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AN EMPIRICAL EVALUATION OF FOREIGN EXCHANGE MARKET EFFICIENCY: GBPUSD CURRENCY PAIR

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ABSTRACT

The purpose of this study is to analyze the efficiency of foreign exchange market using Random Walk Models. For the efficient market hypothesis, daily rates of GBPUSD currency pairs for 5 years period from 01/01/2009 to 31/12/2013 are taken. It is found that the foreign exchange market is not weak form efficient in respect of this currency pair, and traders of foreign exchange in respect of these current pair is able to predict their future values based on their values in the recent past.

Introduction

The purpose of this study is to analyze the efficiency of foreign exchange market using Random Walk Models, viz., Serial Correlation test (Autocorrelation test) and Augmented Dickey Fuller (ADF) test (also called as Unit root test). This is because of the fact that Efficient Market Theory and the Random Walk Model have been at the centre of debate in financial literature for several decades. In developing economies like India, analyzing the efficiency of the functioning of the foreign exchange market may help to solve the concerns of the investors and also can simulate their interest in foreign exchange market activities.

Methodology:

For the efficient market hypothesis, daily rates of selected currency pairs for 5 years period from 01/01/2008 to 31/12/2012 are taken. To test the randomness in the return sequence of selected currency pairs as well as the efficiency of the foreign exchange market in terms of these currency pairs, the statistical tools such as Autocorrelation (Serial correlation) and

Augmented Dickey Fuller (ADF) test are used in the present study. The details of these tests are given hereunder:

Autocorrelation / Serial Correlation Test

Autocorrelation test is the most commonly used tool to test weak form efficiency. This test measures the correlation between series of returns and lagged series and tested whether the correlation coefficients are significantly different from zero. That is, autocorrelation measures the relationship between the foreign exchange market return at current period and its value in the previous period. It is calculated as per the formula given hereunder:

$$\rho_k = \left[\frac{\sum_{t=n-k}^{n} (r_i - \bar{r})(r_{t-k} - \bar{r})}{\sum_{t=1}^{n} (r_i - \bar{r})^2} \right]$$

where ρ_k is the serial correlation coefficient of stock returns of lag k, k is the lag of the period, n is the number of observations, r_i is the stock return over period t, r_{t-k} is the stock return over period t-k, and $\bar{r}$ is the mean of stock returns.

Unit Root Test

Unit root tests are used to see that whether the financial time series is non-stationary which is necessary condition for a random walk. Here Augmented Dickey-Fuller (ADF) test is used to test whether a unit root is present in the foreign exchange market return series. The more negative it is the stronger is the rejection of the hypothesis that there is a unit root at a given level of confidence.

Objectives of the Study

The present study is undertaken with the following objectives:

1. To analyze the efficiency of the Foreign Exchange Markets relating to GBPUSD currency pairs.
2. To test whether the return from Foreign Exchange Market has a unit root or not in relation to GBPUSD Currency pair.

Efficiency Market Hypothesis

Fama (1965) evolved Efficient Market Hypothesis in his doctoral research work and he persuasively made the argument that in an active market, which includes many well-informed and intelligent investors, securities will be appropriately priced, and reflect all available information. Thus, if a market is efficient, no information or analysis can be expected to result in the out-performance of an appropriate benchmark. The "efficient market hypothesis" posits that investors adjust securities prices rapidly to reflect the effect of new information. Proponents of the efficient market hypothesis argue that stock prices are essentially random and therefore, there is no chance for profitable speculation in the stock market. The efficient market hypothesis is based on the assumption that share prices follow a random walk and successive price changes are independent of each other (Rapuluchukwu, 2010). Samuels and Wilkes (1981) defined an efficient market as one in which prices of traded instruments (equity shares or foreign currencies) always fully reflect all publicly available information concerning those instruments. Further, they identified necessary conditions for an efficient market to include accurate signals for investors' choices. The identified necessary condition is that today's price which reflects all publicly available information is the best estimate of tomorrow's price. Thus, a capital market (stock market or foreign exchange market) is said to be efficient if information is widely and cheaply available to investors such that share prices are fair.

Random Walk Theory

Small and medium investors can be motivated to save and invest in the capital market only if their securities in the market are appropriately priced. The information content of events and its dissemination determine the efficiency of the capital market. In the developed countries, many research studies have been conducted to test the efficiency of the capital market with respect to information content of events (Raja and Sudhahar, 2010). Since the real markets are not perfectly efficient, three levels of efficiency have been defined, based on the information that is reflected in prices. Fama (1970) classified the market efficiency into the three categories as: Weak form efficiency, Semi strong form efficiency and Strong form efficiency. The market is considered to be weak form efficient if the prices (share prices / currency prices) reflect all the information that is contained in the historical sequence of prices. At the same time, a financial market is considered to be the semi strong form efficient if the current market prices not only reflect all information content of historical prices but also reflect all publicly available

information. On the other hand, strong form of efficiency of the market is the one in which current market prices reflect all information whether it is publicly or privately (insiders information) available or private information. So, the share price or currency price movements are said to be at random if future price movements cannot be predicted based on any patterns or trends in the past. Hence, the random walk theory asserts and emphasizes that the price movements in share market or currency market will not follow any patterns or trends and past movements cannot be used to predict future movements. Therefore, in the random walk, successive changes in each direction are independent without the affection of each other results. The next time's result cannot be predicted before it happens at all.

Review of Literature:

Christos Kollias et al. (2012), discussed that both the goods market hypothesis and the portfolio balance theory, suggested a nexus between exchange rates and stock prices, albeit with a different direction of causality. They used daily data, takes up the issue of the linkages between stock prices and exchange rates in the case of the euro-dollar rate and two composite European stock market indices: the FTSE Eurotop 300 and FTSE eTX All-Share index. The empirical results provided evidence of time-varying causality between the two markets. Mayowa Gabriel Ajao and Richard Osayuwu (2012) tested weak form efficient market hypothesis in the Nigerian capital market. The serial correlation technique of data analysis was used to test for independence of successive price movement and the distributive pattern while runs test was used to test for randomness of share price movement. They concluded that the past and future prices of stocks traded in the Nigerian Stock market are independent. Kuntara and Lee (2008) in their article on "Weak-Form Efficiency in Currency Markets" found the currencies trend and technical trading rules produced statistically and economically significant profits. In other words, foreign exchange markets were weak-form inefficient. The study examined this phenomenon with use of a new database of currency futures for 1975-2006 that included old and newly liquid currencies. The findings from the recent data are contradictory. The profitability of trend following eroded for major currencies and their associated cross exchange rates around the mid-1990s. Newly liquid currencies after 2000 do trend, however, just as major currencies did in earlier years. The evidence is consistent with early weak-form inefficiency followed by vanishing trends as traders learn and adapt their strategies. Reddy and Sebastin (2008) found that entropic analysis is a novel area in the Indian financial market and there is a lot of scope for the application of entropic analysis

in the Indian markets. They applied entropic analysis to study interaction between forex and stock market and transfer entropy is found to be suited and it was found that only low level interactions existed between the two markets in India although theory suggests interactive relationship between the two markets.Samuel Dupernex (2007) defined and discussed Random Walk Model and outlined its relationship to the efficiency of markets. Empirical evidence is used to investigate the arguments for and against the model. He concluded that the EMH can be used as a benchmark for measuring the efficiency of markets, and from this the traders will have at least a rough idea as to whether the stocks are likely to follow a random walk.

Autocorrelation (Serial Correlation)

To ascertain the reliability or validity of the results of the Runs test, the autocorrelation (also called as serial correlation) test is employed in the present research work. The autocorrelation on foreign exchange market returns series of selected currency pairs is run for 20 lags. The results of the autocorrelation for selected currency pairs are tabulated and discussed hereunder.

Autocorrelation of GBPUSD Currency Pair

Table 1.1

Autocorrelation Coefficients and Q Statistics for Price Movements in GBPUSD Currency Pair for Lags 1 through 20

Lag	Levels			First Difference		
	AC	Q Stat	p Value	AC	Q Stat	p Value
1	0.0630*	5.11	0.0237	-0.4570**	272.34	0.0000
2	-0.0190	0.46	0.4956	-0.0480	3.05	0.0807
3	-0.0090	0.12	0.7343	0.0220	0.61	0.4348
4	-0.0410	2.18	0.1396	-0.0100	0.14	0.7083
5	-0.0520	3.50	0.0615	-0.0520	3.51	0.0610
6	0.0340	1.53	0.2161	0.0540	3.79	0.0516
7	0.0200	0.50	0.4782	0.0050	0.02	0.8875
8	-0.0040	0.02	0.8821	-0.0110	0.18	0.6714
9	-0.0060	0.05	0.8179	0.0350	1.65	0.1990
10	-0.0750**	7.40	0.0065	-0.0600*	4.67	0.0307
11	-0.0320	1.35	0.2458	0.0080	0.09	0.7642
12	-0.0050	0.03	0.8625	-0.0130	0.24	0.6242
13	0.0480	3.00	0.0834	0.0320	1.33	0.2488

14	0.0400	2.14	0.1434	-0.0230	0.73	0.3929
15	0.0770**	7.86	0.0051	0.0380	1.88	0.1703
16	0.0430	2.45	0.1178	-0.0270	0.96	0.3272
17	0.0600*	4.74	0.0294	0.0400	2.14	0.1435
18	0.0010	0.00	0.9643	-0.0380	1.87	0.1715
19	0.0130	0.23	0.6338	0.0090	0.11	0.7401
20	0.0080	0.09	0.7693	-0.0050	0.03	0.8625
All Lags		42.75	0.0022		299.34	0.0000

*Significant at 5% level; **Significant at 1% level.

From Table 1.1, in which results of autocorrelation of daily price return series on GBPUSD currency pair for lags from 1 to 20 are given, it can be observed that the correlation coefficient for return series at levels is significantly positive at lag 1, 15 and 17, and significantly negative at lag 10.

The positive significant correlation at lag 1 as well as at other two lags tend to refute the random walk in the return series at levels. The negative significant correlation at lag 10 has indicated that the information inherent in the return series between lag 1 and lag 9 has influenced the price reversal at lag 10.

Further all autocorrelation coefficients from lag one through lag 20 for return series at levels are simultaneously equal to zero is rejected as Q statistics is significant at 1 per cent level (Q stat = 42.75, $p < 0.01$). This has led to the findings that the actual return series, i.e., return series at levels of GBPUSD currency pair does not follow random walk. The autocorrelation for first differences of return series is significant at lag 1 and lag 10 is negative and significant and it is significant for combined lags as well (Q stat = 299.34, $p < 0.01$). Hence, it is understood that first differences of return series does not follow random walk.

Moreover the negative and significant autocorrelation has shown reversal of prices at current period due to information content inherent in the prices of previous periods as well as in the historical prices. In sum, it is found that there is no random walk in the daily price returns series of GBPUSD currency pair and the foreign exchange market is not efficient in respect of this currency pair.

1.2 Augmented Dickey-Fuller Test of GBPUSD Currency Pair:

Table 1.2 presents the results of ADF test for return series of GBPUSD currency pair.

It can be seen from the table that ADF test statistic, -33.88 for model without drift and trend, -33.87 for model with drift (constant) and -33.90 for model with drift and trend is significantly less than respective critical t-values at 1 per cent, 5 per cent and 10 per cent levels.

As significant ADF values are less than MacKinnon test statistic for all three levels (1%, 5% & 10%), the presence of unit root in the return series for GBPUSD is rejected. The rejection of unit root has led to the conclusion there is non-randomness in return series for GBPUSD currency pair.

Due to non-randomness, it is certain that the series are stationary in turn revealing that foreign exchange market in respect of this currency pair is inefficient.

Table 1.2

ADF Test Results for Return Series of GBPUSD Currency Pair

Particulars		**Without Drift & Trend (None)**	**With Drift (Constant)**	**With Drift & Trend (Constant & Trend)**
ADF test statistics		-33.88**	-33.87**	-33.90**
#Test Critical values	1% level	-2.57	-3.44	-3.97
	5% level	-1.94	-2.86	-3.41
	10% level	-1.62	-2.57	-3.13
Augmented Dickey-Fuller Test Equation Dependent Variable: D(RETURN)				
RETURN(-1)	Coefficient	-0.9371	-0.9374	-0.9387
	SE	0.0277	0.0277	0.0277
	t-Statistic	-33.88**	-33.87**	-33.90**
	p Value	0.0000	0.0000	0.0000
C	Coefficient		-0.0001	-0.0005
	SE		0.0002	0.0004
	t-Statistic		-0.63	-1.39
	p Value		0.5258	0.1644

Trend	Coefficient			0.0000
	SE			0.0000
	t-Statistic			1.24
	p Value			0.2152

Particulars	Without Drift & Trend (None)	With Drift (Constant)	With Drift & Trend (Constant & Trend)
R^2	0.4685	0.4687	0.4693
Adjusted R^2	0.4685	0.4682	0.4685
SE of Regression	0.0068	0.0068	0.0068
Sum of Squared Residuals	0.0610	0.0610	0.0609
F Value of Regression		1147.49**	574.75**
p Value		0.0000	0.0000

#MacKinnon one-sided p-values; **Significant at 1% level

Conclusion:

It is concluded that there is non-randomness in the daily exchange rate return series of GBPUSD currency pair. This is also supported by the presence of serial correlation in the daily exchange rate return series as obtained from Autocorrelation analysis and absence of unit root as revealed by ADF test. From Autocorrelation test and ADF test, it is concluded that the current or future exchange rate is predictable from the exchanges in the recent past for GBPUSD currency pairs.

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