indian rupee and German mark for the period January 1986 to November 2000. The results of this study indicate that the Sri Lankan foreign exchange market is consistent with the weak-form of the efficient market hypothesis (EMH). However, the results of the cointegration tests provide evidence against the semi-strong version of the EMH. Wickremasinghe (2007) used auto-correlation test, cross-correlation test and Ljung-Box Q-statistic to test the weak and semi-strong form efficiencies of the foreign exchange market of Sri Lanka. He used data on Indian rupee, Japanese yen, UK pound, and US dollar for the period January 1986 to December 2004. The results of this study indicate that the EMH does not hold for the Sri Lankan foreign exchange market. Wickremasinghe and Kim (2008) examined the validity of the weak-form of the EMH to the Sri Lankan foreign exchange market using monthly data for UK pound, the Indian rupee, the Japanese yen and the US dollar for the period January 1986 to December 2004. They used Ng-Perron unit root tests, panel unit root tests, Westerlund's (2006) and Lee and Strazcich's (2003) two-break and multi-break LM unit roots tests to examine the validity of the weak-form of the EMH to the Sri Lankan foreign exchange market. Their results supported the validity of weak-form of the EMH to the Sri Lankan foreign exchange market.

3. Foreign Exchange Market of Sri Lanka

The foreign exchange market of Sri Lanka comprises two tiers, namely, the wholesale market (inter-bank market) and the retail market (client market). The wholesale market consists of all licensed commercial banks. The transactions in the wholesale market partly emanate from the transactions in the retail market. The main role of the wholesale market is to redistribute liquidity within the banking system. In the wholesale market, transactions take place between dealers on the spot, cash and forward basis between the Sri Lankan rupee and the US dollar. The Central Bank's role is limited to

intervene in the wholesale market to maintain an orderly market as and when necessary.

Sri Lanka abolished the fixed exchange rate system and adopted a managed float in 1977 unifying the exchange rate at an officially depreciated rate of 46 per cent. Thereafter, the Central Bank of Sri Lanka commenced quoting daily rates for six major currencies, the US dollar, the Deutsch Mark, Franc, Yen, UK pound and Indian Rupee, using the US dollar as the intervention currency. In 1982, the Central Bank abandoned the quotation of daily rates for currencies except for the US dollar. Consequently, the commercial banks were permitted to determine the cross-rates for other currencies based on the market conditions. An inter-bank market for forward currencies was set up in 1983. In 2012, forward volume in the inter-bank market stood at US \$4089 million. The forward transactions accounted for 34 per cent and 30 per cent of the total transactions in the inter-bank market for foreign exchange in both 2011 and 2012, respectively.

In 1990, the Central Bank commenced quoting daily buying and selling rates for the US dollar, abandoning quotation of daily rates for the US dollar. To facilitate the inward remittances of Sri Lankans living overseas, a Non-Resident Foreign Currency (NRFC) account scheme was introduced in 1978. In 1979 commercial banks were permitted to establish Foreign Currency Banking Units (FCBUs). These were authorized to engage in the foreign currency transactions of non-residents, approved residents, and Board of Investment enterprises. In 1991, residents of Sri Lanka were also allowed to open accounts (Resident Foreign Currency accounts) in specified foreign currencies with a minimum balance of US \$500.

In February 2012, Sri Lanka changed its exchange rate policy from a managed floating rate system to market-based floating rate system. Due to this change, Sri Lankan rupee depreciated from Rs. 113.90 to Rs. 127.16 per US dollar. The trading volume in the domestic foreign exchange market in 2012 significantly declined when compared with that in 2011. Further, the total volume in the inter-bank foreign exchange market decreased to US\$ 13.42 billion in 2012 from US\$ 16.44 billion in 2011. The daily average turnover in the inter-bank market (including the forward market) in 2012 was US \$55.4 million as against US\$ 68.5 million in 2011.¹

4. Methodology and Data

As opposed to previous studies using Sri Lankan data, in this paper we use tests that incorporate structural changes to examine the weak-form of the EMH in the foreign exchange market of Sri Lanka. These are tests developed by Saikkonen and Lütkepohl (2002) and Lanne et al. (2002).² The above tests examine whether foreign exchange rates behave as random walks consistent

with the EMH. In other words, they reveal that the future values of an exchange rate cannot be predicted using its past values. If we can predict the future values of an exchange rate from its past values, behavior of such an exchange rate is not consistent with the weak version of the EMH.

The semi-strong efficiency of the foreign exchange market of Sri Lanka is tested using the cointegration test developed by Saikkonen and Lütkepohl (200a,b,c).³ Saikkonen and Lütkepohl cointegration test examines whether the exchange rates move together in the long-run, even though they may drift apart from one another in the short-run. Therefore, the existence of a cointegration relationship among the exchanges indicates that the movement of one exchange rate can be predicated from the movement of the other exchange rates in the long-run. The existence of statistically significant cointegration relationships indicates a violation of the EMH in its semi-strong form.

Data used in this study are end of month exchange rates expressed in terms of Sri Lankan rupee per unit of Indian rupee, Japanese yen, UK pound and US dollar for the period January 1995 to September 2013. They were obtained from the website of the Central Bank of Sri Lanka. We convert them to log values before we perform the tests mentioned above.

5. Analysis of Empirical Results

Table 1 reports the descriptive statistics for exchange rate returns. A perusal of means for the four exchange rate returns indicates that the UK pound has the highest mean return during the sample period. This indicates that the UK pound has the highest amount of depreciation during the sample period. The Japanese yen indicates the second highest degree of depreciation followed by the US dollar and the Indian rupee. As far as the medians of exchange rate returns are concerned, UK pound exchange rate has the highest median followed by the Japanese yen, US dollar and Indian rupee. As far as maximum values of exchange rate returns are concerned, Japanese yen has the highest value followed by Indian rupee, US dollar and the UK pound. These results again indicate that during the period under review Japanese yen depreciated by the highest amount. However, the minimum values for the exchange rate returns indicate that the magnitude of appreciation exceeds that of depreciation with the Japanese yen displaying the highest degree of appreciation, approximately 9.3 per cent, during the sample period. The coefficient of variation for the exchange rate returns were calculated to get an idea as to their volatility. According to the figures reported for this statistic, the Indian rupee has the highest coefficient of variation. This implies that the demand and supply for the Indian rupee has been more variable than that for the other currencies during the sample period. A perusal of Jarque-Bera statistic for this

currency also indicates it has a higher deviation from a normal distribution than the other currencies.

Table 1 Descriptive statistics for exchange rate returns

Descriptive statistic	Exchange rate			
	GBP	INR	JPY	USD
Mean	0.00438	0.00124	0.00435	0.00432
Median	0.00638	0.00241	0.00274	0.00251
Maximum	0.09999	0.12715	0.15756	0.11983
Minimum	-0.08535	-0.07926	-0.09294	-0.05145
Std. Dev.	0.02652	0.02377	0.03383	0.01436
Coefficient of Variance (%)	605.84742	1918.48265	777.92596	332.25359
Skewness	-0.25258	0.46162	0.38282	2.43208
Kurtosis	4.31752	7.77306	4.92793	24.36051
Jarque-Bera	18.58298	220.58820	40.16262	4479.35800
Probability	0.00009 ^a	0.00000 ^a	0.00000 ^a	0.00000 ^a

Note: 1. “a” implies statistical significance at the one per cent level.

Table 2 shows the results of the unit root tests incorporating structural changes. If the exchange rates follow random walks or are consistent with the weak-form of the efficient market hypothesis, their first differences should be stationary. According to the results reported in Table 2 for all the shift functions, the first differences of the four exchange rates are stationary. These results indicate that the foreign exchange market of Sri Lanka is weak-form efficient. In other words, the above results imply that any participant in the foreign exchange market of Sri Lanka cannot devise any trading rule to beat the market on a consistent basis and make abnormal gains.

Table 2 Test results of unit roots with structural changes incorporated

Panel A: Levels of exchange rates				
Exchange rate	Shift function			
	Impulse dummy	Shift dummy	Exponential shift	Rational shift
IR	-1.4367	-1.4121	-1.4082	-1.6074
JPY	-0.4832	-0.5174	-1.0377	-1.1229
GBP	-1.7086	-1.7756	-2.0388	-1.7351
USD	-2.2632	-2.2374	-2.1532	-2.2630
Panel B: First differences of exchange rates				
IR	-9.2389 ^a	-9.2750 ^a	-9.1902 ^a	-9.1743 ^a
JPY	-8.5198 ^a	-8.2644 ^a	-8.1146 ^a	-8.3480 ^a
GBP	-7.6427 ^a	-7.6430 ^a	-7.6587 ^a	-7.5889 ^a
USD	-7.6179 ^a	-7.6019 ^a	-7.5940 ^a	-7.5995 ^a

Notes: 1. Lags were selected using AIC.

2. “a” implies statistical significance at the one per cent level.

The semi-strong form of the efficient market hypothesis is tested by examining if there are any long-run relationships among the four exchange rates. The long-run relationships among exchange rates are examined using

the Saikkonen and Lütkepohl cointegration test. Table 3 reports the results of the above test. According to the results, there is no cointegration or long-run relationship among the four exchange rates used in the analysis. These results indicate that in the long-run any of the exchange rates cannot be predicted by the other three exchange rates. The above results are consistent with the semi-strong version of the EMH. This means that any participant in the foreign exchange market of Sri Lanka cannot devise any trading rule to beat the market on a consistent basis by predicting any exchange rate on the basis of the other exchange rates.

Table 3 Saikkonen and Lütkepohl cointegration test results

Null hypothesis	Likelihood ratio	p-value
$r = 0$	32.12	0.5241
$r \leq 1$	17.11	0.6105
$r \leq 2$	7.38	0.6188
$r \leq 3$	3.07	0.3324

- Notes: 1. The optimal number of endogenous lags included in the test vector auto-regression is two (levels) based on Akaike Information criterion (AIC). Ten lags were considered in selecting the optimal number of lags.
 2. The pantula principle selected the model with an intercept and a trend in cointegration equation and in the test vector auto-regression (VAR) as the model appropriate for the cointegration tests.

6. Conclusions and Policy Implications

In this paper, we investigated the validity of the weak and semi-strong versions of the efficient market hypothesis to the foreign exchange market of Sri Lanka. Four exchange rates during the floating exchange rate regime, the Indian rupee, the Japanese yen, the UK pound and the US dollar, were used in the empirical analysis. The results of the weak and semi-strong form efficiency tests indicate that the efficient market hypothesis holds for the foreign exchange market of Sri Lanka. The above results are consistent with weak-form efficiency tests of Wickremasinghe (2005) and Wickremasinghe and Kim (2008). However, they are inconsistent with those of Wickremasinghe (2005) for semi-strong form and Wickremasinghe (2007) for weak-form and semi-strong forms. These mixed results indicate that results of tests of the efficient market hypothesis are sensitive to the sample period and the econometric methodology employed. Therefore, caution needs to be exercised in making decisions on the basis of these results.

These results have important implications for the participants of the foreign exchange market and Government policy makers of Sri Lanka. As the foreign exchange market of Sri Lanka is efficient, the Government authorities cannot determine the best way to influence exchange rates and reduce the exchange rate volatility. An efficient foreign exchange market also does not provide an

opportunity to the Government authorities to evaluate the consequences of exchange rates on different economic policies. An efficient foreign exchange market needs minimal government intervention and its participants cannot make abnormal gains from foreign exchange transactions.

NOTES

1. Central Bank of Sri Lanka, Financial System Stability Review, 2012, Chapter 4: Financial Markets.
2. See Saikkonen and Lütkepohl (2002) and Lanne et al. (2002) for the technical details of these tests.
3. See Saikkonen and Lütkepohl (200a, b, c) for technical details of this test.

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