TEST OF WEAK AND SEMI-STRONG FORM EFFICIENCY OF NIGERIAN FOREIGN EXCHANGE MARKET

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Abstract

Foreign exchange market is said to be efficient if all available information are reflected in its exchange rates. An efficient foreign exchange translates to absence of profitable and exploitable trends which means that it is impossible for market participants or private agents to outperform the market. This study investigated the weak and semi-strong form efficiency of Nigerian foreign exchange market to determine the significance of past exchange rates in predicting the present rate which is the test of weak form efficiency and it examined the cointegration relationships between selected pairs of exchange rate to determine the semi-strong efficiency. The secondary data used in this study were sourced mainly from the Central Bank of Nigeria Statistical Bulletin and the Oanda exchange rate websites. The data used were the inter-bank spot exchange rates of Naira to Swiss Franc, Euro, Pounds, Dollar and Yen for the period of January 2010 to December 2017. The Augmented Dickey Fuller (ADF) test and the Phillip Peron (PP) test were employed to determine the weak form efficiency while the Variance Decomposition, Granger Causality and Co-integration tests were used to determine the semi-strong form efficiency of Nigerian foreign exchange market. The results of the study revealed that the Nigerian foreign exchange market is efficient in the weak and semi-strong form

at 5% level of significance which indicated that the market cannot be exploited by market participants to make abnormal gain. The study concluded that market participants cannot make exploitable profits by trading in the market because all past and publicly available information are already incorporated in the prices of exchange rates. It was therefore recommended that the inter-bank market in Nigeria should be well monitored and managed by the regulatory authorities so as to promote the effective and efficient smooth functioning of the foreign exchange market as well as achieving a stable and realistic exchange rates.

Keywords: Weak Form, Semi-Strong Form, Foreign Exchange Market, Nigeria, Efficiency

INTRODUCTION

Market efficiency is the characteristics of a market such that the market prices of assets fully reflect all available information in the market and investors cannot use available information or any trading rules to earn extraordinary returns or use available information to exploit the market (Nwosa & Oseni, 2011). The Efficient Market Hypothesis postulates that a market is considered to be efficient if all possible available information is reflected in the prices of assets traded in such market thereby making it impossible for market participants to use such information to outperform the buy and hold strategy (Olowe, 1999).

Efficient Market Hypothesis (EMH) according to Fama (1970) has three forms of efficiency depending on the information set; the weak form efficiency, the semi-strong form efficiency and the strong form efficiency. The weak form efficiency states that past prices and volume of historical data information has already been incorporated in the current security prices thereby making it impossible for participants or investors to outperform the market or make abnormal profit through chart reading, tape watching or any other trading device (Okpara, 2010). The semi-strong form of market efficiency states that current asset prices reflect all publicly available information that is relevant to the market as a whole (i.e. information about stock splits, earnings forecast, exchange rate of another currency, etc.) while the strong form states that asset prices reflect all available information both past and present including insider or privileged information (Olowe, 1999).

The efficiency or inefficiency of a foreign exchange market has policy implications of great importance to both the government and private sectors in formulating adequate intervention policies in the foreign exchange market (Pilbeam, 1992). A foreign exchange market that is efficient needs minimal government intervention and its participants cannot make excessive gains from foreign exchange transactions (Wickremasinghe, 2005). This implies that

all available information are incorporated or reflected in foreign exchange prices, thereby making it difficult and impossible for private agents or market operators to trade on such information to make abnormal gain or outperform the market. Government and policy makers usually take the price in an efficient market as the best reflection of information about the market and condition underlying the determination of exchange rates, intervention therefore by the government will not be necessary (Chiwira & Muyambiri, 2012).

The continuous heavy interventions of the Central Bank of Nigeria (CBN) in the foreign exchange market may suggests that the market is inefficient which means that there is a failure of the market forces of demand and supply to set equilibrium prices. It is therefore not an understatement to say that huge government resources and time are spent on the interventions of the foreign exchange market in Nigeria. Therefore, testing the efficiency of the market in this study will further justify the need for government interventions or refute it and then encourage the government and policy makers to focus on market forces of demand and supply to determine exchange rates.

To arrive at foreign exchange market efficiency in Nigeria, the questions that were addressed in this study include: to what extent can past prices of foreign exchange rate be used to predict current prices in Nigerian foreign exchange market? What is the nature of long run equilibrium relationship between selected pairs of foreign exchange rates in Nigeria? Lastly, to what extent do series of exchange rates in Nigeria follow the Random Walk with intercept and deterministic trend Model.

The broad objective of this study is to test both the weak and semi-strong form efficiency of Nigerian foreign exchange market while the specific objectives are to: determine the extent to which past prices of foreign exchange rate can be used to predict current market prices of foreign exchange market using the spot market rates, assess whether the series of exchange rates in the country follow the Random Walk with intercept and deterministic trend Model and lastly, to determine the nature of long run equilibrium relationship between selected pairs of exchange rates in Nigeria.

LITERATURE REVIEW

Conceptual Literature

Fama (1970) classified efficient market hypothesis into three categories based on the level of information reflected in market price. According to him, a market is deemed efficient it the prices on the market fully reflect all available information relevant for the pricing process. The three levels are the weak form, semi-strong form and the strong form.

The Weak Form

The weak form hypothesis of market efficiency states that stock prices already reflect all information that can be derived by examining market trading data such as the history of past prices, trading volume or short interest (Bodie et al, 1999). In a weak form efficient market, past prices and volume of historical data are already incorporated in the in the security prices and no amount of chart reading or any other trading device is likely to consistently outperform the buy and hold strategy (Olowe, 1999).

In weak form of market efficiency, stock prices reflect all available trading information which can be derived from the market data such as past price, trading volume, this implies that nobody can use information related to past price to identify the undervalued security thereby making abnormal profit by them, it also implies that no one should be able to outperform the market using information that is well known to all, If market are efficient in weak form, technical trading rules cannot be used to make profit on consistent basis.

According to Rehman and Qamar (2014), the weak form of EMH is only limited to historical information about the share price itself. In this regard, there should be no relationship between the current and previous prices resulting from new information. Alternatively, the movement in share price in response to new information should not be traceable from the last movement of price. Hence, the future price cannot be forecasted on the basis of the new information.

Although, a number of empirical studies support weak form of efficient market, but there are still numbers of financial researcher studying the past stock price changes and trading volume in an attempt to generate profit. In summary, weak form of efficient market implies that stock prices quickly incorporate all past price information which can be derived by trading data, past price movement of the market is known to everyone, therefore nobody can outperform the market on a consistent basis using some trading strategy based on past price trends and that price follow a "random walk" means prices of stocks are unpredicted.

The Semi-Strong Form

The semi-strong form of market efficiency according to Okarfor (1983), states that current stock prices reflect not only historical or past information that is relevant to the market as a whole, it also include information about stock splits, financial reports of companies, fundamental data on the firms product line, earing forecast and other public information. This implies that the market is efficient, reflecting all public available information both past and present.

In a semi-strong efficient market, investors would have no public available source of information that could lead them to consistently beat the market. It also implies that share prices

adjust to publicly available new information very rapidly and in an unbiased manner, such that no one should be able to out-perform the market using something that is publicly available to everyone. The implications of semi-strong form are that market prices incorporate all publicly available information, publicly available information is easily reachable for everyone, so no investor can use it to device the strategy which could outperform the market on a consistent basis, share prices adjust to publicly available new information key rapidly and in an unbiased manner, such that no excess returns can be earned by trading on that information and neither technical analyst nor fundamental analyst will be able to help the investors to outperform the market.

The Strong Form

In strong form of efficiency, stock prices quickly reflect all types of information which include the past, public information and companies inside or privileged information. Thus, it is the combination of public and private information that is incorporated into current prices. This form implies that even companies management cannot make profit from inside information; they cannot take advantage of inside affairs or important decisions or strategies to beat the market. According to strong form market efficiency, insider information is also already incorporated into stock prices. The common rationale behind this is the unbiased market anticipation that is already reacted into market before companies' strategic decisions. Azeez and Sulaiman (2012) reported the possibility of the strong form market efficiency in the Nigerian capital market as mutual funds managers with access to sophisticated tools and superior information (even insider information) were not able to out-perform randomly selected portfolios of index stocks. This implies that no special expertise is required for investing in the stock market and investors need not pay a premium for these funds in the form of paying entry load, exit loads and other management charges. This implies that market prices incorporate all public and private information, nobody can gain abnormal return even with insider information and information may be relatively difficult and costly to obtain.

Theoretical Literature

The theory of market efficiency was originally developed and applied to capital markets and its development was pioneered by Fama (1970), who defined an efficient market as a market where prices of its assets fully reflect all available information. Random walk theory which is also one of the theories of market efficiency was first introduced by Kendall (1953) and Cootner (1964). The theory was later expanded upon by Malkiel (1973). The theory is concerned with the international efficiency of the capital Market. In the literature of capital markets, the term

markets efficiency is used to illustrate and explain the relationship between information and share prices. It was first introduced and defined by Fama in 1970, where he defined market efficiency as the efficiency in stock markets when the security prices in that market adjust rapidly to the introduction of new information. Hence, in any efficient market, current prices of securities should reflect all the information useful for price prediction of securities in the stock market and there is no way to earn excess profit by trading with this information. This depends upon the extent to which the information is absorbed, the time taken for absorption and the type of information absorbed. The price of the security reflects the present value of its expected future cash flows, which incorporates many falters such as volatility, liquidity and risk of bankruptcy. However, while the prices are rationally based, changes in prices are expected to be random and unpredictable, because of the fact that new information is unpredictable by its very nature. Therefore, stock prices are said to follow a random walk.

Also, the theory of purchasing power parity as propounded by Gustav Cassel (1916) states that exchange rates between currencies are in equilibrium when their purchasing power is the same in each of the two countries. This means that the exchange rate between countries should equal the ratio of the countries' price levels of a fixed basket of goods and services. When a country's domestic price level increases more rapidly than its major trading partners (i.e. a country experiencing inflation), that country's exchange rate must depreciate in order to return to purchasing power parity.

Broadly, purchasing power parity is a theory of exchange rate determination and a way to compare the average costs of goods and services between countries. The theory further assumes that the actions of importers and exporters, motivated by cross country price differences induce changes in the spot exchange rate. In another vein, purchasing power parity suggests that transactions on a country's current account affect the value of the exchange on the foreign exchange market. Purchasing power parity is based on the extension and variation of the law of one price as applied to the aggregate economy. To explain the theory, it is best to first review the idea behind the law of one price. The law of one price states that, in the absence of transportation and other transaction costs, competitive markets will equalize the price of an identical good in two countries when the prices are expressed in the same currency. If it makes sense from the law of one price that identical goods should sell for identical prices in different markets, then the law ought to hold for all identical goods sold in both markets. However, there is a slight twist added to the law of one price to convert it to the purchasing power parity theory. In the law of one price, goods arbitrage in a particular product is expected to affect the prices of the goods in the two markets. The twist that is included in the purchasing power parity theory is

that arbitrage, occurring across a range of goods and services in the market basket, will affect the exchange rate rather than the market prices.

Review of Empirical Studies

Wickremasinghe (2004) tested the weak and semi-strong form efficiency of the foreign exchange market in Sri Lanka using the average monthly nominal spot exchange rates for Japanese Yen, UK Pound, US Dollar, French Franc, Indian Rupee and German Mark for the period January 1986 to November 2000. The weak form efficiency was tested using unit root tests while the semi-strong form was examined using the co-integration, Granger causality and variance decomposition analysis. The results indicated that the Sri Lankan foreign exchange market is consistent with the weak form of the efficient market hypothesis while the result for Semi-Strong provides evidence against the EMH. The study further recommended that government should make informed decisions on exchange rates, take actions to reduce exchange rate volatility and evaluate the consequences of various economic policies for exchange rates.

Chakrabarti (2005) applied unit root tests of both the Augmented Dickey Fuller (ADF) and Philip Peron (PP) to test whether the Indian rupee followed a random walk or not. The results showed that the rupee to dollar exchange rate for the period 1997 to 2002, failed to reject the null hypothesis of a unit root (i.e. random walk) at the 5 percent level of confidence, although they both reject the same at 10% level. However, when an extended period from 1997 to 2004 was considered, both tests credibly reject the null hypothesis of a random at 1% level of confidence. This result is therefore in support of the weak form market efficiency.

Kasman and Ayhan (2007) examined the relationship between exchange rates and foreign reserve using monthly data between 1982 and 2005. The Augmented Dickey Fuller (ADF) unit root test was employed by them and they reported the absence of long run relationship between exchange rates and foreign exchange reserve.

Noman and Ahmed (2008) investigated the weak form efficiency for foreign exchange markets in seven SAARC countries namely: Pakistan, India, Bangladesh, Sri-Lanka, Bhutan, Nepal and Maldives using monthly return series for each of the market for the period 1985 to 2005. They employed variance test of Lo and McKinley (1988) and chow Denning Joint variance ratio test (1993). Their study failed to reject the null hypothesis of random walk for all the seven currencies and the conclusion was that foreign exchange markets in south Asian region follow random walk process because increments of return series are not serially correlated and therefore are weak form efficient.

Kuhl (2010) investigated the market efficiency on the foreign exchange market since the introduction of the Euro by applying the co-integration analysis and Engle and arranger approach to exchange rates. The study employed a bivariate co integration analysis in order to evaluate if the introduction of a new currency has resulted in inefficient markets. The empirical analysis predominantly draws on the Johansen (1988, 1991) approach and the Gregory-Hansen (1996) approach. The outcome of the study showed that the foreign exchange market is broadly consistent with the market efficiency hypothesis. The study concluded a long run relationship between the exchange rate Pairs of EUR/USD and GBP/USD with the no arbitrage condition satisfied.

Chiou and Williems (2012) studied the behaviour of three daily exchange rates of US dollar/ Brazilian Real, US dollar/ Canadian dollar, and US dollar/ Mexican Peso using daily exchange rate over the period January 1999 to December 2011. The study employed two popular non-parametric tests of randomness which are Runs up and Down Tests and Runs above and below central point test. The major findings of the study are: (1) each exchange rate is not normally distributed. (2) each exchange rate does not follow a random walk in the runs up and down test and (3) each exchange rate does not follow a random walk in the runs above and below a central point test. The study therefore suggested that non-Euro currencies, exchange rate overshoots or undershoots and government intervention may play a role in market efficiency.

Chaudhry and Javid (2012) examined both the weak and semi-strong form of efficiency of four of the seven foreign exchange market of South Asia which are Pakistan, India, Sri Lanka and Bangladesh using three bilateral foreign exchange rates of US dollar, British Pound and Japanese Yen for the period January 1995 to December 2010. The weak form efficiency was examined using unit root test while semi-strong form efficiency was tested using co-integration and granger causality tests. The results of the study indicated that all four foreign exchange markets are consistent with the weak form of the efficient market hypothesis while the result provided evidence against the semi-strong version of the efficient market hypothesis.

Fapetu and Oloyede (2014) examined the foreign exchange management and the Nigeria economic growth from 1970 to 2012. The study adopted the Ordinary Least Square (OLS) estimation technique within the error correction model (ECM) framework and the Johansen co-integration test to test for the presence of a long run relationship between the dependent variables. The result of the co-integration test revealed that trace statistics and maximum Eigen values were greater than the critical values at 5% level of significance. The result also further revealed that export and foreign direct investment were statistically significant in determining economic growth at 5% and 10% level of significance respectively, but exchange

rate, import and inflation were found to be statistically non-significant. It was therefore recommended that effort be made to increase the consumption of made in Nigeria goods which includes the usage of raw materials that can be sourced locally by Nigerian industries in order to increase foreign exchange earnings.

Zobia (2015) investigated the efficiency of foreign exchange market in Pakistan using monthly time series data for the period of July 2000 to October 2013 for 13 different currencies against the Pak Rupee by applying three techniques of regression analysis. The result of regression on trended data showed that unbiased hypothesis does not hold in the exchange rate market due to serial correlation and non-stationary time series data. The regression analysis with de-trended data revealed that the exchange rate market of Pakistan is neither efficient nor speculative while the findings of the regression analysis with orthogonality experiment explored incidence of bandwagon behaviour in the selected currencies. The results of the study suggested that concerned authorities should reinforce information dissemination procedure and regulate unofficial currency markets activities for maintain the efficiency of foreign exchange market in Pakistan.

Otapo (2016) investigated the weak and semi-strong form of exchange market efficiency in Nigeria using the spot and monthly official exchange rate series of Naira to Dollar, Pounds, Yen, Swiss Franc and CFA Franc between January, 1986 and December, 2015. The study employed the Autocorrelation Function and the Unit Root tests to decide the weak form efficiency while the Johansen Co-integration and Granger Causality tests were employed to determine the semi-strong form. The findings revealed that the exchange market in Nigeria is efficient in both weak and semi-strong forms for the period studied. The study therefore recommended that a more liberalized flexible exchange rate regime with policies that would provide more liquidity, transparency and depth in the Nigerian forward market should be established.

Akbar (2016) examined the weak and semi-strong form efficiency of the Nigerian foreign exchange rate of Naira against the US Dollar, Pound Sterling, Australian Dollar, French Franc, and Japanese Yen For the period 2001 to 2013. The monthly exchange rate was used from April 1994 to August 2013 while the yearly sample covers the period 1960 to 2012. The time series analysis was employed by examining unit root test, Johansen co-integration test, Wald test and Impulse response function and variance decomposition analysis. The results of the study revealed that the Nigerian foreign exchange market is weak form efficient but inefficient in the semi-strong form. The study therefore suggested that government should look into making the market more transparent and accountable,

which would not only abandon excess return from the market but will also support export-oriented industries in the economy.

Fusthane and Kapingura (2017) examined the weak form market efficiency of the Johannesburg stock exchange for the period 2005 to 2016 with several methodologies which include unit root tests, autocorrelation test and variance ratio test. The empirical results from the various tests indicated that the null hypothesis of a random walk could not be rejected. The study concluded that irrespective of the few instances which represent inefficiency of the market, to a greater extent, there is evidence of the market being weak form efficient.

Most of the empirical work reviewed only concentrated on testing for the weak form efficiency of the foreign exchange market especially in the developing countries with monthly official exchange rates except Wickremasinghe (2004) and Chaudhry and Javid (2012) that tested both weak and semi-strong form. In Nigeria, only Akbar (2016) and Otapo (2016) studied both the weak and semi-strong form of the Nigerian foreign exchange market with monthly and official market rates. While Otapo (2016) concluded that the exchange market in Nigeria is efficient in both the weak and semi-strong form, Akbar (2016) concluded that the Nigeria foreign exchange is weak form efficient but inefficient in the semi-strong form. In the light of the above findings, this paper will go a step further to examine both the weak and semi-strong form of market efficiency in Nigeria with weekly and inter-bank market rates and the outcome of the study will be used to validate the findings of Akbar (2016) and Otapo (2016) or otherwise.

RESEARCH METHOD

Model Specification

The theoretical framework underpinning this study is based on the theory of market efficiency as stated by Fama (1970) who defined an efficient market as a market where prices of its assets fully reflect all available information.

To test the weak and semi-strong form efficiency of the Nigerian foreign exchange market, the research adopted the Random Walk Model to test the stationarity of exchanges as previously used by Ibrahim *et al.* (2011) and Krishnaveni *et al.* (2014) which was stated as:

$$Y_t = \mu_2 + P_{y-1} + \varepsilon_t \qquad\qquad 3.1$$

Where:

μ and p are parameters and ε_t is assumed to be white noise.

Y is a stationery series if $-1 < p < 1$. If $p = 1$, y is a non-stationery series (a random walk with drift); if the process is started at some point, the variance of y increase steadily with time t and goes to infinity.

This model is employed with minor modifications to suit the spot exchange market in Nigeria and thus written as:

Model I: Random Walk without Drift

$$S_t = \beta_2 + PS_{t-1} + \varepsilon_t \qquad\qquad 3.2$$

Model II: Random Walk with Drift

$$S_t = \delta + \beta_2 PS_{t-1} + \varepsilon_t \qquad\qquad 3.3$$

Model III: Random Walk with Drift and Deterministic Trend

$$S_t = \delta + \beta_1 + \beta_2 S_{t-1} + \varepsilon_t \qquad\qquad 3.4$$

Model IV: Co-integration Model

Model 3.5 is used to test for the semi-strong form efficiency of the Nigerian foreign exchange market. The model is stated as:

$$S_t = \alpha_0 + \alpha_1 X + \varepsilon_t \qquad\qquad 3.5$$

Where S_t is the spot exchange rate at time t, S_{t-1} is the spot exchange rate in the immediate preceding period and ε_t is the random error term. μ and p are parameters while α_0 and α_1 are coefficients. The spot exchange rate change, $\Delta S_t = S_t - S_{t-1}$ is simply ε_t which is the white noise, is assumed to be unpredictable from previous exchange rate changes.

Description of Variables

In the Random Walk Models

S_t is the spot exchange rate in the current period

S_{t-1} is the spot exchange rate in the immediate past period

t is time, the trend parameter

β_1 and β_2 are the coefficients

ε_t is the white noise error term with zero mean and constant variance

In the Co-integration Model,

X and Y are any two stochastic variables integrated of order one I (1).

$\alpha_{1\ and}\ \alpha_2$ are the coefficients

ε_t is the white noise error term with zero mean and constant variance

ε_{t-1} is the immediate past value of the error term.

Estimation Techniques

The weak form of the Nigerian foreign exchange market was examined through testing for stationarity of the residuals using the Augmented Dickey Fuller (ADF) 1981 test. In addition to this traditional unit root test, the Phillips-Peron (PP) 1988 is used to establish the weak form of efficiency of the market. Ultimately, these unit root tests provide evidence on whether the

exchange rates follow a random walk or not. The semi strong form of efficiency on the other hand was examined using the Johansen co-integration, Granger causality and the variance decomposition analysis. In determining which of the random walk models that the foreign exchange rates in Nigeria conform to, the coefficient of determination as contained in the unit root analysis were used to determine the model with the best fit. All these tests were carried out using the E-View statistical software.

Sources of Data

This study focuses on deploying time series data with no exogenous independent variables in analyzing the efficiency of Nigerian foreign exchange market using unit root and co-integration test to examine both the weak and semi-strong form of both markets. Secondary data sources were employed in this study. The data were sourced from the Central Bank of Nigeria (CBN) statistical bulletin 2017 and oanda website on interbank average exchange rates. The data used were the inter-bank spot exchange rates of Naira to Swiss Franc, Euro, Pounds, Dollar and Yen for the period of January 2010 to December 2017.

RESULTS AND DISCUSSIONS

Test of Weak Form Efficiency

This was addressed by a test of stationarity using the unit root tests. The weak form efficiency of Nigerian foreign exchange market was carried out using the Augmented Dickey Fuller (ADF) and the Phillips Peron (PP) tests. The summary of the results are contained in Table 1 and Table 2 respectively.

Table 1: Summary of Unit Root Test of Exchange Rates in Nigeria using
Augmented Dickey Fuller Method @ 5% level of significance

Variable	Model	R^2 (%)	Test statistics	Critical value	Probability
NCHF	Constant	0.09	0.617978	-2.868252	0.9901
	Constant Linear.	0.8	-1.106439	-3.420636	0.9256
	None	0.09	2.039086	-1.941585	0.9904
NEURO	Constant	0.4	1.335654	-2.868319	0.9988
	Constant Linear.	9	-1.127125	-3.421154	0.9220
	None		1.381548	-1.941621	0.9584
NPOUNDS	Constant	9.4	0.445466	-2.868336	0.9846
	Constant Linear.	10	-1.493099	-3.420768	0.8307
	None	9.4	1.616053	-1.941594	0.9744

NUSD	Constant	0.3	1.186539	-2.868319	0.9981	Table 1…
	Constant Linear.	1.1	-0.837691	-3.420741	0.9602	
	None	0.2	2.488827	-1.941592	0.9971	
NYEN	Constant	12.8	0.087220	-2.868285	0.9645	
	Constant Linear.	13.3	-0.756658	-3.420688	0.9674	
	None	12.8	1.359533	-1.941589	0.9566	

* Indicates that the test is significant at 5%

From Table 1, the result revealed that the test is not significant in all the exchange rates since the probability is above 5% level of significance. The result therefore failed to reject the null hypothesis of the presence of unit root, meaning that past prices do not have any significant effect on present prices which is an evident of market efficiency in the weak form. This suggests that past prices of foreign exchange market in Nigeria cannot be used to predict the present prices thereby making an excessive or abnormal gain. This result is corroborated by the unit root results using the Philip Peron as presented in Table 2. The coefficient of determination (R^2) is highest when Random Walk with intercept and linear trend is fitted in all cases. This is an evidence that exchange rate series in Nigeria conform to the Random Walk model with intercept and linear trend.

Table 2: Unit Root Analyses of Exchange Rates in Nigeria at Level, Using Phillip Peron (PP) Method

Variable	Model	R^2 (%)	Test statistics	Critical value	Probability
NCHF	Constant	0.09	0.428236	-2.868252	0.9840
	Constant Lin.	0.83	-1.311404	-3.420636	0.8836
	None	0.09	1.840257	-1.941585	0.9845
NEURO	Constant	0.4	0.875763	-2.868319	0.9952
	Constant Lin.	1.4	-0.884918	-3.420741	0.9954
	None	0.26	1.742795	-1.941592	0.9806
NPOUNDS	Constant	0.21	0.848205	-2.868252	0.9948
	Constant Lin.	1.1	-1.271227	-3.420636	0.8932
	None	0.15	1.889843	-1.941585	0.9862
NUSD	Constant	0.3	0.770040	-2.868319	0.9935
	Constant Lin.	1.1	-1.123977	-3.420741	0.9226
	None	0.29	2.019735	-1.941592	0.9900
NYEN	Constant	0.31	-0.386318	-2.868252	0.9085
	Constant Lin.	0.98	-1.252012	-3.420636	0.8975
	None	0.1	1.068026	-1.941585	0.9257

* indicates that the test is significant at 5%

Test of Semi-strong Form Efficiency

Table 3: ADF Unit Root Test at Level and First Differences Using
Random Walk with Constant and Linear Trend

Variable	Level: critical value @5%		First difference: critical value @ 5%		Comments
	Test statistics	Probability	Test statistics	probability	
NCHF	-1.311404	0.8836	-19.59804	0.0000	I(1)
NEURO	-0.884918	0.9954	-7.070873	0.0000	I(1)
NPOUNDS	-1.271227	0.8932	-7.498880	0.0000	I(1)
NUSD	-1.123977	0.9226	-18.70798	0.0000	I(1)
NYEN	-1.252012	0.8975	-20.34805	0.0000	I(1)

According to Table 3, all the exchange rates became stationary at first difference. This suggests the use of unrestricted Vector Autoregressive Model.

Variance Decomposition Test for Exchange Rate Series in Nigeria
From the VAR estimation results of exchange rates, the variance decomposition, Granger causality, and co-integration test are contained in tables 4, 5, and 6 respectively.

Table 4: Variance Decomposition of USD

Variance Decomposition of NUSD:

PERIOD	S.E.	NUSD	NPOUNDS	NEURO	NCHF	NYEN
1	4.683945	100.0000	0.000000	0.000000	0.000000	0.000000
2	6.973285	99.61800	0.214697	0.011558	0.142271	0.013476
3	8.407024	99.70582	0.156133	0.010536	0.108986	0.018526
4	9.880767	99.44532	0.160064	0.152119	0.224726	0.017775
5	11.23488	99.27031	0.163966	0.243042	0.301325	0.021353
6	12.39689	99.16877	0.187784	0.273242	0.322321	0.047887
7	13.47333	99.07499	0.216231	0.285965	0.352138	0.070675
8	14.48266	99.01019	0.242122	0.288138	0.375680	0.083871
9	15.41254	98.95720	0.271805	0.281639	0.391866	0.097490
10	16.28155	98.89666	0.307117	0.269579	0.413719	0.112929

The variance decomposition test for Naira to US Dollar in Table 4 revealed that in the short and long run, innovations in NUSD are caused by its own shocks to the extent of 99.61% and

98.89% for lag 1 and lag 10 respectively. This suggested that changes (shocks) in other exchange rate series do not lead to significant innovations in the NUSD. This is an evidence of semi strong form efficiency in the Nigerian foreign exchange market.

The Granger Causality Test

Table 5: Granger Causality Test for Nigerian Exchange Rate Series

Dependent variable: NUSD			
Excluded	Chi-sq	Df	Prob.
NPOUNDS	7.135424	4	0.1289
NEURO	0.606708	4	0.9623
NCHF	5.060572	4	0.2811
NYEN	1.042743	4	0.9032
All	14.90710	16	0.5315

In Table 5, individual exchange rates do not granger cause the NUSD rate, in addition, jointly, the series do not also granger cause NUSD with a probability of 0.5315. This confirms efficiency of the exchange rate series in the semi-strong form of the Nigerian foreign exchange market.

The Co-Integration Test

Table 6: Co-integration Test for Nigerian Exchange Rate Series.

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.049091	39.97619	69.81889	0.9480
At most 1	0.029665	20.39514	47.85613	0.9888
At most 2	0.016217	8.680821	29.79707	0.9937
At most 3	0.005927	2.320610	15.49471	0.9894
At most 4	2.07E-05	0.008064	3.841466	0.9280
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.049091	19.58105	33.87687	0.7850
At most 1	0.029665	11.71432	27.58434	0.9436
At most 2	0.016217	6.360211	21.13162	0.9747
At most 3	0.005927	2.312546	14.26460	0.9817
At most 4	2.07E-05	0.008064	3.841466	0.9280

Table 6 indicated that at all the hypothesized number of co-integrating equations (0 to 4), the tests are not significant because the probabilities are all above 5% level of significance which means the result failed to reject the null hypothesis of no co-integration. Thus, both the trace statistics and the maximum Eigen value statistics conclude the absence of no co-integrating equations. This is a proof of semi- strong form efficiency in the exchange rate series in Nigeria.

Summary of Findings

The study of the Nigerian foreign exchange market revealed that the market is efficient in the weak and semi-strong form. This implies that all past and publicly available information are already incorporated in the market prices of exchange rates, thereby making it impossible for investors and market participants to outperform the market by making abnormal gains. This result conforms to the findings of Otapo (2016) which concluded that the Nigerian exchange market is efficient in both weak and semi-strong form.

This suggests that market participants in Nigerian foreign exchange market would not be able to device some rules or techniques that can be used to predict future movements of exchange rates from its past values. It also connotes that all available information both in past and publicly available information have been incorporated in the prices of exchange rates, thereby making it impossible for market participants to make abnormal gains.

CONCLUSION

This study examined the weak and semi-strong form efficiency of Nigerian foreign exchange market using the inter-bank spot exchange rates of Naira to CHF, EURO, POUNDS, and USD for the period of January 2010 to December 2017. The Augmented Dickey Fuller (ADF) and the Phillip Peron (PP) tests were carried out to test for the weak form efficiency while the co-integration, granger causality and variance decomposition tests were used to determine the semi-strong form efficiency of Nigerian foreign exchange market. The study revealed that the Nigerian foreign exchange market is efficient in both weak and semi-strong form. The study concluded that market participants in Nigerian exchange market would not be able to device some rules or techniques that can be used to predict future movements of exchange rates from its past values. Specifically, the following policy recommendations are suggested.

1. The inter-bank market in Nigeria should be well monitored and managed by the regulatory authorities so as to promote the effective and efficient smooth functioning of the foreign exchange market as well as achieving a stable and realistic exchange rates. Also, exchange rate stability should be maintained to avoid adverse effects of exchange rate volatility on macroeconomic variables in the country.

2. Government and concerned authorities in Nigeria should concentrate and focus more on addressing the external factors like international reserves, balance of payments, domestic credits, capital imports, national income, money supply etc., which determines the pattern of foreign exchange rates in order to achieve desired result of depreciation or appreciation of the country's currency.

3. The Central Bank of Nigeria (CBN) should improve their monitoring systems that will promptly detect various malpractices of market participants and erring participants should be severely sanctioned and dealt with to act as deterrent to others that may want to disobey the rules and laid down guidelines of the foreign exchange market. Market participants should also be encouraged to provide market information and analysis that may be helpful as inputs for the development of the system.

4. The flexible exchange rate regime adopted in Nigeria should be liberalized and more of the clean float and government intervention should be minimal since the market is efficient in both weak and semi-strong form. The market forces of demand and supply should be allowed to set equilibrium prices in the foreign exchange market.

5. The depth of the foreign exchange forward market should be improved and liberalized in Nigeria. Presently, the forward exchange market in Nigeria is shallow and illiquid (Canales-Kriljenko (2004). Participants in foreign exchange transactions are exposed to risks without hedging options. The government and regulatory bodies in the country should provide cover facilities for traders and ensure that the market is improved so as to safeguard themselves as much as possible against exchange rate risks and fluctuations in the foreign exchange market.

6. Lastly, exportation of locally made goods should be encouraged, investment by foreigners in Nigeria should also be encouraged and this may be in the form of foreign direct investment or portfolio investment. Effect of cross boarder movement in finance has overtaken effects of trade movements on exchange rate determination due to globalization, as such, policies that will improve domestic security, provide access to domestic and international markets and provide infrastructure that will drive economic development should be pursued.

Researchers can expand the scope of this study by investigating the strong form efficiency of foreign exchange markets in Nigeria. Strong form efficiency measures whether insider information is reflected in the prices of assets in a financial market especially the exchange market. Such efficiency will expand the scope and findings of this work. This can also be extended to money markets thereby testing for the weak form, semi-strong form and strong form efficiency of the Nigerian money markets.

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