

**EXAMINING THE EFFICIENCY OF THE FOREIGN
EXCHANGE MARKET IN NAMIBIA**

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Abstract

This paper examines the weak and semi-strong form of the efficient market hypothesis in the Namibian foreign exchange market using sample data from the period January 1993 to December 2011. The study uses monthly nominal spot exchange rates for the British Pound (GBP), the United States Dollar (USD) and the European Currency Unit (EURO). The weak form is examined using the unit root tests, namely: the Augmented Dickey Fuller (ADF), the Philips-Perron (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS); while the semi-strong form is tested using the Johansen Co-integration Test, Granger Causality Test and the Variance Decomposition Analysis. The results indicate that the variables are stationary at first differencing, implying that the Namibian foreign exchange market is informational efficient, that is, the exchange rates exhibit random walks and are consistent with the weak form of the Efficient Market Hypothesis (EMH). In other words, past exchange rates cannot be used to predict future exchange rates. In addition, the results also show that one currency cannot, to a certain degree, be used to predict another, which implies that the Namibian foreign exchange market is consistent with the semi-strong form EMH. These results are quite interesting, especially for a small open Sub-Saharan African economy such as Namibia's. Such countries are often associated with shallow and underdeveloped financial markets typified by absence of forward markets, and low levels of foreign exchange reserves. Moreover, these results have important implications for government policy makers and market participants in the foreign exchange market of Namibia. An efficient market needs minimal intervention given that its participants cannot make abnormal gains from foreign exchange transactions.

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Declaration

I, Mukela Engelbrecht Peter Mabakeng, declare hereby that this study is a true reflection of my own research, and that this work, or part thereof has not been submitted for a degree in any other institution of higher education.

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Date

Dedications

I dedicate this work to my late father, Fwafwa Johnson Mabakeng, for his gracious love and support during the early days of my studies. I further dedicate this work to my siblings; Taleni, Rudy, Pinehas, Aluhe, Maliwa, Sililo, Warlyce, Hope and Mbuche. I hope that my example as an elder brother will inspire you to author numerous research-based academic papers of your own.

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CHAPTER 1

INTRODUCTION

This chapter presents a general introduction to the thesis. It is divided into the following sections. Section 1.1 provides an orientation of the study by defining the concept of the efficiency of foreign exchange market and gives an overview of the salient features of the foreign exchange market set-up in Namibia as a member of the Common Monetary Area (CMA) vis-à-vis the world. Section 1.2 defines the problem that the study strives to address and also gives an outline of the research objectives to be dealt with in section 1.3. The significance and limitations of the study are highlighted in section 1.4 and 1.5, respectively. Lastly, the structure of the remainder of the study is outlined in section 1.6.

1.1 Orientation of the Study

An important strand of the study addressed the question of whether or not the Namibian foreign exchange market is efficient; that is, whether frequent changes in the exchange rate are attributable to stabilizing speculation which reflects changes in the fundamentals or long-run determinants of currencies; or whether such changes are due to destabilizing behavior of various kinds, driving prices away from fundamentals, and hence creating excess volatility.

According to Hallwood and MacDonald (2000) an efficient exchange rate market is the one which:

- Fully utilises all available information, that is, there is no unexploited information.

- All participants in the foreign exchange market utilise all available information to provide a set of exchange rates both spot and forward that do not provide any opportunity for unusual profits.
- Unusual profits cannot be made by speculators.
- There is no room for government intervention in the foreign exchange market because it reflects all available information.
- Both Covered Interest Parity and Uncovered Interest Parity conditions are assumed to hold at all times.
- The forward exchange rate equals the expected spot rate. Therefore, empirically, running the regression, the forward rate is an unbiased estimator of the spot rate. That is, the forward rate should correctly reflect the future spot rate.

According to Shipanga (2009), Namibia officially became a member of the Common Monetary Area (CMA) in 1990. Although all member countries of the CMA, which comprises of South Africa, Namibia, Lesotho and Swaziland, adhere to the same exchange control regulations, Namibia has its own foreign exchange operations (Exchange Control) to manage foreign currency transactions. Day to day handling of exchange control takes place through the commercial banks which act as the authorized dealers in foreign exchange on behalf of the Bank of Namibia and the Ministry of Finance. Within the monetary area, exchange rates between the participating countries are fixed and there are no payment restrictions. The CMA has many of the characteristics of a monetary union, as the exchange rates vis-à-vis other member states are fixed and capital flows are free. As a consequence, interest rates and the money supply cannot be directly influenced by the individual country except for South Africa. Monetary policy in such a system is at best

subordinated to exchange rate policy, as domestic credit creation must be kept within limits in order to ensure a sufficient volume of net foreign assets of the banking system.

One major advantage of the current arrangement is that it helps to avoid exchange rate fluctuations between the country's exchange rate and the South African Rand and reduces the unfavorable effects of exchange rate uncertainty on trade and investment, thus providing price stability in the domestic economy. The Namibian foreign exchange reserves are denominated into three (3) reserve currencies, the South African Rand (ZAR), European Currency Unit (EURO) and the United States Dollar (USD).

According to Aron (1997), the prospect of fully floating and convertible currencies introduces new policy dilemmas for many Sub-Saharan African economies often associated with shallow and underdeveloped financial markets typified by absence of forward markets, and low levels of foreign exchange reserves. The role of the exchange rate is crucial in small import-dependent Sub-Saharan African economies with highly concentrated export sector. Policy concerns include: the extent of allocation efficiency in thin markets with a volatile exchange rate; whether volatility deters investment or renders it inefficient and whether the exchange rate can, or should be, smoothed through intervention mechanisms. In the words of Aron (1997), we obviously expect to find inefficiencies in a small African developing country such as Namibia, characterized by institutional imperfections such as interest rate regulation, credit rationing and exchange rate control. Furthermore, these are frequently thin markets with high transaction costs and are subject to frequent policy and other structural breaks. An important strand of this study addresses the question of whether or not the Namibian foreign exchange market is

efficient: that is, whether frequent changes in the exchange rate are attributable to stabilizing speculation which reflects changes in the fundamentals or long-run determinants of currencies; or whether such changes are due to destabilizing behavior of various kinds, driving prices away from fundamentals, and hence creating excess volatility. Although the Namibian Dollar is linked to South African Rand (at one-to-one), it is expected that given the fluctuation of the Rand in the international market it is indirectly translated or passed to the CMA currencies of which Namibia is not an exception (Shipanga, 2009).

1.2 Statement of the Problem

The role of the exchange rate is crucial for small import-dependent economies, such as Namibia's, characterized by highly concentrated export sectors. Proponents of efficient markets hypothesis argue that excess volatility damages the real economy, by imposing large costs on producers and consumers, who then make less than efficient allocative decisions. However, policy concerns include the extent of allocation efficiency in thin markets with a volatile exchange rate, coupled with institutional imperfections such as interest rate regulation, credit rationing and exchange rate control. These are thin markets with high transaction costs and they are subject to frequent policy adjustments. If indeed foreign exchange markets are inefficient, a model that best predicts the exchange rate movements can be developed. Effectively, this implies that there could be a case for intervention, for example, the smoothening of exchange rates through intervention mechanisms (Froot & Thaler, 1990). Elimination of exchange rate fluctuations can ensure economic stability in terms of prices and wages and enhance economic performance.

Alternatively, a foreign exchange market that is efficient needs minimal government intervention in that its participants cannot make abnormal gains from foreign exchange transactions. Though many studies have been conducted on the efficiency of the foreign exchange markets in developed countries, little is known about these markets in the developing economies and much less so in Namibia . Therefore, this study looks at the question of whether or not the Namibian foreign exchange market is efficient. It further explores the implications of efficiency, or the lack thereof, on the real economy. By implication, the study also attempted to ascertain whether there exist a relationship between the Namibia foreign exchange market and that of South Africa given that the Namibian dollar is pegged to the South African Rand and the close economic and trade relationship between the two economies, by comparing the findings.

1.3 Research Objectives

This study aims to examine the efficiency of the foreign exchange market in Namibia. The specific objectives of this paper are:

1. To examine the efficiency of the Namibian foreign exchange market during the period 1993 to 2011; and also
2. Contribute to the knowledge base regarding the foreign market efficiency in Namibia.

1.4 Significance of the Study

This study will contribute to knowledge specifically pertaining to the Namibian foreign exchange market for which little work has been done to-date. Ultimately, it would point the way ahead in terms of further specific work that could be carried out given similar data or applying different methodologies highlighted in the literature. Further, the results of this

study could aid policy makers in making timely interventions in the foreign exchange market, which would contribute greatly to investor confidence.

1.5 Limitations of the Study

Owing to the fact that the market for forward contracts does not exist in Namibia as yet, and hence, the forward exchange rates are not published by the Bank of Namibia; the scope of this study is limited to the efficiency of the spot foreign exchange market. The data on the monthly bilateral spot exchange rates covering the period January 1993 to December 2011 were obtained from the Bank of Namibia (2012). On the other hand, it would have been interesting to examine and contrast the behavior of the same market prior to Namibia becoming part of the CMA. However, due to lack of a fairly consistent long time series data, the study only used monthly data which covers the period of January 1993 to December 2011. This could have implications on the interpretation and generalization of the results for the long-term coefficients of the estimated model. Nonetheless, no methodological limitations are foreseen.

Further, the study only had a limited amount of time of six months within which it had to be completed and submitted to the University. This period is considerably limiting to conduct all the necessary investigations given the complexity of a subject such as the efficiency testing of the foreign exchange market. To the knowledge of the author, there are no previous empirical studies on the application of Efficiency Market Hypothesis (EMH) examining of the Namibian foreign exchange market. This limitation coupled with very minimal work in Sub-Saharan Africa (SSA) also poses challenges on the study.

1.6 Outline of the rest of the study

The remaining part of this study is structured as follows: Chapter two explores the theoretical framework, literature reviews and the empirical frameworks. This chapter also gives an overview of factors influencing exchange rate fluctuations as well as the macroeconomic implications of exchange rate fluctuation. Chapter three discusses the methodology and model specification, the econometric framework of the study as well as the data, data sources and data measurements. Chapter four presents the estimation results and findings of the study. Chapter five presents the conclusion and policy implications.

CHAPTER 2

LITERATURE REVIEW AND THE THEORETICAL FRAMEWORK

2.0 Introduction

This chapter discusses the theoretical literature and relevant empirical studies to give an overview of all economic theories related to analyses of the efficiency of the foreign exchange markets. Since the publication of Fama's seminal work (Fama, 1970), foreign exchange markets especially in the developed countries have been extensively tested for efficiency using different econometric techniques. According to Wickremasinghe (2005), there have been several recent studies some of which provided mixed evidence in this area using data from developing countries. Section 2.1 discusses the theoretical literature which forms the basis for the examining of the EMH. Section 2.1.1 gives an overview of causes of factors influencing exchange rate fluctuations. The subsequent section, 2.1.2, highlights

macroeconomic implications of exchange rate fluctuations. Section 2.2 gives an overview of the empirical literature. The last section, section 2.3, concludes the chapter.

2.1 Theoretical Literature

Although the Efficient market hypothesis (EMH) is often applied to the stock market, it can also be used to show the foreign exchange rates, like stock price (Ibrahim et al, 2011). A great amount of research which makes reference to market efficiency and performance exists. In general, various international studies have been done regarding the topic of efficiency of the foreign exchange market. EMH refers to markets where prices fully reflect the information available such that unusual profit cannot be earned through exploiting this available information set. Fama (1970) asserts that in an efficient market, prices always fully reflect available information. Accordingly, the EMH has three forms; weak, semi-strong and strong reflecting different degrees of information. 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 all publicly available information. Whereas, in a strong-form efficient market, participants cannot use (i) past prices, trading data such as trading volumes or returns of financial assets; (ii) publicly available information; or (iii) information available to the insiders of the market to devise any method to beat the market consistently. The last form of efficiency, by implication, encompasses both the weak and semi-strong forms of the EMH. According to Mussa (1979) the random walk assumption implies market efficiency in its weak form means no extra profit can be earned by exploiting information about the past exchange rate values.

Hallwood and MacDonald (2000) assert that the EMH is one which emphasizes the fact that financial markets are *informationally* efficient. Thus, one cannot consistently achieve returns in excess of average market returns on a risk-adjusted basis; given the information available at the time the investment is made. Hallwood and MacDonald (2000) agree that there are three major versions of the hypothesis namely; weak, semi-strong form of efficiency and strong form of efficiency. The weak-form efficiency states that prices on traded assets for example stocks, bonds, or property already reflect all past publicly available information. The semi-strong form occurs when despite increasing the information set to publicly available information, it is not possible for the market participant to earn abnormal profit. Finally the strong-form efficiency holds when it is impossible for a trader to make abnormal profits using a trading rule based on either public or private information.

Palermo (2003) asserts that, historically, there was high confidence in Purchasing Power Parity (PPP) theories and monetary explanations of the exchange rate. Nevertheless, these models have given unsatisfactory results in the explanation of the movements of the major exchange rates, particularly in the short run. Palermo states further that opposite theories on the cause of the relative strengths or weaknesses of major currencies have been developed. During the first half of the 1980s Keynesian theories were refined; the Mundell-Fleming model attributed the dollar's strength in the period 1980-85 to the increase in the US budget deficit. After the collapse of the dollar in 1985, other models were introduced predicting that the only way the US could stop the decline of the dollar was by reducing the budget deficit. According to Palermo, such models however, though capable of explaining the high volatility of the exchange rate, have shown low predictive

properties, which considerably reduces their usefulness. Palermo continues to state that, because of the poor econometric performance of economic theories and of the economists' fondness for market efficiency and rational expectations, the model of random walk for exchange rate has become popular.

Over the years, classical and neoclassical economists consistently maintained that, an unregulated market price serves as the best yardstick which reflects the true scarcity or worth of a commodity. The EMH is based on the notion that stock prices are informational efficient, that is reflecting all available information about the value of an asset in the financial market at any given time. This implies that asset prices are impossible to predict from available public information and the only thing that can possibly move them is the news that changes the market perception of the asset value. Thus when good news on the market's prospect becomes public, the value of the asset appreciates and when the prospect of the market deteriorates the value of the asset depreciates (Oseni & Nwosa, 2011). Oseni and Nwosa (2011) stress further that critics of the EMH emphasize that there is every reason to doubt that market players are always rational and that asset prices are informational efficient because asset prices are influenced by psychological perceptions of market player's economic outlook. Conversely, proponents of EMH argue that simply because asset prices rose or declined in the past is not an indication that they will follow a similar trend in future.

2.1.1 Factors Influencing the Exchange Rate Movements

According to Ngerebo (2012), exchange rate which is defined as the relative price of the home currency in terms of a foreign currency, and the movements thereof, are traditionally determined by the following main factors, namely:

- (a) Trade flow, which refers to dynamics of import and exports;
- (b) The portfolio balance, which refers to the returns on assets; and
- (c) The monetary aspects, which refer to the changes in the money stock and inflation rate between an economy and its trading partners' economy.

Mirchandani (2013) who defines volatility to represent the degree to which one variable changes over the time period, identifies some of the direct or indirect determinants of the exchange rate fluctuations or volatility such as:

- (i) Inflation rate; a country with consistently lower inflation rate faces a rising currency value and high purchasing power relative to other countries;
- (ii) Interest rates; countries with higher interest rates attract large number of investors seeking investments opportunities, thus making the currency more attractive as a form of investment and resultantly increasing the demand for that currency and in turn the exchange rate.
- (iii) Current Account deficits; the current account deficit indicates that the country is spending more on international trade than it is earning and in order to balance the deficit it is thus borrowing capital from foreign sources. The deficit will resultantly lead to the depreciation or devaluation of the currency, depending on the exchange rate regime. The opposite is true for the current account surplus;
- (iv) Foreign investment and capital flow; that is to say, demand for domestic currency will increase as foreign investors have to sell their currency in order to buy the local currency, thus increasing the value of the domestic currency.

2.1.2 Macroeconomic Impacts of Exchange Rate Fluctuations

Alweendo (1999) emphasizes that market determined exchange rates are prone to excess volatility that can be damaging to the real economy. Overshooting of the exchange rate could have some real negative economic effects. The elimination of such fluctuations promotes economic stability. Overshooting of the exchange rate between countries doing little trade may not matter much, but between countries engaged in substantial trade, it does. A stable exchange rate will ensure the stability of the prices of traded goods and hence eliminate volatility, not only in the exchange rate, but also in wages and prices and hence enhance economic performance.

According to Wang and Barret (2007), one of the leading conundrums in international economics concerns the relationship between exchange rate risk and international trade volumes. The popular perception that greater exchange risk reduces trade is strongly related to currency intervention by central banks. Most current theoretical models of exporter behavior predict a negative relation between exchange rate risk, associated with high volatility, and export volumes. Wang and Barret (2007) continue to state that yet a vast economic literature yields highly inconsistent empirical results on this issue. One common argument is that exporters can easily insure against short-run exchange rate fluctuations through financial markets, while it is much more difficult and expensive to insure against long term risks. Several authors found that exchange rate uncertainty may induce marginal producers and traders to shift from traded to non-traded goods, thereby dampening trade volumes.

Empirically, Wang and Barret (2007) explored the longstanding question of the effect of the exchange rate volatility on international trade flows by studying the case of Taiwan's export to the United States for the period 1989 to 1999. In particular, they employed sectoral level, monthly data and multivariate GARCH-M estimator with correction for leptokurtic errors. This estimator allows for the possibility that traders' forward-looking contracting behavior might influence the way in which exchange rate movement and associated risks affect trade volumes. They found that changes in importing country industrial production and changes in the expected exchange rate jointly drive the trade volumes. More strikingly, monthly exchange rate volatility significantly affects agricultural trade flows, but not trade in other sectors. Agriculture appears far more responsive to both expected exchange rate and to expected volatility in the exchange rate and less responsive to importers incomes, than do other sectors in Taiwan's economy.

Peridy (2003) stresses that from the theoretical point of view, the first models with uncertainty concluded that exchange rate volatility depressed international trade. However, other theoretical works questioned this traditional result and rather outline the ambiguous relationship between exchange rate variability and trade. He emphasizes that, in fact, the relationship depends on various factors, and the most common ones being the level of the relative risk aversion parameter and the size of the market. Peridy further states that another equally important determining factor is hedging. He highlights that in the presence of a forward market, exchange rate volatility increases risk. However, the negative impact of this increasing risk on trade flows is not necessarily significant, given that exchange rates may be one minor factor compared to other risks expected from the international trade. Conversely, he argues that exchange rate fluctuations do not only represent risk, but

also a source of profit for firms, for instance, it may lead the price of goods to deviate from the law of one price, thus, providing for an opportunity for commodity arbitrage in international trade.

According to Shipanga (2009), the exchange rate volatility is a measure that intends to capture the uncertainty faced by exporters, due to unpredictable fluctuations in the exchange rates. Shipanga asserts that trade has been shown in various studies to have backward linkages, both for employment generation, poverty reduction and general economic growth. The foreign exchange earnings from trade could be a considerable source of revenue for the domestic economy. Shipanga stresses that the conventional understanding is that the appreciation of the domestic currency will lead to increased trade deficits through the current account and vice versa. However, since the collapse of the Bretton Woods system in the early 1970s, the exchange rate movements have not been consistent with this prediction, thereby posing a challenge for establishing the optimal role of exchange rate for desired economic policy objectives.

2.2 Empirical Literature

Aron (1997) surveyed efficiency tests on various African foreign, including South Africa, exchange markets using the cointegration methodology. Specifically for South Africa, Aron tested the weak form of efficiency market hypothesis by a variant of the Martingale model and found that the exchange rate returns were predictable by past values of exchange rates, thus the market is inefficient in its weak form for the period 1979:2 to 1995:3. However, she argues that the model for South Africa should be more satisfactorily formulated as the '*excess returns predictability*' by incorporating the uncovered interest

parity condition. She further states that it seems more plausible that when similar methodologies using error correction models and real monetary determinants for excess currency returns one tends to find a far lower degree of predictability. According to Aron, these results, though may not be plausible in that the model does not take into account policy and structural breaks, they are wholly expected in light of tight exchange controls, imperfect capital markets as well as controlled forward market which tend to leave little room for speculation in the South Africa financial market.

Aron (1997) concluded by stating that the controversy between proponents of the efficient market and their opponents centers on whether the small measured deviation from efficiency is due to the presence of a time-varying risk premium or such factors as the “peso effect” which will not detract from the EMH; or whether investors, or a subset of investors, make systematic prediction errors.

Similarly, Aron and Ayogu (1997) assessed for the appropriate tests for efficiency testing and also applied the methodologies on the South African foreign exchange market by performing the following tests: the weak form efficiency test, the forward market unbiasedness test and the returns predictability test using macroeconomic variables. The authors surveyed the efficiency tests which used the cointegration methodology and highlighted significant data difficulties in empirical work, given credit and exchange controls and frequent structural breaks, for the use of these techniques in Africa. Using monthly parallel market and official exchange rates for South Africa, weak-form efficiency was tested by a variant of the Martingale Model that tests whether the log exchange rate is a martingale, possibly with drift, against autoregressive alternatives. For South Africa, it

was found that exchange rate returns were predictable by past values of the exchange rate. Thus, the market is inefficient for the period considered. For the returns predictability test, the null hypothesis was rejected which implied no predictability of excess returns for South Africa.

Mlambo and Biekpi (2007) studied the weak form of EMH for ten African stock markets using the serial correlation and run tests. Serious thin trading was observed on all markets, and particularly for Namibia and Botswana, the two markets with considerable dual-listed stock on the Johannesburg Stock Exchange (JSE). In all markets studied, except for Namibia, a significant number of stocks rejected the random walk hypothesis. According to Mlambo and Biekpi, the weak-form efficiency on the Namibia stock market is attributable to its correlation with the JSE which was also found to be weak form efficient for the period investigated.

According to Noman and Ahmed (2008), a good number of methods have been developed to test for the efficiency of the foreign exchange market. A common and popular method to test the nonstationarity is the ADF (Augmented Dickey Fuller) commonly used for the weak-form efficiency. This conventional test examines the unit root null of the autoregressive time series. Although ADF test can decide whether the time-series is difference stationary or trend stationary, a necessary property for random walk process, it is not able to detect the serial correlation of error terms. Noman and Ahmed (2008) state further that apart from the low power of the ADF test, using too-short time intervals and low-frequency series that consider outliers as permanent trend breaks causes spurious rejection of the unit root null hypothesis.

Equally, Wang and Jones (2002) examined various methodologies used in testing for the efficiency and rationality in foreign exchange markets. They found that the single equation regression method ignores exchange rate dynamics and could distort the true parameters even if the estimated parameters are statistically significant whether overlapping data or non-overlapping data are used to estimate the model. From their analyses the authors concluded that the sufficient conditions can only be met with the exchange rate variables in levels being included and that the basic VAR used in the previous studies can only test whether the necessary conditions hold and that efficiency and rationality are not guaranteed, although a rejection of the null hypothesis is enough for a verdict.

Palermo (2003), on the other hand, explored the process of determination of the exchange rate between the Italian lira and the US dollar and indirectly, the hypothesis of weak efficiency of the market, covering the period from 14 March 1991 to 30 June 1994 (daily data), applying the Dickey Fuller (DF) and the Augmented Dickey Fuller (ADF) tests. The sample was divided into two sub samples: 14 March 1991 to 17 January 1994, and 18 January 1994 to 30 June 1994 so as to capture the effects of the exit of the lira from the European Monetary System (EMS). The conclusion was not unambiguous; the random walk hypothesis was not rejected for the first sub sample but questionable for the latter.

Moreover, Wickremasinghe (2004) examines the weak and semi-strong forms of the efficient market hypothesis (EMH), using the currency of Sri Lanka as a starting point for six international currencies. In order to examine the weak-form of EMH, he considered the traditional unit root test, while in order to contrast the semi-strong efficiency he utilized the

methodology of Engle and Granger, in which the tests of Augmented Dickey Fuller (ADF) and of Phillips-Perron (PP) were applied over the residuals of the cointegration equation. This is also the same methodology applied in this study. In addition, Wickremasinghe carried out Johansen's tests, Granger causality and Variance Decomposition. In this work, monthly spot rates were used for the Japanese Yen, the Pound sterling, the US dollar, the French Franc, the Indian Rupee and the German Mark, relative to the Sri Lankan Rupee, for the period of January 1986 until November 2000. The principal results point to the fact that evidence exists for rejecting the semi-strong version of the EMH.

Noman and Ahmed (2008) examined the weak form of efficiency of the foreign exchange markets in seven (7) of South Asian Association for Regional Cooperation (SAARC) countries, an economic and political organization comprising of India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan, and Maldives using monthly return series for each of these markets over a period of 21 years (1985-2005). They applied a battery of unit root tests and variance ratio tests to see whether the return series of the first seven (7) follow a random walk. In a weak-form efficient foreign exchange market, time series of spot rate show the properties of nonstationarity and follows random walk process. Each spot rate at any given time depends upon its own random shock that governs the direction of the rate's next movement. These random shocks or error term, like spot rate, also constitute a time series in which they are not serially correlated. The results thereof suggest that the increments of return series are not serially correlated. Therefore, the conclusion is that foreign exchange markets in SAARC countries are weak-form efficient.

As opposed to others, Sifunjo et al. (2008) used Bachalier's RWH which suggests that asset prices in an efficient market are well described by a random walk pattern and therefore could be normally distributed. This argument gave birth to the random walk hypothesis (RWH) in which changes in asset prices do not display any pattern. The rationale is that if markets quickly impounded any new information into its current asset, that is the market is efficient, then there could be no pattern in prices changes hence asset prices are random. Sifunjo et al. (2008) carried out run tests, unit root tests and the Ljung-Box Q-statistics to test the RWH in its weak form. The rationale was to determine whether foreign exchange rate returns follow a random walk pattern. The data covered the period starting January 1994 to June 2007 for the daily closing spot price of the Kenyan shillings per US dollar exchange rate. The main finding of this study was that the foreign exchange rate market is not efficient.

On the other hand, Kumar (2011) examined the weak form of the Indian foreign exchange market using a family of variance ratio tests. Monthly Nominal Effective Exchange Rate (NEER) data from April 1993 to June 2010 were used for the analysis. The justification for the use of the NEER series in the analysis was that it has a tendency of capturing more information compared to the bilateral exchange rates. After analyzing the results from both individual and joint variance ratio test, it was concluded that the Indian foreign exchange market does not exhibit weak-form market efficiency for the period under consideration.

Moreover, Peridy (2003) attempted to build on the theoretical export model with country-specific and industry-specific variables to test the impact of the exchange rate volatility on six of the Group of Seven (G-7) countries' (USA, France, Japan, UK, Canada and Italy)

exports, at a disaggregated sectoral and geographical level. Exchange rate volatility was measured both by the GARCH model and a moving sample standard deviation. The results clearly indicate that the impact of the exchange rate volatility is misleading at an aggregate level, since the impact greatly varies between industries and between destination markets. Peridy concludes by stating that this may partially explain why many empirical studies fail to establish an unambiguous aggregate relationship between exchange rate volatility and trade.

Shipanga (2009) examines the impact of exchange rate volatility on the export flows of Namibia as one of the developing countries over the period 1998 to 2008, applying the Engle-Granger two step procedures on quarterly data of exchange rate and the trade flow of real exports in Namibia for the given period. These procedures were developed by Engle and Granger (1987) using estimation, tests, and empirical examples to determine long term relationships among time series, which are known as cointegration; besides devising error correction models (ECM), they also allow the short term dynamics of these series to be represented.

To this end, a methodology for contrasting the hypothesis of cointegration between series and the corresponding stationary of their linear combinations was devised, and so the existence of cointegration was confirmed. During this period, Namibia experienced tremendous volatility in its exchange rate according to Shipanga. His study produced mixed results. While the mean adjusted relative change as a measure of exchange rate volatility indicated positive and insignificant impact of exchange rate on real exports in Namibia, the moving average as a measure of exchange rate volatility produced a negative

insignificant impact of exchange rate volatility on real exports in the country. Conversely, the last measure of exchange rate volatility, the GARCH method, indicated a positive and significant impact of exchange rate volatility on Namibia's real exports.

Evidently, from the literature reviewed above, there have been many studies that investigated foreign exchange market efficiency in many countries around the globe. Nonetheless, besides studies such as Aron (1997), Aron and Ayogu (1997), Mlambo and Biekpe (2007), Noma and Ahmed (2008) and Sifunjo et al. (2008), there still remains a dearth of investigations that involves developing markets. This is in line with Mlambo and Biekpi (2007) assertion that little is known about the efficiency of emerging markets, especially those in Africa.

Clearly, although the concept of EMH has been investigated on the Namibian stock exchange market by Mlambo and Biekpi (2007), to the knowledge of the author, there have been no previous studies on the examining of the efficiency of the foreign exchange market test in Namibia. The two are significantly different. Therefore, this gap is sufficient justification for this study. Another observation is that the majority of the empirical work only goes as far as testing for the weak-form of the EMH using the traditional unit root tests, whereas this study goes a step further to examine the semi-strong form of EMH.

2.3 Conclusion

This chapter discussed numerous studies on the subject of foreign exchange market efficiency in both the developed and developing parts of the world. Generally, it should be pointed out that the majority of the afore-mentioned publications are premised on Fama's (Fama, 1970) seminal work, and there is also convergence in terms of methodologies

applied and conclusions obtained thereof. Notwithstanding that most of the studies on foreign exchange market efficiency test were conducted early 1980s, no recent studies have disproved the findings, hence, providing reliability in terms of methodological choice and application, and also in terms of basis for future empirical analyses and the current study. It would have been convenient to segment the literature reviewed into two categories, namely; those on Sub-Saharan Africa and those outside the region. However, given that there is very little literature on the efficiency test of the foreign exchange markets in the SSA, the categorization would have been of no significant consequence.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter outlines the methodology and the techniques applied in examining the efficiency of the foreign exchange markets in Namibia. From the section of the empirical literature, it is evident that the traditional unit root testing, in particular the ADF and the PP, are the predominant approaches in studies analyzing the EMH in its weak form. However, this study goes a step further by analyzing the semi-strong form of EMH using the cointegration, Granger causality, and the Variance Decomposition analysis as in Wickremasinghe (2004 & 2005). This being the case, it is therefore indispensable that an overview of these approaches be discussed to enhance and enrich understanding of how these techniques work. This chapter is divided into three major sections. Section 3.1 discusses the baseline model or anchor model used in the analysis of the efficiency of the foreign exchange markets. Section 3.2 presents the econometric framework or analytical framework. Section 3.3 discusses the data, data sources and data measurements.

3.1 Model Specification

Empirical tests of foreign exchange market efficiency have been carried out using various econometric techniques. These models were mainly aimed at establishing whether (i) spot exchange rates behave as random walk variables; (ii) the forward exchange rate is an unbiased predictor of future spot exchange rate; or (iii) there is cointegrating relationship among a series of spot exchange rates (Wickremasinghe, 2005).

From the traditional unit root tests and specifically; the Dickey Fuller (DF), the Augmented Dickey-Fuller (1981) and the Phillips-Perron (1988) used for testing stationarity of time

series in economics which tend to exhibit trend over time, one can already draw inferences about the weak-form of EMH. Although Noman and Ahmed (2008) criticize the ADF, particularly, for its low power, it still remains one of the commonly used techniques or methods used to assess whether a certain foreign exchange market follows a random walk. However, in order to contrast the semi-strong efficiency, which is also the extension of the interests of this paper, the cointegration methodologies such as the Engle-Granger procedures, Johansen cointegration, the autoregressive distributed lags (ARDL) and the Cointegrating Regression Durbin-Watson (CRDW) may also be used besides the variance decomposition, impulse response functions and the Granger causality.

In order to test or make inferences on the EMH in Namibia, the following generic random walk model adopted from Oseni and Nwosa (2011), with minor modifications to suit the foreign exchange market and the Namibian context such as the absence of the forward market, is employed:

$$S_t = S_{t-1} + \mu_t \quad (3.1a)$$

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 μ_t is the random error term. The spot exchange rate change, $\Delta S_t = S_t - S_{t-1}$, is simply μ_t which is the noise or white variable, is assumed to be unpredictable from previous exchange rate changes.

The other statistical technique used to examine the weak form EMH is a regression model. In this model it is assumed that the natural logarithm of spot exchange rates $S_t = \ln S_t$. Thus, the equation is expressed simply as:

$$\ln S_t = \lambda_0 + \lambda_1 \ln S_{t-1} + \mu_t \quad (3.1b)$$

as in the random walk model (3.1a) above, S_t is the spot exchange rate at time t , S_{t-1} is the spot exchange rate in the immediate preceding period and μ_t is the random error term. The new parameters introduced in 3.1b, λ_0 and λ , are the constant and the coefficient of the spot exchange rates, respectively. This model has been used by Fama (1984), Zietz (1995), Aron (1997), Oseni and Nwosa (2011) and others who all reported the rejection of the null hypothesis that $H_0: \lambda_0=0$ and $\lambda_1=1$.

3.2 Econometric or Analytical Framework

This paper adopts the Engle-Granger two-step procedure (Engle & Granger, 1987). This procedure which is carried out in two steps was used by Shipanga (2009) and Wickremasinghe (2005). The first step entails the analysis of the order of integration of the variables, which is the determination of the long-term cointegration relationship through testing for stationarity of the residuals using the Augmented- Dicky Fuller (ADF) (1981) test. In addition to this traditional unit root test, the Phillips-Perron (PP) (1988) is used to establish the weak form of efficiency of the foreign exchange market. Ultimately, these unit root tests provide evidence on whether the exchange rates follow a random walk. Therefore, they are also the tests for the weak-form of the EMH. The semi-strong form of efficiency, on the other hand, is examined using the: cointegration, Granger causality, impulse response and the variance decomposition analysis. The analysis of the strong-form of efficiency is a topic for future research.

This chapter entails econometrics analyses to assess the weak and the semi-strong form of efficiency tests of the Namibia's spot exchange rates. In order to test or make inferences on weak-form efficiency of the foreign exchange market in Namibia, and to establish whether or not the spot exchange rates follow random walks, the ADF is obtained by:

$$\Delta x_t = \alpha_0 + b_0 x_{t-1} \sum_{i=1}^k c_0 \Delta x_{t-1} + w_t \quad (3.21)$$

where Δ is the difference operator, α_0 , b_0 and c_0 coefficients to be estimated, x is the variable whose time series properties are examined and w is the white-noise error term. The lags of the dependent variables used to obtain white noise residuals are determined using Akaike Information Criterion (AIC). The null and alternative hypotheses are: $b_0 = 0$ (series is non-stationary) and $b_0 < 0$ (series is stationary) (Wickremasinghe, 2005). Conversely, the PP test suggests a non-parametric method of controlling for higher order autocorrelation in a series and is based on the following first order autoregressive [AR (1)] process:

$$\Delta y_t = \alpha + \beta y_{t-1} + \varepsilon_t \quad (3.22)$$

where Δ is the difference operator, α is the constant, β is the slope and y_{t-1} is the first lag of variable y . The null and the alternative hypotheses tested are the same as for the ADF test described above.

Unit root testing

Most time series in economics exhibit trend over time and when this is the case, it is usually said that these time series are not stationary (contain unit root). Being non-stationary implies that the mean, variance and covariance are not constant over time. When data contains a unit root it means any result derived from such data will be spurious or nonsensical. Spurious regression implies that relationship between variables may appear statistically significant, though no meaningful relationship among the variables exists. Hence, the whole idea for unit root test to search for data generating process (DGP) namely:

(a) Pure random walk, meaning no intercept and no time trend items:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \varepsilon_t \quad 3.23$$

(b) Random walk with drift, meaning intercept and no time trend item;

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \varepsilon_t \quad 3.24$$

c) Random walk with drift and time trend, meaning intercept and time trend item:

$$\Delta y_t = \alpha + \gamma t + \delta y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \varepsilon_t \quad 3.25$$

Given the obvious non-stationarity of the time-series data, unit root tests are performed to establish whether the data is stationary using, for instance, the ADF, PP test types and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests so as to avoid the spurious regressions alluded to above. This model refers to a situation of non-stationarity series, where the variance of the series is not stationary. This refers to the effect which is not carried over to the next period or the value of the current period does not depend on the previous period's value. In this case, there is no short run effect. If there is an effect on the series, that effect would never be adjusted and there would never be an equilibrium point because the effect is equal to a unit.

Making reference to the last PP model given above, 3.22, the ε_t is the disturbance term that is generated from a white noise process and assumed to be independently and identically distributed with zero mean and constant variance and ε are uncorrelated across time. In each case, the estimated coefficient will then be divided by its standard error to compute the tau statistic (t): and refer to the ADF tables. If the computed absolute value of the tau statistic exceeds the ADF, then reject the hypothesis that $\beta = 1$, which indicates that the time series is stationary. Alternatively, if the computed absolute value of the tau statistic

does not exceed the critical tau value, then do not reject the null hypothesis (Gujarati, 2003).

Regression equations with non stationary variables have serious implications. Along with other problems, their t-ratios and the adjusted R-square will be overestimated by a large margin. Therefore, we tend not to get the true results from the tests, and the regression is known as a spurious regression. To avoid the problem of spurious regression, trend data will be differenced to generate a stationary series and this procedure is called difference stationary process (DSP). There are many tests for determining whether there is stationarity or not in a series; however, this study only considers the unit root test. There are various methods for testing for unit roots such as: Augmented-Dickey test (ADF), the extension to the Dickey Fuller test for example Pantula tests, Phillips Peron tests, Kwiatowski-Phillips-Schmidt-shin (KPS), Elliot-Rothenberg-stock point optimal (ERS), Ng-Perron tests and the graphical analysis and the correlogram test. However, this study will only use ADF, PP and KPSS tests for unit root.

Cointegration Test

The following step would be to conduct tests for co-integration, i.e. if two or more series have long-run equilibrium. The econometric literature deals with the cointegration subject from several perspectives. The cointegration test can be applied in several ways, according to the nature of the equation that is tested. If it is a single one, the Engle Granger method is used, however, if it is a multivariate system, then the Johansen Approach is applied to determine the existence of the long run relationship among variables.

Engle Granger Method: cointegration is defined as a linear combination of two or more non-stationary time series, or as the existence of a long run equilibrium relationship between two or more series. If this combination is stationary then it is said that the series are cointegrated. When running a cointegration test, one checks for the following relation between any two or more series:

$$Y_t = \alpha_0 + \alpha_1 X_t + \varepsilon_t \quad 3.26$$

This is called cointegration equation, it is said that Y_t and X_t are cointegrated if both series are $I(1)$ and the error term from cointegration equation ε_t is $I(0)$. Cointegration could be used as an evidence of a long-run equilibrium relationship among variables. In other words by investigating if two series are cointegrated, one is asking if there is a long run relationship between the trends of these two series.

Single Equation Error Correction Model: In order to determine the existence of the cointegration relation between the series each single equation is investigated for an error correction form. This requires an investigation of the short run relationship and this is often done by running ordinary least squares (OLS) regression over the differenced series in order to eliminate the trends or the long run movement in the variables. To do this we estimate the following OLS regression:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta X_t + \alpha_2 \varepsilon_t(-1) + \mu_t \quad 3.27$$

Where: ΔY_t : indicates the difference in the endogenous variable

ΔX_t : indicates the difference in the exogenous variable

μ_t : indicates the white noise error term and

$\varepsilon_t(-1)$ represents the lagged error term estimated from the long run relationship or represents what we call the Error Correction term in estimating the equations.

Johansen Cointegration test: the Johansen cointegration test is used to determine the number of cointegration relations for forecasting and hypothesis testing. The vector error correction (VEC) is also estimated to investigate weak exogeneity and to do hypothesis testing since VEC is applied only to a cointegrated series. To be able to run Johansen cointegrating test the data must be nonstationary.

One of the drawbacks of the Johansen cointegration test is the dependency of the critical values of the test statistic on the trend assumptions. There are five deterministic trends assumptions, the first two assumptions are used when there is no trend in the data, and the third and fourth assumptions are used when there is a linear trend in the data, while the fifth assumption is used when there is a quadratic trend. The other drawback is related to the setting of the appropriate lag length of the VAR model.

The Johansen procedure uses two tests to determine the number of cointegration vectors: the Trace Test and the Maximum Eigen Value Test. Trace statistics investigate the null hypothesis of r cointegrating relations against the alternative of n cointegrating relations, where n is the number of variables in the system for $r = 0, 1, 2 \dots n-1$. Its equation is computed according to the following formula:

$$LR_r(r/n) = -T * \sum_{i=r+1}^n \log(1 - \hat{\lambda}_i) \quad 3.28$$

The Maximum Eigen value statistic tests the null hypothesis of r cointegrating relations against the alternative of $r+1$ cointegrating relations for $r = 0, 1, 2 \dots n-1$. These test statistics are computed as:

$$LR_{\max}(r/n + 1) = -T * \log(1 - \hat{\lambda}) \quad 3.29$$

Where λ_i is the Maximum Eigen value and T is the sample size. In some cases, Trace and Maximum Eigen value statistics may yield different results and Alexander (2001) indicates that in this case the results of the Trace Test should be preferred. The critical values are presented by Johansen and Juselius (1990) and Osterwald-Lenum (1992).

There are many steps that must be followed before applying the Johansen test. First it is necessary to determine the number of lags since this has a big effect in the analysis. There are five criteria: the Sequential Likelihood Ratio (LR), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), Final Prediction Error (FPE) and Hannan Quinn Information Criterion (HQ).

If cointegration is found among the variables, the adjustment of the short-run to the long-run equilibrium is obtained through the vector error correction model (VECM). The VEC model starts from the standard reduced form of VAR (p) model:

$$Y_t = A_1 Y_{t-1} + \dots + A_p Y_{t-p} + ED_t + \mu_t$$

3.30

Where Y_t is a $(n \times 1)$ vector of I(1) variables, D_t a vector of deterministic terms, and A_1, \dots, A_p are $(n \times n)$ coefficient matrices. E is the coefficient matrix associated with the deterministic terms, such as a constant, trend and seasonal dummies. Subtracting Y_{t-1} from both sides of the VAR equation we obtain the following model which represents a Vector Error Correction model:

$$\Delta Y_t = \mu + \alpha_1 \Delta Y_{t-1} + \alpha_2 \Delta Y_{t-2} + \dots + \alpha_{p-1} \Delta Y_{t-p+1} + BX_{t-1} + \varepsilon_t$$

or we can write it in different way

3.31

$$\Delta Y_t = \mu + \alpha_1 \Delta Y_{t-1} + \alpha_2 \Delta Y_{t-2} + \dots + \alpha_{p-1} \Delta Y_{t-p+1} + BA'Y_{t-1} + \varepsilon_t$$

Thus, in the VEC model we regress changes in each variable on a constant (μ), (p-1) lags of the variable's own changes, (p-1) lags of changes in each of the other variables, and the level of the h elements of X_{t-1} . Where $BA'Y_{t-1}$ represent the Error Correction Term.

$X_t = A' Y_t$ is ($h \times I$) stationary vector must be $I(0)$.

Y_t : is ($n \times I$) vector of $I(1)$ variables.

B : is ($n \times h$) matrix contains the adjustment parameters (long run relationship).

α_i : holds the short run parameters (the coefficients on the lagged terms).

h : represents the number of cointegrating equations.

μ : is ($n \times I$) the constant matrix

A' : represents ($h \times n$) matrix of cointegrating vectors, whose rows are linearly independent such that $A'Y_t$ is a stationary ($h \times I$) vector.

$$A' = \begin{bmatrix} a'_1 \\ a'_2 \\ \cdot \\ \cdot \\ a'_h \end{bmatrix} \text{ and } a_i's \text{ are nonzero } (n \times I) \text{ cointegrating vector such that } (a_i'Y_t) \text{ is a}$$

stationary.

If we are interested in the long run process then our attention must be concentrated on matrix B , while our attention must be on α_i 's if we are interested of the short run process.

In an event where co-integration among the variables is not found to exist, then a VAR model specification is estimated.

Granger Causality

The VAR can be considered as a means of conducting causality tests, or more specifically Granger causality test. A Granger causality test is considered a useful technique for determining whether one time series is good for forecasting the other. The concept of granger causality test is explored when the coefficients of the lagged other variables are not zero. Granger causality really implies a correlation between the current value of one variable and the past values of others; it does not mean changes in one variable cause changes in another. If there are two series Y_t & X_t , then it is said that X_t doesn't granger cause Y_t if all lagged coefficients for X_t are zero, that is:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \dots + \alpha_p Y_{t-p} + \beta_1 X_{t-1} + \dots + \beta_p X_{t-p} + \varepsilon_t \quad 3.32$$

Then $\beta_1 = \beta_2 = \dots = \beta_p = 0$, that is lagged of X_t has no effect on Y_t .

Granger causality test is used to see how much of a current series Y can be explained by the past values of Y and to know whether adding lagged values of another series X can improve the explanation of the variance of Y or not. By using an F-test to jointly test for the significance of the lags on the explanatory variables, this in effect tests for 'Granger causality' between these variables. It is possible to have causality running from variable X to Y , but not Y to X ; from Y to X , but not X to Y and from both Y to X and X to Y , although in this case interpretation of the relationship is difficult. The 'Granger causality' test can also be used as a test for whether a variable is exogenous, i.e. if no variables in a model affect a particular variable it can be viewed as exogenous also Granger non-causality is a necessary condition for strong exogeneity.

To determine which variable causes the other, Pair-wise Granger Causality tests are used. But since this test is affected by the number of lags, before running this test it is necessary to determine the number of lags. There are many criteria used to indicate the number of lags. These criteria are Hannan-Quinn (HQ), Schwarz Information Criterion (SC), Akaike Information Criterion (AIC), Final Prediction Error (FPE) and Likelihood Ratio (LR). After determining the number of lags it is possible to run a Pair-wise Granger Causality Test. Estimated VAR satisfies the stability condition.

Impulse Response Functions

In empirical applications, the main use of the VAR is the impulse response function which traces the response of the endogenous variables to one standard deviation shock or change to one of the disturbance terms in the system. A shock to a variable is transmitted to all of the endogenous variables through the dynamic structure of the VAR. In general, the number of possible impulse responses for a structural VAR with n variables and hence n equations and n shocks, is the number of different combinations of shocks and variables, namely n^2 .

Usually the impulse response functions will all have the same general shape, since it is known that all the variables in multi-equation system share similar types of dynamics, by virtue of having the same fundamental dynamic equation representation. If the system is stable, the impulse responses will all approach zero. There will be a difference in the timing of the effects. The impulse responses to the shock in the variable that comes first in the causal chain will all start in the first period. In general, only the variables that are below the variable in the casual chain will react within the period. Therefore, an impulse response function shows the interaction between/among the endogenous variable sequence. The

assumption is that the VAR error returns to zero in the subsequent periods and all other errors equal to zero. Phillips and Perron (1998) shows that the IRF will be inconsistent in the long horizon with unrestricted VAR with a unit root. While the VEC (reduced Rank Model) produces a consistent IRF.

Variance Decomposition

Variance decomposition is an alternative method to the impulse response functions for examining the effects of shocks to the dependent variables. This technique determines how much of the forecast error variance for any variable in a system, is explained by innovations to each explanatory variable, over a series of time horizons (Stock & Watson, 2001). Usually own series shocks explain most of the error variance, although the shock will also affect other variables in the system. It is also important to consider the ordering of the variables when conducting these tests, as in practise the error terms of the equations in the VAR will be correlated, so the result will be dependent on the order in which the equations are estimated in the model. This study also briefly reports the results from Granger causality tests, impulse responses and forecast error variance decompositions.

3.3 Data, Data Sources and Data Measurements

Owing to the fact that the market for forward contracts does not exist in Namibia as yet, and hence, the forward exchange rates are not published by the Bank of Namibia; the scope of this study is limited to the efficiency of the spot foreign exchange market. Therefore, the data used in this paper consists of monthly nominal spot exchange rates of the UK pound (GBP), the US dollar (USD), the European Currency Unit (EURO). The monthly bilateral spot exchange rates covering the period 1993:01 to 2011:12 are obtained from the Bank of Namibia Quarterly bulletin (2012). These spot exchange rates were then transformed in to natural logarithms. Although the Namibian dollar is linked to South African Rand, it is

expected that the fluctuations of the rand in the international market are indirectly translated or passed onto the CMA currencies of which Namibia is not an exception (Shipanga, 2009).

3.4 Conclusion

This chapter outlines the methodology followed and the techniques applied to examine the efficiency of the foreign exchange markets in Namibia. It looks at the predominant approaches used in empirical studies to analyze the EMH in its weak form, namely the ADF and the PP. Moreover, since the interests of this study go beyond examining the weak-form of EMH, a step further is taken to analyze the semi-strong form of EMH. Applicable techniques used such as the cointegration, Granger causality and the variance decomposition analysis are extensively discussed so as to enhance and enrich understanding of how these methodologies work. The issues pertaining to data, data sources and measurements are also discussed in this chapter.

CHAPTER 4 EMPIRICAL ESTIMATIONS AND ANALYSES

4.1 Introduction

This chapter presents the empirical estimations and analyses. It is divided into two sections. Section 4.2 presents a discussion on the detailed estimation carried out, empirical findings of the efficiency test of the foreign exchange market in Namibia using techniques such as the unit root tests for the weak form of EMH (i.e. ADF, PP, and KPSS), the cointegration tests for the semi-strong form of EMH, namely the Johansen cointegration test, the Granger causality and finally the variance decomposition analysis. All discussions are augmented with tables showing the empirical findings. Finally, the chapter is concluded with section 4.3.

4.2 DETAILED ESTIMATIONS

Unit Root Test

In testing for unit root the following test were used: namely, the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The KPSS was added as confirmatory test due to the fact that the ADF and PP statistic has limitations of lower power and successive or persistent unit roots, respectively. They tend to under-reject the null hypothesis of unit roots. The results of the unit root test in levels are presented in Table 4.1 below.

Table 4.1: Unit root tests: ADF and PP in levels and first difference

Variable	Model Specification	ADF	PP	ADF	PP	Order of Integration
		Levels	Levels	First Difference	First Difference	
USD	Intercept	-1.940	-1.948	-11.386**	-11.425**	1
	Intercept and Trend	-1.915	-1.796	-11.416**	-11.416**	1
GBP	Intercept	-2.338	-2.107	-12.265**	-12.203**	1
	Intercept and Trend	-1.790	-1.506	-12.405**	-12.343**	1
EURO	Intercept	-1.743	-1.646	-11.736**	-11.736**	1
	Intercept and Trend	-2.605	-2.413	-11.752**	-11.752**	1

Source: author's compilation and values obtained from Eviews

Notes: (a) *, **, *** are levels of significance at 1, 5, and 10%, respectively. ** means the rejection of the null hypothesis at 5%.

(b) USD, GBP and EURO denote the nominal exchange rate for US dollar, Pound sterling and the European currency unit (EURO), respectively.

(c) The ADF is obtained by: $\Delta x_t = \alpha_0 + b_0 x_{t-1} + \sum_{i=1}^k c_0 \Delta x_{t-i} + w_t$ where Δ is the difference operator, α_0 , b_0 and c_0 coefficients to be estimated, x is the variable whose time series properties are examined and w is the white-noise error term.

(d) From (c), the null and the alternative hypotheses are respectively $b_0 = 0$ (series is non-stationary or follow random walk¹); and $b_0 < 0$ (series is stationary or do not follow random walk).

¹ If the random walk holds (i.e. presence of unit root or non-stationarity), the weak form of EMH must hold or the market is efficient. Alternatively, if the random walk does not hold, the market is inefficient.

Table 4.1 above reports the results of the ADF unit test for the three nominal exchange rates for levels and the first differences of the natural log values. Interestingly, all exchange rates under consideration are non-stationary in levels, that is; their mean is not zero, the variance is not constant and the residuals appear to be correlated over time. When the variables were found to be non-stationary in levels, they were differenced once and became stationary, that is, with a zero mean, constant variance and the residuals uncorrelated over time. The level of significance of the ADF statistics for all currencies is 5%. The relevance of these results is the fact that they inform us about the EMH in Namibia. For instance, the fact that the variables were found to be non-stationary implies that they are consistent with the weak form of EMH which states that financial time series behave as random walks. In other words, past exchange rates cannot be used to predict future exchange rates. In this case, exchange rates at time $t-1$ cannot be used to predict exchange rates at time t . This implies that the participants in the foreign exchange market cannot devise any statistical technique to gain from the foreign exchange market transactions consistently.

Table 4.1 also shows the results of the PP unit root test for the three exchange rates. The PP test procedures are quite similar to those of the ADF test also at 5% level of significance. The results from the PP test also indicate that the series of the exchange rate are non-stationary in levels. Hence, concurring with those of the ADF, and thus further affirming that the weak form of EMH is existent in the Namibia's foreign exchange market.

Table 4.2: Unit root tests: KPSS in levels and first difference

Variable	Model Specification	Levels	First Difference	Order of Integration
USD	Intercept	1.290	0.184**	1
	Intercept and Trend	1.345	0.060**	1
GBP	Intercept	1.487	0.296**	1
	Intercept and Trend	0.401	0.043**	1
EURO	Intercept	1.766	0.097**	1
	Intercept and Trend	0.201*	0.032**	1

Source: author's compilation and values obtained from Eviews

*Notes: (a) *, **, *** are levels of significance at 1, 5, and 10%, respectively. ** mean the rejection of the null hypothesis at 5%.*

Many economists have argued against using the standard unit root test and suggested using other powerful test, such as tests that can be used to test the null of stationarity against the alternative of non-stationarity (Ibrahim et al, 2011). The most popular one is the KPSS. The KPSS test was also then conducted for confirmatory purposes so as to augment the ADF and PP tests conducted earlier. The results in Table 4.2 above still show that the series were found to be non-stationary in level form as in the case of ADF and PP. The results for the KPSS test also affirm the presence of the weak-form of EMH in Namibia. After differencing the data once, the unit root test shows that the series became stationary, implying that the series are integrated of order 1.

These results are similar to those of Wickremasinghe (2005) who examined the weak and semi-strong forms of the efficient market hypothesis (EMH) of the Sri Lankan foreign exchange market, and also those of Noman and Ahmed (2008) for the seven (7) of the SAARC countries. They are also similar to those of Palermo (2003) who explored the process of determination of the exchange rate Italian lira- US dollar and indirectly, the hypothesis of weak efficiency of the market, covering the period from 14 March 1991 to 30 June 1994 (daily data), applying the Dickey Fuller (DF) and the Augmented Dickey Fuller (ADF) tests to capture the effects of the exit of the lira from the European Monetary System (EMS).

Most importantly, these results are fairly consistent with those by Aron (1997) on the efficiency of the South African foreign exchange market. They are also supported by Mlambo and Biekpi (2007). One can therefore safely conclude that the weak-form efficiency on the Namibian foreign exchange market is attributable to its correlation with the JSE (in that most stock listed on the Namibian Stock Exchange (NSX) are dual-listed on the Johannesburg Stock Exchange (JSE) which was also found to be efficient in its weak form and the fact that the Namibian dollar is pegged (one-to-one) to the South African Rand through the CMA arrangement (Mlambo & Biekpi, 2007).

Cointegration test

After establishing the univariate characteristics of the series and having found the presence of the weak form of EMH, it was deemed necessary to proceed so as to establish whether there is a presence of the semi-strong EMH in Namibia's foreign exchange market. This process requires testing for cointegration which is the next

step. This test was done by employing the Johansen cointegration test based on trace and Maximum Eigen values of the stochastic matrix. The results are presented in Table 4.3 below.

Table 4.3: The Johansen co-integration test based on trace and maximal Eigen value of the stochastic matrix

Maximum Eigen Test				Trace Test			
H₀: rank = r	H _a : rank = r	Statistic	95% Critical Value	H ₀ : rank = r	H _a : rank = r	Statistic	95% Critical Value
r = 0	r = 1	9.05	29.80	r = 0	r >= 1	18.51	21.13
r <= 1	r = 2	6.28	15.49	r <= 1	r >= 2	9.46	14.26
r <= 2	r = 3	3.18	3.84	r <= 2	r >= 3	3.18	3.84

Source: author's compilation and values obtained from Eviews

Note: Both Max-Eigen value and Trace tests indicates no cointegrating equations at the 0.05 level. Sample period 1993:01 to 2011:12.

Table 4.3 reports the results of the Johansen Cointegration Test of the three exchange rates. It was necessary to test whether there are indeed co-integration relationships among these variables. The Johansen Maximum Likelihood (JML) approach to test for cointegration was used on a VAR system of three variables based on Full Information Maximum Likelihood (FIML). The FIML procedure is essentially used to identify the rank of the matrix Π . The null hypothesis as stated above is that $r=0$ against the general alternative hypothesis $r \geq 1$, or $r \geq 2, 3$. In this regard a λ -trace statistic was employed, since the null hypothesis is $r=0$ and there are three variables

(i.e. $n=3$). Table 4.3 shows that the null hypothesis that $r=0$ could not be rejected, since the calculated t-statistic (18.50) is smaller than the critical value (21.13) at 5 per cent significance level.

The trace-statistics have a very general alternative hypothesis. A more specific hypothesis is tested and in this regard a λ -maximal test is applied and the null hypothesis is that $r=0$ against the specific alternative hypotheses $r=1$. Table 4.3 shows that the null hypothesis of no co-integration could not be rejected, that $r=0$, meaning that no co-integrating vector exists among the variables in this model. This is again because the calculated t-statistics (9.049) are lower than the critical values (29.80) at 5 per cent significance level.

To sum up, it is evident that both the Maximum Eigen Values and Trace statistics strongly accepted the null hypothesis that there is no co-integration between all these variables in the model (i.e. that $r = 0$). This suggests that there are indeed no co-integrating vectors between these variables. The relevance of these results is their usefulness in determining whether there is a presence of semi-strong EMH. The fact that there is no cointegration among the variables implies that there are no co-movements between currencies. That is to say that, none of these currencies can predict the other. Hence one can safely conclude that there is no violation of the semi-strong form of the EMH. Therefore, this suggests that prices of financial assets instantly reflect public available information, as the semi-strong EMH postulates.

These results should however be interpreted with caution especially in light of thin trading which has been identified as a problem for Namibia's financial markets attributable to dual-listing of stocks (Mlambo & Biekpi, 1997). Furthermore, it would have been plausible to use simulative technical analysis methods such as those used by analysis to see if one can actually beat the market by profitably trading the Namibian dollar vis-à-vis other currencies. Given that this was not the focus of this study, future studies should investigate this and compare with current findings, also taking into account other determinants of exchange rates such as interest rates, growth rate, and inflation figures. It is further suggested that future studies should use other methodologies such as the event study in testing the semi-strong form of efficiency and compare the findings thereof with those in the current study.

Granger-causality test

To further analyze the semi-strong form of EMH, a Granger causality test was conducted. This is an additional test to verify the results of the cointegration test by confirming the presence of the semi-strong form of EMH. The Granger causality statistics are examined to determine whether lagged values of one variable do help to predict another variable. Table 4.4 summarizes the Granger-causality results for the three-variable VAR. It shows the p-values associated with the F-statistics for testing whether the relevant sets of coefficients are zero. The results show that none of the variables helps in predicting another. Notably, these results confirm the earlier results on the weak form of EMH and most importantly for this section; they are consistent with semi-strong form of EMH. Hence, one can confirm the presence of semi-strong form of the EMH in Namibia. This implies that the coefficients on their lags will all be equal to zero in the reduced-form equation. This is consistent with the semi-strong

form of EMH. This implies that the exchange rates instantly reflect all publicly available information.

Table 4.4: Granger causality tests for the generic model

Regressor	Dependent Variable in Regression		
	USD	GBP	EURO
USD	0.00	0.84753	0.48689
GBP	0.17834	0.00	0.54619
EURO	0.95578	0.27847	0.00

*Notes: (a) The entries in the table show the p-values for F-tests. (b)** mean the rejection of the null hypothesis at 5%.*

(b) USD, GBP and EURO denote the nominal exchange rate for US dollar, Pound sterling and the European currency unit (EURO), respectively.

Variance Decomposition

The variance decomposition analysis is merely complementary to Granger-causality test results to examine the out-of-sample causality. It is important to state at the onset that a Generalized Forecast Error Variance Decomposition (GFEVD) test is preferred and used in this case. The GFEVD is advantageous as it is not sensitive to the ordering of variables.

Tables; 4.5 a, b and c report the results of the variance decomposition. The results show how much of spot exchange rate's own shock is explained by the movements in its own variance and those of the others over the forecast horizon (i.e. 48 months).

Forecast Error Variance Decomposition

Table 4.5 a: Variance decomposition for the GBP

Monthly	GBP	USD	EURO
1	100.0000	0.000000	0.000000
12	99.69266	0.051167	0.256169
24	97.77365	0.109157	2.117193
36	94.12573	0.177243	5.697030
48	89.53772	0.191485	10.27079

Note: (a) figures in the first column refer to months after a once-only shock. Cholesky ordering for the variance decomposition was log (GBP), log (USD), and log (EURO).

(b) Variance decompositions for the months 1, 12, 24, 36, and 48 only are reported.

Table 4.5b: Variance decomposition for the USD

Monthly	GBP	USD	EUR
1	59.75741	40.24259	0.000000
12	73.28161	24.66283	2.055562
24	76.54492	20.20684	3.248235
36	77.32179	17.68965	4.988557
48	76.58236	16.21845	7.199187

Note: (a) figures in the first column refer to months after a once-only shock. Cholesky ordering for the variance decomposition was log (GBP), log (USD), and log (EURO).

(b) Variance decompositions for the months 1, 12, 24, 36, and 48 only are reported.

Table 4.5c: Variance decomposition for the EUR

Monthly	GBP	USD	EUR
1	74.89929	1.021363	24.07934
12	80.20292	1.492011	18.30507
24	83.97363	0.940281	15.08609
36	86.36683	0.942894	12.69028
48	87.49874	1.079375	11.42188

Note: (a) figures in the first column refer to months after a once-only shock. Cholesky ordering for the variance decomposition was log (GBP), log (USD), and log (EURO).

(b) Variance decompositions for the months 1, 12, 24, 36, and 48 only are reported.

The results reported in Table 4.5a above show that most of the variation of up to 90 % in the Sterling pound even after 48 months following the once-only shock is explained by itself. In all three cases, the generalized forecast error variance decomposition (GFEVD) was preferred as it is not sensitive to the ordering of variables. Hence, the GFEVD does not reveal any causal relationship from other currencies. This is consistent with the semi-strong form of EMH. In Table 4.5b, results of the variance decomposition for the US dollar are shown. Interestingly, most of the variation in the dollar is explained by the Sterling pound even after 48 months following the once-only shock. These results are inconclusive. Similarly, in Table 4.5c, the results for the Euro also appear to be inconclusive as most of the variation of up to 90% is explained by the Sterling pound even after 48 months

following the once-only shock. They are inconclusive in the sense that they do not conform to those of Granger-causality. They tend to suggest that there might be some degree of causal relationship from other currencies. However, despite this inconclusiveness on the part of the USD and the EURO, there is presence of semi-strong form of EMH as shown by the British Pound sterling.

The study found that there is very minimal amount of empirical work that went beyond testing for the weak-form of EMH, i.e. a step further to test for the semi-strong form of EMH. Nonetheless, these results are different from those of Wickremasinghe (2005) who examined the weak and semi-strong forms of the EMH of the Sri Lankan foreign exchange market. They are also different from those of Gredilla et al. (2006) who analyzed the efficiency of the European currency markets after the euro came into force, which found the violation of the EMH, in other words investors could device arbitrage strategies with certain pairs of foreign exchange rates.

4.3 Conclusion

This chapter mainly presents the empirical estimations and analyses. Section 4.2 presented and discussed detailed estimations carried out, empirical findings of the efficiency test of the foreign exchange market in Namibia using techniques such as the unit root tests for the weak form of EMH (i.e. ADF, PP, and KPSS), the cointegration tests for the semi-strong form of EMH: namely, the Johansen cointegration test, the Granger causality and finally the variance decomposition analysis. All discussions are augmented with tables showing the empirical findings.

The results indicate that the variables are stationary at first differencing, implying that the Namibian foreign exchange market is informationally efficient, that is, the exchange rates exhibit random walks and are consistent with the weak form of Efficient Market Hypothesis (EMH) for the period investigated. In other words, past exchange rates cannot be used to predict future exchange rates. In addition, the results also show that one exchange rate cannot, to a certain degree, be used to predict another, which implies that the Namibian foreign exchange market is consistent with the semi-strong form EMH. Generalization of these results should however be done cautiously. Future studies should take into account other determinants of exchange rates such as interest rates, growth rate and inflation figures which was not the focus of the current study. It is further suggested that future studies should use other methodologies such as the event study in testing the semi-strong form of efficiency and compare the findings thereof with those in the current study.

CHAPTER 5

CONCLUSION AND POLICY IMPLICATIONS

5.1 Conclusion

This chapter gives a brief summary of all the other preceding chapters. It also highlights some policy implications given the findings in the last section of this chapter, i.e. section 5.2. Ultimately, the objective of this study was to examine the efficiency of the Namibian foreign exchange market. Specifically the paper considered the weak and semi-strong form of EMH. The main findings were that the variables were stationary at first differencing, which implies that the Namibian foreign exchange market is informationally efficient, that is, the exchange rates exhibit random walks and are consistent with the weak form of Efficient Market Hypothesis (EMH). In other words, past exchange rates cannot be used to predict future exchange rates.

When the foreign exchange market is weak-form efficient, its exchange rates reflect all the information available in the past exchange rates or returns. In addition, the results also showed that one currency cannot, to a certain degree, be used to predict another, which implies that, in addition to the weak form efficiency, the Namibia foreign exchange market is also consistent with the semi-strong form EMH. The semi-strong form has prices of financial assets instantly reflecting publicly available information.

These findings are interestingly different from what was expected for a small open Sub-Saharan African economy with highly concentrated export sectors such as Namibia's; often associated with shallow and underdeveloped financial markets typified by absence of forward markets, and low levels of foreign exchange reserves (Aron, 1997). These findings

are also consistent with those by Aron (1997) on the efficiency of the South African foreign exchange market. They are also supported by Mlambo and Biekpi (2007). One can therefore safely conclude that the weak-form efficiency on the Namibian foreign exchange market is attributable to its correlation with the JSE (in that most stock listed on the Namibian Stock Exchange (NSX) are dual-listed on the Johannesburg Stock Exchange (JSE)) which was also found to be efficient in its weak form and the fact that the Namibian dollar is pegged (one-to-one) to the South African Rand through the CMA arrangement (Mlambo & Biekpi, 2007).

On the other hand, the findings appear to be as expected in light of tight exchange controls and imperfect capital markets in Namibia which leaves little room for speculation in its financial markets. Further, prospective researchers can corroborate the results of this study by subjecting it to other econometric techniques and potentially also examine the strong-form of the EMH in Namibia.

5.2 Policy Implications

The efficiency or lack of efficiency, of a foreign exchange market has policy implications of enormous importance (Wickremasinghe, 2005). If a foreign exchange market is inefficient, a model that best predicts movements in the exchange rates can be developed, thus, providing opportunities for profitable foreign exchange transactions. Moreover, in an inefficient market, the regulatory authorities can determine the best way to influence exchange rates, thereby reducing excess volatility and also assess the implications of various economic policies. The findings of this paper have important implications for policy makers and market participants in the foreign exchange market of Namibia as of any

country. They show that the Namibian foreign exchange market is efficient for the period investigated. A foreign exchange market that is efficient, as is the case with the Namibian foreign exchange market, needs minimal intervention by the authority as the exchange rates are not predictable and its participants cannot devise any trading rules or techniques to make abnormal gains from foreign exchange transactions persistently. Generally, the findings appear to be as expected in light of relatively tight exchange controls and imperfect capital markets in Namibia as well as its strong linkages to the well developed South African financial markets, thus leaving little room for speculation. Further, prospective researchers can corroborate the results of this study by subjecting it to other econometric techniques and potentially also examine the strong-form of the EMH in Namibia. An efficient market also provides certainty in terms of the exchange rate movements and thus contributes to investors' confidence and improves trade and investment in the Namibian economy. However, as stated by Mlambo and Biekpe (2007) Namibia would need to develop its financial markets that would create investment opportunities in order to retain funds in the country (reduce capital outflows) and address the issue of thin-trading, for it to optimally realize full benefits that come along with an efficient foreign exchange market.

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