

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
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COLLEGE OF HUMANITIES & SOCIAL SCIENCES

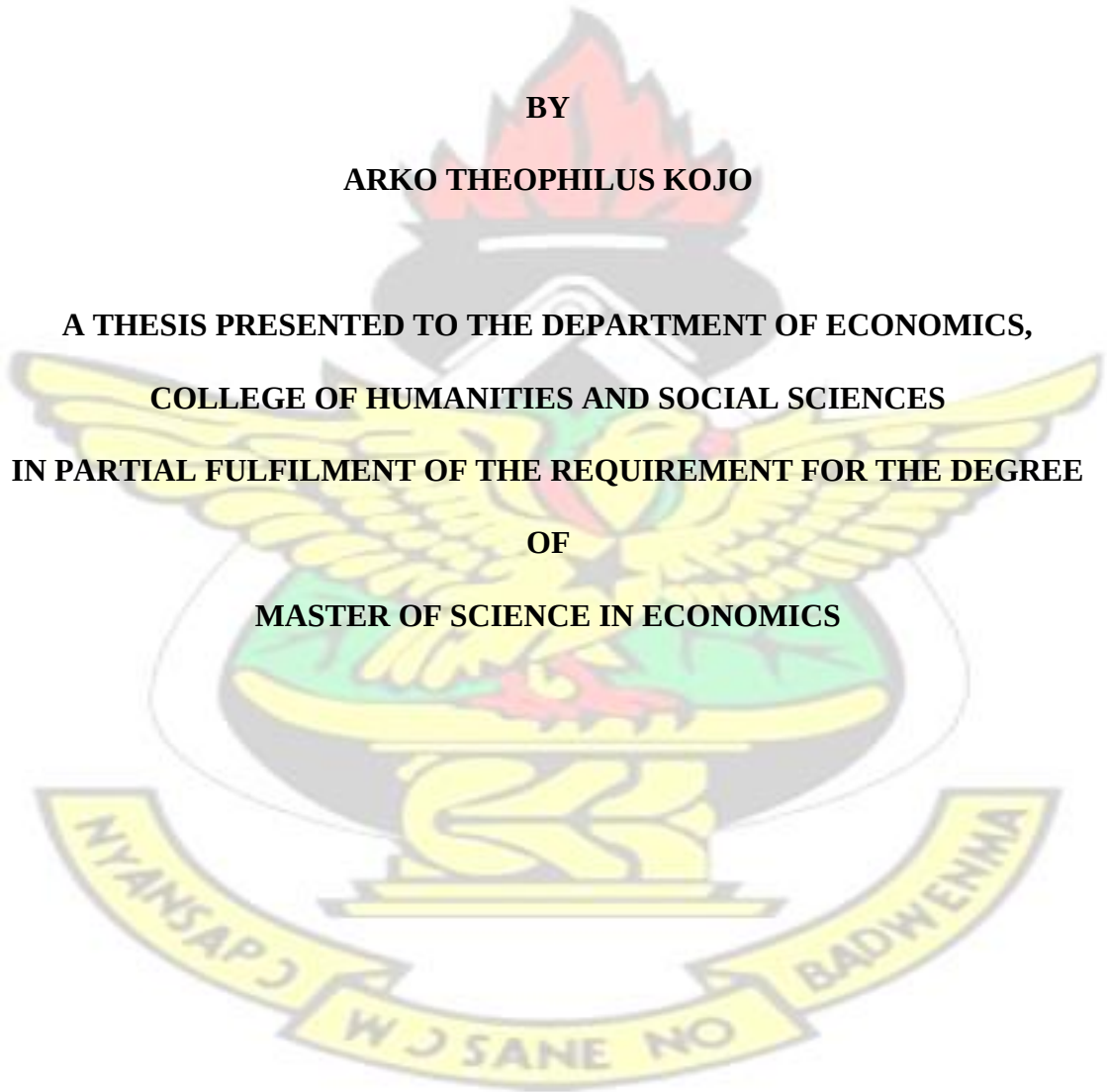
DEPARTMENT OF ECONOMICS

**ASSESSING THE DETERMINANTS OF EXCHANGE RATE BEHAVIOUR
IN GHANA**

BY

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**A THESIS PRESENTED TO THE DEPARTMENT OF ECONOMICS,
COLLEGE OF HUMANITIES AND SOCIAL SCIENCES
IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE
OF
MASTER OF SCIENCE IN ECONOMICS**



MAY, 2016.

DECLARATION

I hereby declare that this submission is my own work towards the degree of Master of Science (Economics) and that, to the best of my knowledge; it contains no material previously published by another person, nor material which has been accepted for the award of any other degree of the University, except where acknowledgement has been made in the text.

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ABSTRACT

The study sought to investigate the determinants of exchange rate behavior in the economy by specifically assessing the short run and long run impact of inflation, interest rate and real GDP on nominal exchange rate, using the Autoregressive Distributed Lag (ARDL) model on time series dataset on quarterly series from 1970Q1 to 2012Q4.

The study found that inflation did not have any significant impact on the behavior of the exchange rate in both the short run and long run. Money supply and the real GDP on the other hand, were significant in the behavior of exchange rate both in the long run and short run. Interest rate was significant in the short run but not in the long run. While interest rate was significant just in the short term but did not matter in the long run. The study found that an increase in money supply causes appreciation of the cedi in the short term but gradually lead to depreciation in the long run. While the real GDP causes depreciation in the short run but eventually causes appreciation of the cedi in the long run. Money supply becomes a crucial target in the long run but real GDP is crucial in the short run when it comes to stabilization of the domestic currency. The study also found that, the change in the exchange rate regime from the fixed to the floating did not have significant impact on the trends in the domestic currency.

DEDICATION

I dedicate this project to GOD ALMIGHTY, for favoring me with wisdom to apply the knowledge and understanding he has bestowed on me.



ACKNOWLEDGEMENT

Even though the research is based largely on the result of my field work and research, I have obtained a great deal of guidance from a wide range of personalities, books and publication, the sources of which are acknowledged in the text.

First and foremost, I express my gratitude to God Almighty for giving me the strength to embark on and to complete this thesis. Appreciation and gratitude is also given to my supervisor, Prof. Joseph Ohene-Manu for his supervision coupled with his constructive criticisms, going a long way to bring this study into shape.

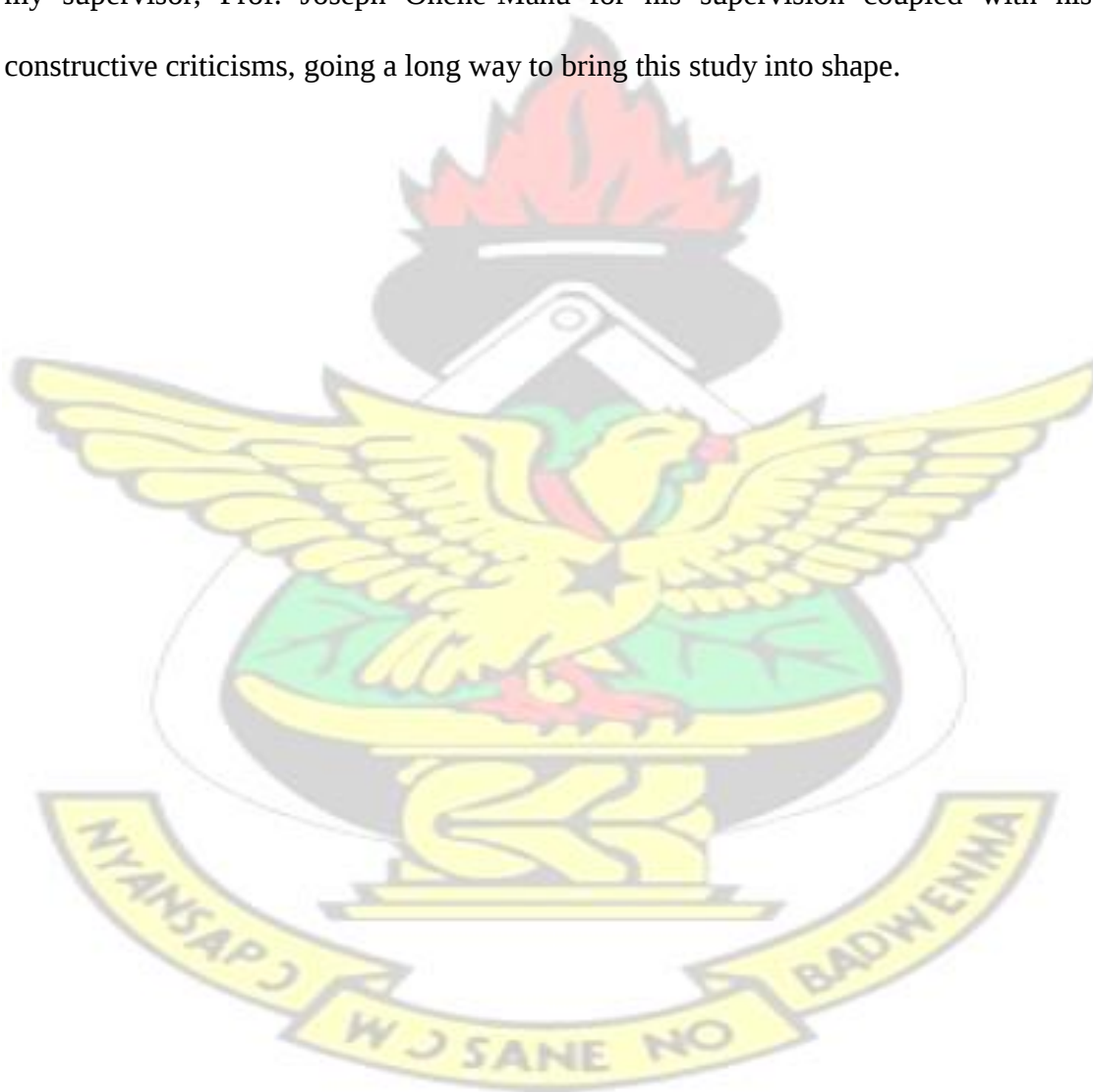


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CHAPTER ONE

INTRODUCTION

1.0 Background to the Study

One of the most important responsibilities of every government is fostering a healthy economy, which benefits all its citizens. It is the duty of all governments to promote efficient management of economic variables in the economy. Monetary authorities and governments however, implement policies to ultimately achieve some macroeconomic goals such as price stability, economic growth, high level of employment, interest rate stability, Balance of payment equilibrium, and promotion of a more stable financial institution among others (Handa, 2009).

One very crucial macroeconomic indicator which is of great concern to all governments and monetary authorities is the exchange rate. The exchange rate is the price of the currency in terms of another currency. It is the value of a foreign nation currency in terms of the home nation's currency. Aside it being a relative price of one currency in terms of another, it connects domestic and foreign markets for goods and assets and as such, signals the international competitiveness of a country in the global economy. The issue of exchange rate fluctuations has become more imperative especially for countries that depend heavily on importation of essential commodities such as crude oil and raw materials for industrial production because of its effects on economic growth. With the heavily dependence on imports given the foreign prices of these products, a rise in the exchange rate may result in higher prices for domestic consumers.

The Ghanaian economy has over the years adopted various exchange rate regimes just like several other countries; from a fixed exchange rate regime to periods where the exchange rates were determined by market forces. For most of the period, the fixed exchange rate regimes failed essentially due to the break down in fiscal and monetary

discipline. This situation led to high inflation, a shortage of foreign currency, imposition of exchange controls, and the emergence of a vibrant black market for foreign currency.

In periods prior to the implementation of the Economic Recovery program (ERP), the exchange rate regime in Ghana could be likened to the Bretton Woods system of exchange rate; where countries could define their currencies relative to gold or the dollar, so that those currencies will be at par with each other. So in cases where Ghana was facing Balance of Payment deficits (BOP), the government could solve the problem by using its foreign reserves. But should the BOP deficit persist, Ghana would have to devalue the cedi only with the approval of the International Monetary Fund (IMF).

This was evident when Ghana had its first devaluation in 1967 by the National Liberation Council (NLC) military government after the overthrow of Dr. Nkrumah. The reason for the devaluation was as a result of the worsening economic condition after the coup in 1966. However, the cedi was further devalued by 44% in 1971 by the Busia led administration (Jebuni et al, 1991).

In 1972 the cedi was revalued after the cedi appreciated about 25% but the cedi was devalued again in 1978. In 1973 through to 1978, the real exchange rate appreciated and this appreciation according to Harrigan and Oduro (2000) was attributed largely to government deficit and inflation.

In 1978 Ghana mimicked the flexible exchange rate regime, so that the exchange rate could adjust to reflect the true economic happenings in the country. But it could not stand the test of time as it was later abandoned before the end of 1978 and the cedi was eventually pegged to the dollar again. The cedi however appreciated from 1979 through to 1982 (Dordunoo, 1994).

Ghana moved away from the fixed exchange rate regime towards a floating (market determined) regime during the era of the Structural Adjustment Program (SAP) and ERP from 1983. Indeed, one of the most important reforms of the SAP was to allow a gradual liberalization of the market for foreign exchange. To bridge the gap between black market and official exchange rates, foreign exchange bureaus were established in February 1988, leading to the virtual absorption of the foreign exchange black market. The cedi exchange rate therefore became market determined with an increase in demand for foreign currency resulting in depreciation, while the increase in supply of foreign currency resulted in the appreciation of the cedi, other things being equal.

In recent times, the Ghana Cedi has performed poorly amidst demand pressures from official sources, largely for oil imports, amid inadequate foreign exchange supply on the market. In the Inter-Bank Market, the Ghana Cedi, over a nine month period in 2014, depreciated by 31.19% against the US dollar, compared to a depreciation of 4.12% recorded during the corresponding period in 2013 (GoG Budget statement, 2015).

Exchange rate volatility can be attributed to economic, political and psychological reasons either in the short or long run. The fact that macroeconomic variables were important in determining exchange rates was made evident in 2008 when the Cedi depreciated by 24.7% against the US Dollar. This was associated with a substantial growth in government expenditure of about 42% (Jebuni et al, 1991).

1.1 Statement of problem

Changes in exchange rate have pervasive effects, with consequences for prices, wages, interest rates, production levels, and employment opportunities.

Notwithstanding, some periods of stability, the cedi has been persistently declining in value since independence. Over the last three decades, the cedi has lost about 99.9841% of its value against the US dollar (Bawumia, 2014).

In 1983 the exchange rate was ₵52.6 per dollar, it rose to ₵520.8 per dollar in 1992 and by 2000, the exchange rate was ₵7,047 per dollar. By 2008, the exchange rate escalated to GH₵1.19 (₵11,900) per dollar. This is attributed to redenomination of the cedi in 2007. In December 2013, the exchange rate had reached GH₵2.20 (₵22,000) per dollar. For the entire period of 2014, the cedi depreciated by 31.2%, making it the worst performing currency in 2014. The currency depreciation led to substantial contraction of imports and narrowing in the currency account deficit which nonetheless ended at 9.2 percent of GDP in 2014 (IFS, 2014).

The rate of depreciation of the cedi against the US dollar in 2014 has been at an unusually fast pace. The cumulative depreciation in 2013 was 14.5%. In the first quarter of 2015, the cedi has already depreciated by 16%. This trend is worrying for a small open economy like Ghana, because these massive depreciations in the currency end up increasing the cost of living and the cost of doing business.

Cedi depreciation raises the domestic currency value of foreign currency debt and debt service burden in view of the fact that domestic revenues are in domestic currency. For instance, between 2013 to 2014 financial year, as a result of depreciation of the exchange rate, Ghana's debt increased by US\$33 billion. Debt service payments on government and government guaranteed external debt, made through the Bank of Ghana amounted to US\$213.8 million for the fourth quarter of 2014, compared with US\$173.8 million paid in the previous quarter. Obviously, an increased exchange rate goes to increase the quantum of debt payments since these debts are denominated in foreign currency (IIAS, 2015).

Exchange rate is one of the drivers of inflation in Ghana. This is because of the country's high dependency on imports. There is high demand for imports and consumption of finished goods and therefore fluctuations in the exchange rate have a significant impact on domestic inflation. Such a situation does not only raise the cedi prices of final goods through imports of such goods but also increase cedi costs of imported inputs as alluded in the 2015 Budget Statement. This tends to make local firms less competitive and sometimes running into financial distress. Indeed, economic agents are often caught in a web of speculation in a rapidly depreciating exchange rate period with adverse effect on investments and economic growth.

Managers of financial institutions are concerned with foreign exchange rates, because these rates affect the value of assets on their balance sheet that are denominated in foreign currencies. In addition, financial institutions often engage in trading foreign exchange, both for their own account and for their customers. Fluctuations in exchange rate tends to increase the riskiness of their investments. Forecasts of future foreign exchange rate can thus have a big impact on the profits that financial institutions make on their foreign exchange trading operations.

High exchange rate pressures resulted into increases in utility tariffs and transport costs especially in the first quarter of 2015. Exchange rate is a key component for the pricing of utilities and petroleum products and this explains why there are increases in the prices of petroleum products using the automatic adjustments formula, when the cedi depreciates, even when there are no corresponding increases in the world market prices of crude oil.

Most firms in Ghana face a higher degree of uncertainty, given that exchange rate fluctuations limit firm's ability to estimate their future cost and profit streams. For instance, businesses (based on exchange rate) set out the amount of money to be

committed into acquiring raw materials and equipment/machines from abroad, in addition to their future stream of income. Instability in the exchange rate may distort the realization of such estimates. For instance, exchange rate depreciation results in high cost of production and reduces the profits of the firms importing these items. In order to cushion the effects, they also pass on to consumers in a form of high prices. Besides, production will decline and unemployment will rise. Couple with these, are reduction in exports, accumulation of trade deficits and deterioration of balance of payments, as well as decline in the welfare of the people.

Though exchange rate fluctuations are most often associated with economic mismanagement, fiscal indiscipline and macroeconomic instability, very little efforts has been made to investigate these assertions empirically.

Therefore, given the challenges, assessing the determinants of exchange rate movement has become imperative in facilitating the design of appropriate policies and programs by government to address its negative effects.

1.2 Objectives of the Study

The main objective of the study is to identify the determinants of exchange rate behavior in Ghana from 1970-2012. The study endeavored to achieve the main objective following these specific objectives:

- i. To examine the trend in exchange rate, inflation, money supply, interest rate and output from 1970 to 2012.
- ii. To investigate empirically the short run and long run effects of inflation, money supply, interest rate and output on exchange rate trends in the Ghanaian economy.
- iii. To compare inflation, money supply, interest rate, output effects on exchange rate before and after the flexible exchange rate regime.

1.3 Hypothesis Testing

To achieve the above stated objectives the study tested the following hypothesis

- i. Inflation has no effect on the rate of exchange.
- ii. Money supply innovations do not influence the exchange rate.
- iii. Changes in output do not impact the rate of exchange.
- iv. Interest rates do not influence the exchange rate.
- v. Parametric equality or otherwise for the before and after flexible exchange rate regime do not affect the rate of nominal exchange rate.

1.4 Scope of the study

The foreign exchange rate is not only broad but also complex area as far as the Ghanaian economy is concerned. There are a lot of foreign currencies used in the country, each of which has an impact on the exchange rate determination in the economy. But because of limited time, space and resources, the study will be limited to the major trading currency of US dollar used in the determination of the exchange rate by the Bank of Ghana. The study used quarterly time series data on the nominal exchange rate, return on the 91-day Treasury bill as a measure of interest rate, real GDP, broad money supply and inflation from 1970 to 2012.

1.5 Significance of the study

In private sector-led market-oriented economies such as ours, the behavior of key macroeconomic variables such as the exchange rate is of critical importance. In the face of uncertainty, stakeholders (private enterprises, central Bank, MDAs, financial institutions, investors etc) are challenged in taking critical decisions that eventually inure substantial benefits to them thereby compelling them to take “a wait and see” posture in their investment and regulatory decisions. This behavior and attitude of

stakeholders eventually cost them to lose a huge amount of wealth which could have been easily avoided. This is as a result of the limited empirical knowledge of the behavior of exchange rate in Ghana.

1.6 Methodology

To achieve the objectives of the study, it employed secondary time series data analysis. Specifically, the study used Autoregressive Distributed Lags methodology to identify the relationship between exchange rate and other macroeconomic variables for the period between 1970 – 2012. Through this exercise, the result can tell which macroeconomic variables really influence exchange rates in the Ghanaian economy and the variables which do not matter. Data used in the analysis was obtained from the Bank of Ghana and Institute of Fiscal Studies. The study employed quarterly data on nominal exchange rate, Inflation, Interest rate, Money supply and output.

1.7 Organization of the study

The research work covers five chapters. The first chapter introduces the study and it contains the background of the study, statement of the problem, research objectives and methodology, statement of hypotheses, scope and significance of the study. Chapter two contains review of relevant literature, both theoretical and empirical that underpins the exchange rate determination and the possible influence it has on the economy. Chapter three presents the methodology employed in the study including the model specification and source of the data used. The fourth chapter presents the statistical analysis of the results and findings of the study. The conclusions and recommendations drawn from the research are presented in the final chapter of the work.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents existing literatures related to the study. The chapter is divided into two main sections. The first section provides the theoretical background of the study and economic theories related to the paper. The second section presents the empirical review which identifies varied works done by scholars related to the paper.

2.1 Theoretical Review of the Exchange rate

Several views have evolved on the determination of exchange rate over the years. Brief presentations of the exchange rate regimes are reviewed. And notable theories such as the purchasing power parity, the monetary approach to exchange rate, the portfolio balance approach are considered in the study.

2.1.1 Fixed exchange rate regime

The fixed exchange rate can be described as a situation whereby a country pegs or fixes its domestic currency to either another currency or an item which is used as a measure of value such as gold. The fixed exchange rate regime can be divided into two periods; the gold standard and the Bretton woods system.

Countries followed the Gold standard in the periods between the 1879 and 1934 with the exception of the World War 1 period. Salvatore (1995) noted that, an economy can be described as implementing this system of exchange rate if the country defined its domestic currency in terms of certain quantity of gold. The country, in addition is required to maintain a fixed relationship between its accumulation of gold and domestic currency. And the country must encourage free movement of gold in and out of the country. Countries define their currencies in terms of gold to enable the currencies have a constant relationship among themselves.

Bretton woods system as another form of the fixed exchange rate regime came into play after the great depression and World War II when it became necessary to introduce a new monetary system because international trade was in disarray (Brue and McConnell, 1996). The Bretton Woods system was an adjustable system of exchange rate where countries define their currencies in terms of either gold or dollars. And this however establishes a par rate of exchange for countries. The International Monetary Fund (IMF) was introduced to supervise the system. Countries were expected to keep a stable rate of exchange with a one percent band (+/-). Countries with temporary balance of payment issues could either fall on their reserves or borrow from the IMF to salvage the situation. However, if the balance of payment persist, the country's currency devalue or revalue (depending on the issue at hand) but only with approval from the IMF (Salvatore, 1995).

Because the dollar was considered as a substitute for gold the Bretton wood system collapsed in 1971 after President Nixon, the then US president suspended the convertibility of dollars into gold (Brue and McConnell, 1996).

2.1.2 Flexible exchange rate regime

Flexible exchange rate regimes came into play when the Bretton Woods system collapsed. Under this regime the rate of exchange is allowed to be determined by supply and demand forces. Thus the rate of exchange adjusts automatically to changes in the foreign exchange market operations. However, Central bank may intervene in the foreign exchange market in attempt to influence the level of the exchange rate. They either buy or sell domestic currency to influence its prices in periods of balance of payment difficulties (Dutttagupta et al, 2005).

2.1.3 The Purchasing Power Parity (PPP)

According to Frenkel (1976, 1981), the PPP in absolute version states that “the equilibrium exchange rate between the domestic currency and foreign currencies is the ratio of domestic price to foreign prices. It thus shows the amount of the domestic currency that will be converted into foreign currencies to buy the same amount of goods in each economy. In other words, it shows that when all currencies are expressed in a common unit, it should be able to buy the same amount of goods and services.

The PPP can be expressed as;

$$P_t = \epsilon_t P_t^* \quad 2.1$$

Where, P_t represents the price in domestic currency, ϵ_t is the nominal exchange rate between the domestic currency and foreign currency and P_t^* is the foreign price at period t .

Equation 2.1 shows the Law of One Price, which proves that prices across different countries should be the same when expressed in a common currency. The above equation can be modified into three versions of the PPP.

Making the nominal exchange rate the subject gives

$$\epsilon_t = \frac{P_t}{P_t^*} \quad 2.2$$

The nominal exchange rate in the above equation is expressed as the ratio of domestic currency to the foreign currency. We then multiply equation 2.2 by a constant, say K .

The equation now becomes

$$\frac{P_t}{P_t^*} = K \quad (2.3)$$

From equation 2.3, if K equals to one, then it is defined as the absolute version of the PPP. However, if K is either less than or greater than one then that defines the relative version of the PPP. Because of differences in the way variables are constructed across countries Patterson (2000) opined the possibility of absolute PPP may be ruled out.

We therefore modify equation 2.3 by taking the natural logarithm of both sides

$$\ln \left(\frac{P_t}{P_t^*} \right) = \ln K \quad (2.4)$$

Taking the total differential of equation 2.4 gives

$$d \ln \left(\frac{P_t}{P_t^*} \right) = d \ln P_t - d \ln P_t^* \quad (2.5)$$

The total differential of a constant is zero, hence $d \ln K$ equals to zero. From equation 2.5, we can find the growth rate of the nominal exchange rate. This is because the differential of a natural logarithm is an indication of the growth rate. Therefore equation 2.5 can be rewritten as

$$\tilde{\pi}_t = \tilde{P}_t - \tilde{P}_t^* \quad (2.6)$$

Where $\tilde{\pi}_t$ is the rate of depreciation of the nominal exchange rate and $\tilde{P}_t$ and $\tilde{P}_t^*$ represents domestic inflation and foreign inflation respectively.

Patterson (2000) defines equation 2.6 as the relative purchasing power parity. From the equation, an increase in domestic prices (inflation) relative to foreign prices will cause depreciation in the domestic currency (the exchange rate goes up). But if foreign

inflation increases relative to domestic inflation, it will lead to an appreciation of the domestic currency (the exchange rate goes down). It proved that changes in the exchange rate are as a result of variability in prices.

2.1.4 The Monetary Approaches to Exchange rate

The monetary approach is considered one of the oldest approaches in exchange rate determination. It has over the years served as a benchmark to which the other approaches to exchange rate determination are compared to. This approach considers extensively the domestic and foreign money supply and money demand. The model includes the flexible price approach put forward by Frankel (1976) and the sticky price approach by Dornbusch (1976). The basic model assumes a simple demand curve for exchange rate and the purchasing power parity rule holds. It also assumes a vertical exchange rate which implies flexible prices.

Based on the absolute purchasing power parity rule;

$$P = \epsilon P^* \quad 2.7$$

Where P denotes the domestic currency, ϵ denotes the exchange rate and P^* denotes foreign currency. Equation 2.7 shows that the domestic currency equals to the product of the exchange rate and the foreign price

Also the money demand function is expressed as

$$M^d = fPy \quad 2.8$$

Where f is a constant, M^d is money demand, y is the real level of income in the economy and P is the domestic price.

In equilibrium money demand equal to money supply. Therefore

$$M_d = M_s$$

Therefore equation 2.8 can be transformed to

$$fPy \propto M^s \quad 2.9$$

Making P the subject of equation 2.9 gives

$$P \propto \frac{M^s}{fy} \quad 2.10$$

From equation 2.7, equation 2.10 can be rewritten as

$$\frac{P}{P^*} \propto \frac{M^s}{fy} \quad 2.11$$

$$\frac{P}{P^*} \propto \frac{M^s}{fy} \quad 2.12$$

$$\frac{P}{P^*} \propto \frac{M^s}{fy} \quad 2.13$$

Equation 2.13 shows that the exchange rate in the economy is directly related to money supply but inversely related to foreign price and the level of real output in the economy. It also shows the external equilibrium attained by the economy. If we assume P^* and y are constant (P^* is constant because foreign prices cannot be influenced by the domestic economy and y is constant because we assume output is at full level employment), increases in M^s leads to increase demand for goods and services. Because output is fixed, the increased demand will push prices up which might eventually lead to the depreciation of the domestic currency.

In a situation where foreign prices increases coupled with the increased demand for domestic goods, it results in balance of payment surplus. The surplus in the face of

increase in money supply will result in increases in domestic prices and makes the economy more competitive in the international market.

2.1.5. Portfolio Balance Approach

The portfolio balance approach is usually attributed to Mckinnon (1969). It is based on the idea that agents in the economy can hold portfolio of assets from the domestic economy or from foreign economies. The assets can be held in the form of money which does not yield interest but facilitates the purchase of goods or bonds which is expected to yield some form of returns.

The portfolio balanced approach determines the equilibrium exchange rate, the domestic and international rate of interest that clears the domestic bond, money and foreign bond markets. The short run variation in the exchange rate according to this approach is determined by the expectations of future returns on the various forms of holding money (Carbaugh 2002).

The desire to hold some wealth in the form of money (domestic currency) even though it does not yield any form of return is because it is risk free and facilitates easy transactions of goods and services. The opportunity cost of money, however, is the interest forgone that could have been earned if wealth were held in securities. The opportunity cost also increases as the interest on those securities increases. An increase in the interest rate on either domestic and foreign bonds will mean a reduction in the portion of assets held in the form of money but an increase in the portion held in the form of bonds.

Also the desire to hold some portion of wealth in the form of bonds depends on the expected return. If the interest on domestic bonds is rising, the demand for domestic bonds will rise relative to the demand for money and foreign bonds. To maintain a balanced portfolio requires disposing of foreign bonds (reduction in the foreign bonds).

This will mean the supply of foreign bonds will increase, which increases the supply of foreign currency in the domestic economy. The increased foreign currency will cause the exchange rate to fall.

Similarly, when the interest on foreign bonds increases, the demand for foreign bonds will increase. People will desire to hold a greater portion of their wealth in the form of foreign bonds. This will imply an increase in the demand for foreign currency. The increased demand for foreign currencies will cause the exchange rate to rise.

The portfolio balanced approach shows that expectations about returns based on interest rate changes on either domestic or foreign bonds causes economic agents to readjust their portfolio of assets. And this action eventually causes the exchange rate to vary.

2.2 Empirical Review

Influential writers have broadened the knowledge base about the possible causes of currency depreciation and appreciation both in developing and developed countries and test for the validity of the various theories that attempt to explain the determinants of exchange rate.

2.2.1 International Literatures on Exchange rate

Earlier writers such as Frenkel (1981) investigated the validity of the Purchasing Power Parity (PPP) in four countries; Germany, UK, US and France. The study employed the two stages least squares technique using monthly data. The study first considered the PPP doctrine during the 1920s which had flexible exchange rates and further studied the PPP during the 1970s with floating exchange rates. The first study showed that the PPP doctrine holds during the 1920s for the four countries in question but same cannot be said during the 1970s. This is because in the 1970s the world market has become more integrated. And exchange rate variations were extensive during the period.

Corbea and Ouliaris (1988) further tested the validity of the PPP using co-integration technique. The study employed monthly data on Canada, France, Germany, UK, US, Italy and Japan for the period July 1973 to September 1986. For the PPP hypothesis to be true, deviations from linear combination of the spot exchange rate and domestic and foreign price levels should be stationary. However, the co-integration results showed that five of the exchange rates contained unit root proving that the deviations in the PPP is not likely to converge to equilibrium path therefore the assumption of the PPP might not hold in the long run.

Ndung'u (1997) did a study on the relationship between exchange rate and inflation in Kenya. The study employed a multivariate co-integration test using quarterly time series data from the period 1970 to 1993. Evidence on the study proved bilateral causality between inflation and exchange rate. The study proved that world prices predicts exchange rate changes but does not predict changes in domestic prices.

Barung (1997) also employed the Engle-Granger two step procedure in analyzing the interrelationship between exchange rate and inflation in Uganda. The study found out that devaluation of the domestic currency has an indirect impact on prices through its effects on exchange rate.

MacDonald (1993) investigated the PPP model of exchange rate determination using the multivariate co-integration technique following Johansen (1988). The study employed wholesale price index and consumer price index as proxies for price levels on the currencies of Canada, U.S., France, Germany, Japan and U.K, with monthly data spanning from January 1974 to June 1990. The study used a VAR methodology and it proved a strong evidence for relative PPP and thus the long nominal exchange rate is linked to prices.

On the examination of the macroeconomic variables on the exchange rate trends, Branson 1981 examined the macroeconomic variables that determines exchange rate for four countries; U.K., U.S, Germany and Japan. The study employed the VAR methodology using quarterly time series data on effective exchange rate, relative prices, money and the current account from the fourth quarter of 1973 to the fourth quarter of 1981. The study found out that real exchange rates adjust to real disturbances in the current account.

Eichenbaum and Evans (1995) also did a study on how monetary policy shocks impacts the exchange rate. The paper employed the VAR methodology with five currencies in relation to the U.S. dollar; Japanese yen, German mark, French Franc, British pound and the Italia lira for monthly data spanning between 1974 and 1990.

The study included the variables based on the flexible monetary model of exchange. The study found that contractionary monetary policy are usually followed by persistent rise in the U.S. interest rate which results in the appreciation of the nominal and real exchange rates.

Oriavwote and Oyovwi (2012) examined the determinants of exchange rate in the Nigerian economy. The study used time series data on real effective exchange rates, nominal exchange rates, prices, ratio of capital flow to GDP, degree of openness, government spending, real GDP terms of trade and technological progress from 1970 to 2010. The study employed the error correction model (ECM). The result revealed that capital flow, price level and nominal effective exchange rate proves to be unimportant determinants of exchange rate in Nigeria. However, the result from the ECM shows that increase in prices, capital flow and trade openness leads to appreciation of the domestic currency but increases in the nominal exchange rate and output depreciates the naira. The Johansen co-integration test also proved the existence of a long run relationship among the variable.

2.2.2 Literature on Ghana's Exchange rate Determinants

Mumuni and Owusu Afriyie (2004) investigated the major determinants of the cedi/dollar exchange rate in Ghana after the adoption of the floating exchange rate regime with monthly data from December 1992 to November 2003. Using the cointegration technique, the paper included political variables to identify how it also influences exchange rate. The study found out that speculation about past behaviors of the cedi/dollar is a very key determinant of exchange rate in Ghana and this can be attributed extensively to the underdeveloped nature of the exchange rate market and the financial institution. The paper proved that macroeconomic fundamentals are very crucial in the exchange rate dynamics.

Akosah (2014) studied the volatility and asymmetric effects of the dollar/cedi exchange rate. The study made use of the GARCH family models and identified the macroeconomic implications of uncertainties. The study showed that asymmetric and leverage effects exerts greater and persistent effects on exchange rate and negative innovations has greater destabilizing effects on the volatility of the exchange rate than positive innovations. The study reveals that exchange rate volatility has reduced during the period of the Highly Indebted Poor Countries Initiative but had subsequently increased after the adaptation of the Inflation targeting framework in Ghana. And interest rate has shown to have a dampening pass-through effect on exchange rate to inflation.

Bhasin (2004) studied the relationship among exchange rate, prices and the terms of trade using the VAR framework, the study proved the existence of a stable long run relationship among nominal exchange rate, prices, terms of trade of cocoa, bank rate, domestic credit and foreign exchange reserves.

Iossifov and Loukoianova (2007) estimated the behavioral equilibrium exchange rate model for the real effective exchange rate of the Ghanaian cedi. The study made use of quarterly data from 1984 to 2006. Using the unconstrained VAR the study found out that, GDP at Purchasing Power parity per capita relative to Ghana's trading partners, real interest rate differential with the trading partners and the weighted Average of real world prices of Ghana's main export commodities are the fundamental determinants of the real effective exchange rate of the cedi.

Sackey (2001) employed co-integration to identify the determinants of exchange rate in the Ghanaian economy. The study used the terms of trade, real net official development assistance to Ghana as a proxy for external aid inflows, government consumption in GDP and technological progress. The study used annual time series data from 1962 to 1996. The study found out that increased aid inflows has the tendency to lead to depreciation of the real exchange rate.

Edwards (1988) studied the dynamics in the behavior of exchange rates in 12 developing countries assuming a three commodity economy; exports, imports and non-tradable. The study was analyzed with pooled data on the 12 countries from 1960 to 1985. The study rejected the hypothesis that the absolute version of the PPP holds.

Yemidi (2010) also investigated the variables that contribute to the changes in the exchange rate in the Ghanaian economy. The main objective of the study was to investigate the effects of the past history of nominal GDP, prices, imports, exchange rate and government on the short run movement of exchange rate. The study made use of quarterly time series data from 1985 to 2008. The study proved a long run and significant relationship among the variables. And that Government spending has proved to be significant in predicting the changes in the exchange rates. The study

recommended government expenditure needs to be controlled to influence the impact it has on the rate of exchange in the long run.

The above empirical literature attests to the fact that the volatility in the exchange rate trend in Ghana is at least influenced by the rate of inflation, monetary expansion, interest rate and the total output in the economy irrespective of the regime whether floating or fixed.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

In this chapter, the econometric techniques are succinctly stated with the aim of achieving the stated objective and hypothesis in chapter one. The chapter is organized into three sections. Section 3.2 presents a discussion on model specification, justification of the included regressors and a priori expectations on the signs and magnitudes of the coefficients to be estimated. Section 3.3 describes the data, variable measurements and sources of data. Finally, Section 3.4 presents the details of the estimation strategy adopted to ensure the robustness of results. In particular, discussions on the need to test for the presence of (or otherwise) unit roots in the data series as well as joint stationarity (co-integrating relationship) among the variables in a given equation are presented.

3.1 Model Specification

In theory, the determination of the impact of independent variables on a dependent variable is given by;

$$y = f(x_{it}) \quad (3.1)$$

where y is the dependent variable while x_{it} is a representation of all independent variables under observation.

In the study, determinants of exchange rate are as a result of changes in the rates of inflation, interest rates, money supply and the gross domestic product. The decision to focus on these variables as our regressants which affect exchange rate is justified following the Monetary and Purchasing Power Parity (PPP) approach to exchange rate which emphasize the fact the exchange rate changes with respect to price differentials among countries but not constant in output.

Given our regressor and regressants, the regression for the study can be specified as;

$$EXR_t = f(INF_t, IR_t, MS_t, GDP_t) \quad (3.2)$$

where EXR_t = the nominal exchange rate, INF_t = Inflation at time t , IR_t = interest rate at time t , MS_t = Money supply at time t and GDP_t = Gross domestic Product at time t .

Exchange rate, Gross domestic product, Inflation, Money supply and Interest rate can be rewritten econometrically as;

$$\ln EXR_t = \alpha_0 + \alpha_1 \ln INF_t + \alpha_2 \ln IR_t + \alpha_3 \ln MS_t + \alpha_4 \ln GDP_t \quad (3.3)$$

Where α_0 is the intercept while $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ are the coefficients of inflation, interest rate, money supply and government expenditure respectively.

The model is specified in the log form to ensure the elimination of possible large coefficient and the interpretation of the coefficients as elasticities. Elasticities are of significance as it would bring to bear the actual response of exchange rate to changes

in the rate of inflation, interest rates, monetary expansion and the gross domestic product at any point in time.

3.1.1 A Priori Expectation of inflation and exchange rate

It is expected per the study that changes in rates of inflation would positively affect the volatility in exchange rate. Thus, an increase in the general prices of goods and services would cause the nominal exchange rate to also rise, the inverse is also true. This is justified by the fact that increases in prices would cause domestic goods and services to be more expensive relative to foreign goods. This would cause consumers to demand relatively lower good thus increasing the amount of imports which would affect the amount of domestic currency needed to exchange the foreign currency. This would cause the nominal exchange rate to soar, thus, the depreciation of the cedi.

3.1.2 A Priori Expectation of Interest rate and Exchange rate

The researcher predicts a negative relationship between interest rate and the nominal exchange rate. Since rate of return on investments in domestic currency is the measure of our interest rate, an increase in the interest rate is expected to increase the domestic investment relative to foreign investments. This would put foreign investment at a competitive end leading to the decline in the foreign investment in the long run, thus, a reduction in the nominal exchange rate is an indication of appreciation of the cedi.

3.1.3 A Priori Expectation of Money Supply and Exchange rate

Furthermore, monetary expansion would lead to more money in hands of the consumers, the scenario where more money tend to chase fewer goods. This would result in the increasing inflation due to shortage of goods and services. Inflation indirectly would cause the depreciation of the domestic currency through increased imports. Thus money supply is expected to move in the same direction as the nominal exchange rate.

3.1.4 A Priori Expectation of Real Gross Domestic Product and Exchange rate

Also, it is projected that the economic growth would be positively related to the nominal exchange rate. Increasing government activities, investors and individual's results in the increasing level of employment and output thus the real GDP also increases. The increasing economic growth is an indication that the individual is better off than previously was. This would result in increased demand for goods and services. Inflation is thus ensued due to shortages and thus compels consumers to look for alternative but relatively cheaper one. Demand for foreign goods increase and thus cause the depreciation of the cedi.

3.2 Data Sources and Type

The study employs quarterly time series ranging from the period 1970 -2012. These were obtained mainly from secondary sources, including Bank of Ghana (BOG), the World Development Indicators (WDI) and the international financial service (IFS) of the IMF. The choice of the sample period was based on the interest in capturing the both the fixed and flexible exchange rate system of the Ghanaian economy. Since the study attempted to empirically evaluate the long run and short run dynamics in the trends of the exchange rate, the key variables considered for the study are inflation, interest rate, money supply and gross domestic product.

3.2.1 Variable Definition

To achieve the desired results based on our stated objective and hypothesis, the following variables are thus relevant for the study;

Nominal Exchange Rate (EXR) is the official and actual quotation of a particular currency versus another foreign currency. The study attempts to use the cedi/US\$ as a measure for the exchange rate. This is because the US dollar is one of the major international trading currencies across the globe. An increase in the value of the nominal

exchange rate indicates a depreciation of the domestic currency while a fall confirms its appreciation.

Inflation (INF). Inflation is the persistent increase in the general price level of goods and services. The proxy for the measure of inflation per the study is the year on year inflation rate which is the percentage change in the consumer price index (CPI).

Interest Rate (IR) is the return that is earned by individuals on the investment in the domestic assets. The study uses the 91-day Treasury bill rate as a measure of the study's interest rate. The rise in interest rate thus makes domestic investment more attractive compared to other foreign investment, the inverse is true.

Money Supply (MS) is the specified amount of money that would be supplied at various interest rates and income levels referred to as the total money supplied in any economy (Handa, 2009). The M2+ is the proxy for the measurement of money supply in the study. The M2 is the detailed amount of M1 plus travelers cheques of nonbankers and demand deposits. The most liquid monetary base is the M1 which is the amount of money in the hands of the general public in the form of coins and notes including all savings deposits in the commercial banks.

Furthermore, the Gross Domestic Product (GDP) which measures the total amount of goods and services produced by the economy within a particular year. In this study, real GDP is used as a measure of the business cycle. Real GDP at constant prices served as the proxy in the analysis.

3.3 Estimation Strategy

3.3.1 Stationarity and Co-integration Test

In order to consistently estimate the parameters in the equation 3.4 using time series data, three steps are followed. First, the study examines the stationarity status of the

individual series in our regressions model to ensure that the estimated relationships are not spurious. Secondly, the study test for the existence of long-run equilibrium relationship among the variables in the models specified above using the ARDL/bounds test to co-integration technique.

3.3.1.1 Stationarity Test

In order to evaluate if the data are stationary or not, unit root test is required. Davydenko (2011) cited in Moussa (2012) stated in his researches that stationary is implemented to detect if the mean, variance and autocorrelation of a variable do not change with time.

The use of time series data for analysis requires the test for stationarity of the variables to determine the order of integration of each of the variables used. The order of integration test is necessary for econometric model specification in co-integration process. A number of alternative tests are available for testing whether a series is stationary or not, the Dickey-Fuller (DF), the KPSS as well as the Phillips Perron (PP) test. This study applied the Augmented Dickey-Fuller Test (ADF) to check for stationarity. Since the Phillips-Perron (PP) test attempt finding a way of handling deviations in order not to achieve white noise in the estimated model, it was applied to confirm the results of the ADF test. The PP tests are based on the following ADF regression, and the critical values are the same as those used for the DF tests since Augmented Dickey -Fuller (DF) is an extension of Dickey -Fuller test following Phillips and Perron (1988).

The Augmented Dickey -Fuller (ADF) is an extension of Dickey -Fuller test. The following equation is employed:

$$\Delta y_t = \alpha_1 y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \beta_1 t + u_t \quad (3.4)$$

where

Δ is the difference operator, $\ln$ is the natural

logarithm of the series, t is a trend variable,

α_1, α_2 and α_3 are the parameters to be estimated,

A is the vector of the estimated parameters of the lagged values of the differenced value of time series Δy_{t-i} stands for the vector of the lagged value of the differenced value of the series and u is the error term.

If the coefficient is significantly different from one, then the hypothesis that y contains a unit root is rejected. Rejection of the null hypothesis denotes stationarity in the series. If we don't reject the null hypothesis, we conclude we have a unit root. So the ADF and the PP tests are run at level and first difference with trend and intercept.

3.3.2 Co-Integration and Bounds Test

The bounds test to co-integration test incorporated in the ARDL model is an estimation procedure which is used to test the long run relationship given the fact that the time series is strictly $I(0)$ or $I(1)$ or a combination of both. It makes use of the F- and t statistics to test for the significance of the lagged variables when there is uncertainty or if the time series exhibits a trend or its stationary at first difference.

$$\Delta y_t = \alpha_0 + \sum_{i=1}^p \beta_i \Delta X_{t-i} + \sum_{j=1}^q \gamma_j \Delta Z_{t-j} + \varepsilon_t \quad (3.5)$$

From the above mentioned equation, we perform an overall F-test of the null hypothesis that there is no co-integration between the variables X and Z as against the alternative that it is not true. The rejection of the null hypothesis implies that there exist long run relationships between the variables. The ARDL bounds test gives an upper and lower boundary with which the overall F-statistic is to be compared. If the F-test is greater than the upper boundary, we reject the null hypothesis whiles an Ftest lower than the lower boundary moot for the acceptance of the null hypothesis.

The outcome is inconclusive if the F-test falls in between these two boundaries.

3.3.3 The ARDL Model

This study employs the ARDL technique to estimate the relationship between GDP, inflation, Interest rate, money supply and exchange rate. This technique has a number of advantages which include; first, the ARDL model is a more statistically significant approach to determine the co-integration relation even in small sample. Also, the ARDL approach is that, while other co-integration techniques require all of the regressors to be integrated of the same order; the ARDL technique can be applied whether the regressors are I(1) and/or I(0). This means that the ARDL technique avoids the pre-testing problems associated with standard co-integration, which requires that the variables be classified into I(1) or I(0) (Pesaran et al, 2001). The case where the unit root properties of the data are uncertain, then applying the ARDL procedure is the more appropriate model for empirical work. Applying the Augmented Dickey Fuller and the Phillips-Perron tests for unit root, one may incorrectly conclude that a unit root is present in a series that is actually stationary around a one-time structural break. The ARDL approach is useful because it avoids these problems. The ARDL model specifies both the long run and short run impact of the independent variables on the dependent variables.

The researcher considers the model of the form $ARDL(p, q, k, m, L)$. The long run outcome from the ARDL regression process is specified as;

$$EXR_t = \alpha_0 + \sum_{i=0}^p \alpha_i EXR_{t-i} + \sum_{i=0}^q \beta_i INF_{t-i} + \sum_{i=0}^k \gamma_i IR_{t-i} + \sum_{i=0}^m \delta_i MS_{t-i} + \sum_{i=0}^L \theta_i GDP_{t-i} + \varepsilon_t \quad (3.6)$$

The short run dynamics of the coefficient from the regression process is expressed by finding the error correction model associated with the long run estimates.

$$\Delta EXR_t = \alpha_0 + \alpha_1 \Delta EXR_{t-1} + \alpha_2 \Delta INF_{t-1} + \alpha_3 \Delta IR_{t-1} + \alpha_4 \Delta MS_{t-1} + \alpha_5 \Delta GDP_{t-1} + \alpha_6 \Delta_{t-1} \quad (3.7)$$

Where; α_6 represents the error correction factor whereas α_1 is the speed of adjustment.

The error correction tells the speed of adjustment of the variables to the long run should there be any deviation. The error correction factor should be negative and significant.

The negative state spells out the fact that with any deviation from the long run, the variables would turn back to equilibrium. However, a positive error correction term tells the explosive state of the variables an indication of no return back to its equilibrium.

CHAPTER FOUR

EMPIRICAL RESULTS AND ANALYSIS

4.0 Introduction

This chapter uncovers and analyzes the respective outcomes to meet our prior objectives and stated hypothesis in chapter one. The chapter first presents the descriptive analysis of the variables of interest. The test for stationarity and cointegration are presents as well and finally, the actual regression to meet the long run and short run impact of the macroeconomic variables on exchange rate.

4.1 Descriptive Statistical Analysis

An overall description of the properties and characteristics of the variables under study is presented in this section. The purpose of this analysis is to uncover the location and variability of the dataset to be used.

Table 4.1: Summary of descriptive Statistics

variables	lnEXR	lINF	lnIR	lnM2	lnRGDP
mean	-4.013664	3.106743	2.794678	3.411865	7.894546
Standard dev	3.63517	.8377751	.6516765	4.062158	.4468408
minimum	-9.21034	.6205765	1.386506	-3.218876	7.343853
maximum	.6347392	4.985318	3.882182	10.02653	8.947177
observation	172	172	172	172	172

Source: Author's Estimation (2015)

From Table 4.1 above, it is evident that the total number of observations under consideration is 172 since the dataset are quarterly frequencies between 1970 and 2012.

The nominal exchange rate (lnEXR) which is the dependent variable ranged between 9.210 and 0.634 and has a mean and standard deviation of about -4.013 and 3.635

respectively. It recorded the least mean and but a high standard deviation, this supports the volatile nature of the exchange rate. The real GDP recorded the highest mean of 7.89 followed by money supply, inflation and interest rate of about 3.411, 3.1067 and 2.7 respectively. Their respective standard deviations are 0.44, 4.04, 0.8377 and 0.6516. Money supply is thus next to the exchange rate in terms of volatility, real GDP is the least volatile. This description is a good description of the Ghanaian economy due to the developing state of the economy where the domestic currency is prone to depreciation.

4.2 Trend Analysis of the Nominal Exchange Rate Relation

The analysis of trends in the nominal exchange rate is prominent as it brings out the path it has taken so far. It would uncover the peaks and troughs in the trends as well as whether the nominal exchange rate has been on the ascension or descending. This trend is depicted in figure 4.1 below.

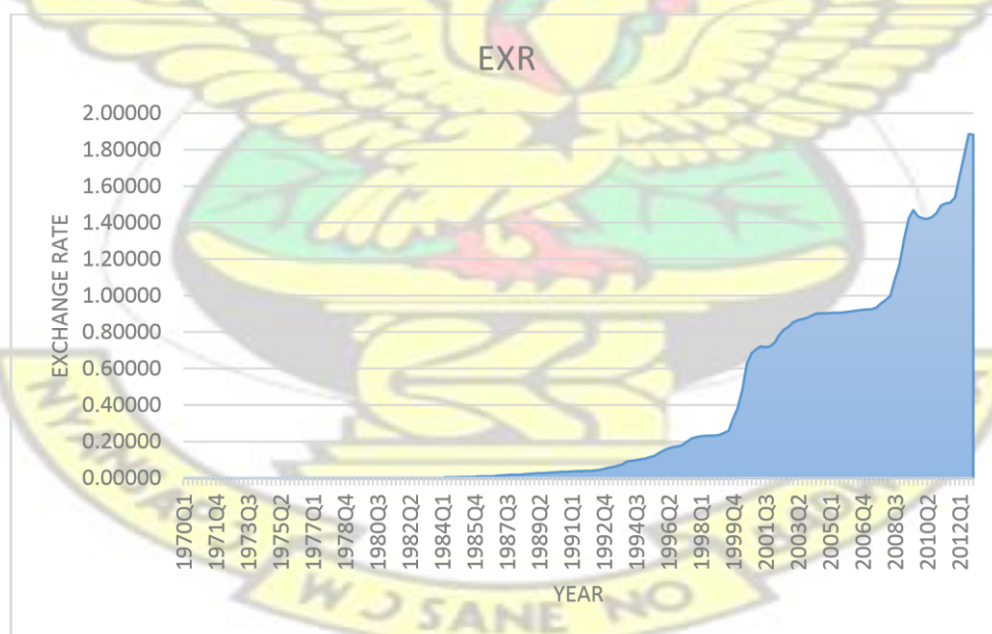


Figure 4.1: Trends of the Nominal Exchange rate

Source: Author's own construct (2015)

The figure above shows the path of the nominal exchange rate from 1970Q1 to

2012Q4, it is evident that the nominal exchange rate measured by the cedi against the US Dollar has been on the ascendency over the 42 years.

Between 1970 and 1980's, the growth rate in the nominal exchange rate was quite insignificant as it was quite stable, this is justified by the fact that the Ghanaian economy was on the fixed exchange rate regime. Nevertheless, after these periods when the floating exchange rate was adopted in 1981, the nominal exchange rate has been on the ascendency continually with increasing magnitude. With much focus on the floating exchange rate, this continuous growth has been amidst fluctuations due to the influence of some macroeconomic forces such as money supply, inflation, interest rate and the like. The fourth quarter of 1999 and the third quarter of 2008, the exchange rate was low which spells out appreciation of the cedi during this period. The appreciation of the cedi between 2007 and 2008 was attributed to the initial stages of the redenomination of the Ghanaian cedi. On the average, these upswings and downswings could be attributed to the adjustment to the flexible exchange rate regime, the economic recovery program and the redenomination of the cedi.

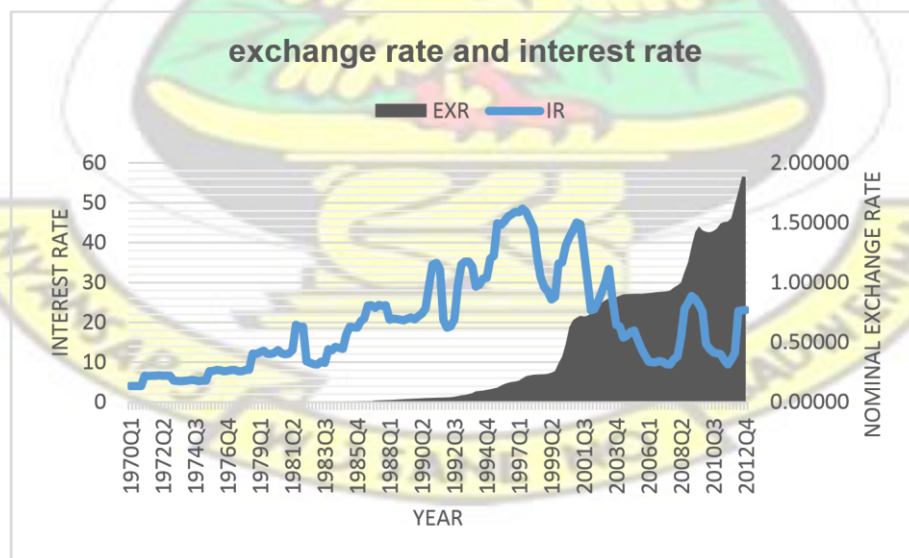


Figure 4.2: Nominal Exchange rate and Interest rate trends

Source: Author's own construct (2015)

Figure 4.2 plots the trends in the nominal exchange rate and nominal interest rate between 1970Q1 and 2012Q4. The trends can be isolated into three sub-periods. Periods between 1970Q1 and 1982Q4 saw interest rates everywhere greater than exchange rate, with exchange rate almost insignificant, this period was characterized by the fixed exchange rate regimes. This implies that real interest rate was predominantly negative. The second sub-period (i.e., the flexible exchange rate) is also predominantly characterized by positive and increasing interest rate at the same time the nominal exchange rate was on the increase. However, the last sub-section (period after 1997Q1) saw interest rates gradually declining. Financial sector liberalization might have accounted for the lowering down in interest rates periods after the 1990s. For instance, between 2001 and 2012, nominal interest rate has averaged 17.4% per annum compared to its antecedent decadal average of 34.4%. Exchange rate during this period saw drastic and continuous increase. It can thus be said that, the two series are inversely related.

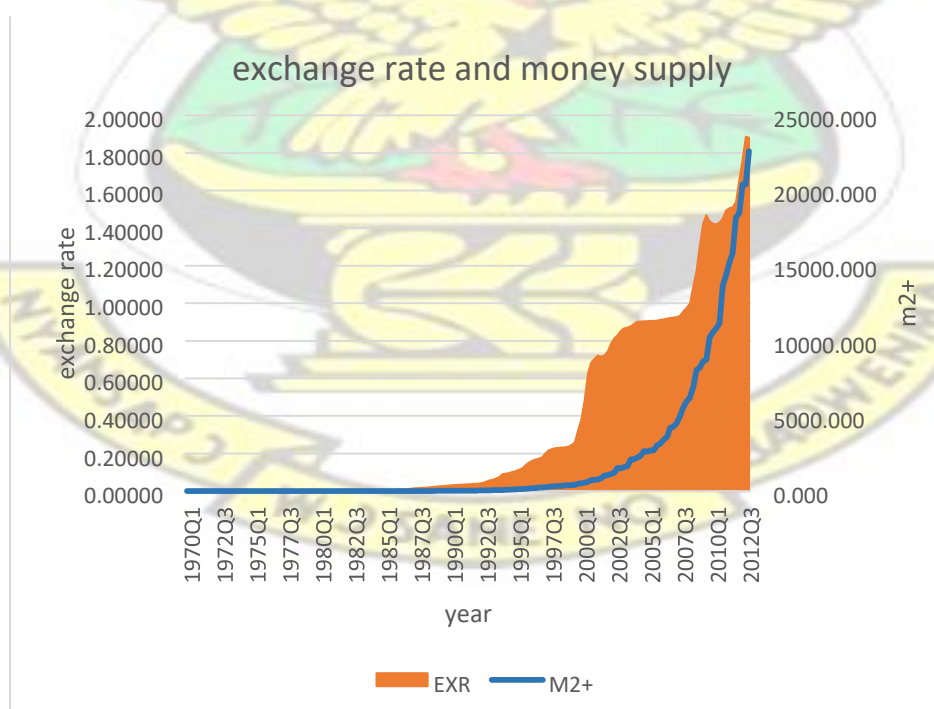


Figure 4.3: Nominal Exchange rate and money supply trends

Source: Author's own construct (2015)

Fig 4.3 gives a pictorial relation between the nominal exchange rate and money supply, it is visible that both series has been on the increase over the period under study. The general trend in money supply is suggestive of how poor monetary authorities manage it in attempt to implement policy options such as bringing exchange rate under control. Monetary expansion through the printing of more domestic currencies has been the means by which the economy finance its deficits over the years resulting from huge investment drive in the economy.

Periods during the Economic Recovery Programme (ERP) (1983 – 2000), growth in money supply ironically remained high and even averaged at 42.1% per annum. The average thereafter (i.e., since 2000) has been quite impressive relative to the long history of recording high growth rates. The general relationship shows the series tend to move in the same direction with a keen look at both, such that increasing supply of money would lead to the increasing level of the nominal exchange rate and thus depreciation.

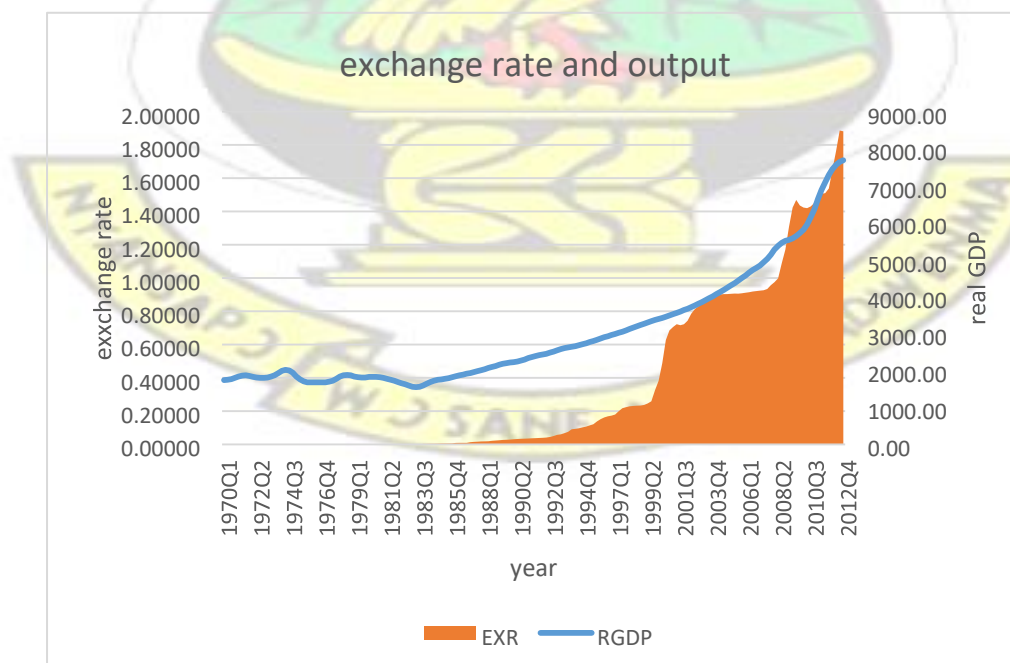


Figure 4.4: Nominal Exchange rate and output trends

Source: Author's own construct (2015)

The total amount of goods and services produced in the economy tend to be rising over time. Since 1984, real GDP has consistently grown, albeit mild fluctuations while exchange rate remained stable and relatively low. The higher level of output was accompanied by rising although fluctuating rate of exchange. This depreciation of the domestic currency resulting from economic growth is associated with the fact that the Ghanaian economy is more import dependent for majority of its raw and finished goods. A causal relationship between the exchange rate and output growth in Ghana within the period under consideration is thus positive.

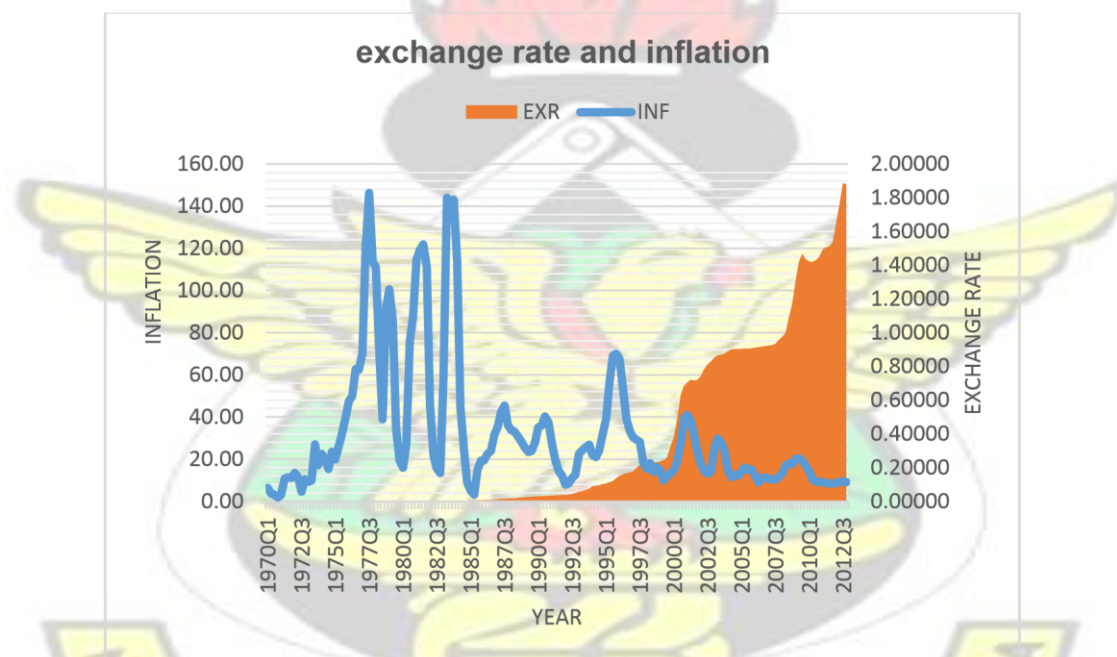


Figure 4.5: Nominal exchange rate and Inflation Trends

Source: Author's own construct (2015)

Three phases of inflation rate can be pointed out in figure 4.5 above, the first (1970Q1-1975Q4) and third (1985Q1-2012Q4) phases are basically periods with relatively low inflationary trends. The second (1975Q4-1985Q1) phase is associated with high and volatile inflation rate which ranged from a record high of 123% in 1983 to 39.7% in 1984 following the implementation of the Economic recovery program

(ERP). At the same time this period witness low exchange rates. The third phase witnessed an increasing rates of the nominal exchange rate at the initial stages with inflation higher than it, but after 1997Q3, the rates of nominal exchange rate exceeded the growth in inflation although inflation remained volatile but stable. These periods of increasing rate of exchange could be associated with the high importation due to uncertainty about price changes on the domestic market. Inflation and the nominal exchange rate series thus tend to move together.

4.3 Stationarity Test Results

In assessing the determinants of exchange rate behavior in Ghana focusing on inflation, money supply, interest rate and economic growth, the study tested for the existence of unit root in the series. To ensure that the evidence of presence of unit root in the individual series or otherwise is strong, we applied two competing tests; the augmented dickey Fuller (ADF) test and the Phillips Perron (PP) test for unit root. In both cases, the null hypothesis is the presence of unit root in the individual series (non-stationarity). This is tested against the alternative of stationarity. Table 4.2 shows the unit root test results.

Table 4.2: ADF and Philips Perron Test for Unit Root

Variables	ADF tau Test		Philips Perron Test		Order of Int
	Constant	Constant +T	Constant	Constant + T	
PANEL A: LEVELS					
lnEXR	-0.685	-1.273	-0.649	-1.341	?
lnINF	-4.564***	-5.050***	-3.546***	-3.774***	I(0)
LnM2+	-0.384	-1.521	-0.123	-2.036	?
lnIR	-1.772	-1.510	-2.359	-2.292	?
lnRGDP	3.443**	-0.909	3.303**	-0.509	?
PANEL B: FIRST DIFFEREN					
lnEXR	-8.483***	-8.473***	-12.040***	-12.015***	I(1)
lnINF	?	?	?	?	?
lnM2+	-9.234***	-9.221***	-15.175***	-15.134***	I(1)
lnIR	-6.333***	-6.388***	-9.777***	-9.786***	I(1)

The presence of unit root in the data has both statistical and economic implications worth noting. Statistically, the presence of unit root in the data has the potential of producing spurious relationships when ordinary least squares methods are applied on the data. It is thus important to know the order of integration of each of the series in the model prior to estimation.

From the Table 4.2 above, the null hypothesis of unit root could not be rejected for all the series at the level for both the ADF and the Philips-Perron tests except for the inflation rates. Inflation was rejected at about 1% level of significance indicating inflation is stationary at levels whether there are trends or not. However, the unit root null is flatly rejected at 1% level of statistical significance for both the ADF and the PP tests for the exchange rate, money supply, interest rate and economic growth.

We therefore conclude that all the underlying series except inflation rate in the present study are a whiles inflation is integrated of order zero $I(0)$. The economic implications of unit root is that shock to money supply, interest rate and the nominal exchange rate will have a lasting effect (lack of mean reversion) but shocks to inflation would have only temporary effects.

4.4 Results for Co-integration Analysis

The bounds test to co-integration emphasizes the fact that there is presence of cointegration when the F- statistic is greater than the upper bounds thus if it falls below the lower bounds there is no co-integration. If the F- statistic however falls between the lower and the upper bounds, the results become inconclusive thus no economic implication. Table 4.3 gives a summary of the co-integration outcome.

Table 4.3: Bounds Test to Co-Integration

Level of significance	1%	2.5%	5%	10%	Decision
I(0) Bound	3.74	3.25	2.86	2.45	Co- integrated
I(1) Bound	5.06	4.49	4.01	3.52	
F-statistics	4.612001				

Source: Author's Estimation (2015)

Table 4.3 above, the results of the bounds test approach to co-integration is seen, the overall F- statistic for the variables of 4.612001 was significant at 5% level. This confirms the long run relationship amongst inflation, interest rate, money supply, real GDP and the nominal exchange rate. We thus reject the null hypothesis of no cointegration amongst the variables. The implication of the co-integration amongst the variables is that in the long run, there at least exists some form of economic relationship between the variables.

4.5 Results and Analysis of the Exchange rate Function

This section brings together the outcome of both the long run and short run estimates of inflation, money supply, interest rate and economic in respect of the nominal exchange rate.

4.5.1 Short Run Analysis

The short run analysis with an error correction model (ECM) term incorporated is estimated within the ARDL framework. It tells the immediate impact of inflation, interest rate, money supply and the real GDP on exchange rate. The error correction model (ECM) determines the speed of adjustment to return to equilibrium when there is any deviation. As a priori, the coefficient of the ECM is supposed to be negative and statistically significant for the variables to converge to equilibrium.

Table 4.4: The ARDL Short run Results (1970-2012)

Variables	Coefficients	Standard error	p-value
lnINF	0.002588	0.023181	0.9113
lnM2+	-0.510056	0.234431	0.0310*
lnIR	0.328100	0.095357	0.0007****
lnGDP	2.418739	1.187382	0.0433*
CointEq(-1)	-0.065934	0.027594	0.0180*

The log of the nominal exchange rate is the dependent variable

Note: ***, **, * indicates significance at 1%, 5% and 10% respectively, variables without * are not statistically significant.

In the short run estimations, all the coefficients of the variables could not met the priori expectations except the rate of inflation and real GDP. The coefficient of inflation, money supply, interest rate and output are 0.00258, -0.510056, 0.328100 and 2.418739 respectively in the short run. It brings to knowledge that in the short run a percentage change in inflation, interest rate and the real GDP would cause the nominal exchange rate to increase by 0.2%, 32% and 241% respectively. Inflation, interest rate and the RGDP were positively related to exchange rate whiles money supply was inversely related. However, money supply was the only variable that turned out to be inversely related to the nominal exchange rate, such that a 1% increase in money supply would cause the exchange rate to decrease by approximately 51%.

Thus increasing inflation, interest rate and economic growth per the results found causes the cedi to depreciate against the US Dollar whiles the increasing money supply would lead to the appreciation of the cedi. The appreciation of the cedi caused by money supply in the short run is unusual and could be argued from the supply point of view

rather than the demand side. Monetary expansion would cause increasing supply of goods and services domestically which would reduce import into the country; however this could just be temporal.

Furthermore, money supply and the real GDP were significant at 10% an indication of about 90% confidence of both variables in the explanation of the fluctuations in the exchange rate. We therefore reject the null hypotheses that both money supply and output do not have any significant impact on exchange rate. Also, we reject the null hypothesis at 1% level of significance that interest rate do not impact on exchange rate. There is thus 99% confident of its impact on the exchange rate. Inflation nevertheless turned to be the only statistically insignificant in the determination of the exchange rate per the study. The insignificant state of the inflation with regard to the exchange rate dynamics though positively related could be attributed to the fact that the demand for domestic goods and services are gradually becoming inelastic irrespective of the prices. In the short run therefore we accept the null hypothesis of inflation not significantly influencing the appreciation or depreciation of the domestic currency in Ghana.

Furthermore, the ECM term is statistically highly significant at the 1% significance level and the sign of its coefficient is also negative confirming the presence of long run relationship between the variables under study. The coefficient for the ECM is approximately 0.1165 implying that, when there is a 1% shock or deviation of the variables from equilibrium, the long run equilibrium relationship of the exchange rate is restored at the rate of approximately 12%. In other words, the highly significant error correction suggests that about 11% of the disequilibrium caused by the shocks in the current year is corrected in the long run. The speed of adjustment though very low spells the exact situation in the Ghanaian economy since it takes a long time for the cedi to appreciate when there is a shock.

4.5.2 Long run Results

Table 4.5: The ARDL Long run results (1970-2012)

Variables	Coefficients	Standard error	p-value
lnINF	0.039244	0.361311	0.9136
lnMS	1.215497	0.306499	0.0001***
lnIR	0.505035	0.603757	0.4041
LnRGDP	-4.433676	2.602437	0.0904*
Constant	26.408676	20.777967	0.2056

The log of the nominal exchange rate is the dependent variable

Note: ***, **, * indicates significance at 1%, 5% and 10% respectively, variables without * are not statistically significant.

The results presented in table 4.5 shows that, in the long run the real GDP did not meet its priori positive sign but was nonetheless remained statistically significant at 10%. According to the results, a one unit increase in GDP will lead to about 443% decrease in the nominal exchange rate. It thus becomes evident that output growth can cause appreciation of the cedi against the US Dollar in the long run rather than the short term. The large magnitude of the coefficient of GDP suggests a much stronger response of exchange rate to changes in the GDP in the long run. Care should thus be taken in the interpretation of the relation from short run to long run between output and exchange rate, since output in the long run causes the cedi to appreciate but causes depreciation in the short run.

Inflation, money supply and interest rate had a higher impact on the exchange rate in the long run than in the short run. Interest rate, however, could not meet our priori expectations but money supply and inflation did meet. A 1% increase in inflation, money supply and interest rate would cause the exchange rate to increase by approximately 3.9%, 121% and 50% respectively. The higher magnitudes of the

coefficients in the long run confirms the *Le Chatelier's Principle* which hypothesize that in the short run, due to fixed-cost constraints the elasticities are less responsive than in the long run therefore the long run magnitude of impact is higher economically.

However, inflation and interest rate were statistically insignificant in the long run when it comes to exchange rate fluctuations. The statistical insignificance of inflation is justification since it is insignificant in the short run thus irrespective of the time period, inflation does not explain the movements in the exchange rate. The insignificant rate of interest could be attributed to the long run which confirms the fact that the investors are not responsive to returns on domestic investment compared to the short run. Investors in the Ghanaian economy are seen to be short term investors.

The null hypothesis is thus rejected for output and money supply since they have a significant impact on exchange rate whiles we accept the null hypothesis that interest rate and inflation do not have a statistical impact on the domestic currency dynamics in Ghana.

The outcome of both the long and short run estimates confirm the importance of money supply and output. The depreciation or appreciation of the cedi is statistically dependent on the contraction or expansion of money supply and output per the study.

4.5.3 The Exchange Rate Function with Structural Break

Ghana has embarked on two main exchange rate policy regimes, that is the fixed and the floating which is perceived to have some level of impact on the value of the domestic currency. Prior to the adoption of the flexible exchange rate regime in 1983, the nominal exchange rates were determined at fixed rates. However, the introduction of the floating exchange rate regime meant the nominal exchange would now be determined by market forces. Thus, the need to find out whether the policy framework changes in 1983 has any major impact on the current dynamics in exchange rate.

Originally, two regimes were estimated (before and after the floating exchange rate regime), however, the estimated results were not economically interpretable especially for the “before” regression. We incorporated a structural break by introducing dummy variables where prior to the policy change is assigned zeros and after the policy implementation is assigned ones. Below is the short and long run estimate with the inclusion of structural break.

Table 4.6: Short run Results with Structural Break

Variables	Coefficients	Standard error	p-value
lnINF	0.001337	0.02725	0.9551
lnM2+	-0.502954	0.236638	0.0351*
lnIR	0.332623	0.097152	0.0008***
lnGDP	2.521629	1.252856	0.0458*
FER	-0.033070	0.125143	0.7919
CointEq(-1)	-0.058194	0.040296	0.0150*

Table 4.7: Long run Results with Structural Break

Variables	Coefficients	Standard error	p-value
lnINF	0.022971	0.411847	0.9556
lnMS	1.355926	0.720829	0.0618*
lnIR	0.561247	0.718079	0.4356
LnRGDP	-5.457079	5.507539	0.3233
FER	-0.568272	2.451419	0.8170
Constant	34.407880	43.307977	0.4281

Note: ***, **, * indicates significance at 1%, 5% and 10% respectively, variables without * are not statistically significant.

Table 4.6 and 4.7 illustrate the short and long run results respectively with the inclusion of structural breaks. The respective macroeconomic variables retained their respective signs just as without the inclusion of the structural breaks.

In the short run, in comparison to the exclusion of the structural breaks, the differences in outcome were not vast as again only inflation was statistically insignificant. All the other macroeconomic factors were statistically significant. Nonetheless, it was observed that the economic impact of inflation and money supply reduced slightly from 0.1% and 50% respectively as opposed to their initial 0.2%, 51% with the introduction of the break. Interest rate and real GDP on the contrary, increased slightly from about 32% and 241% of impact on exchange rate to about 33% and 252% respectively.

Furthermore, the speed of adjustment from any deviation to its equilibrium was fairly at a lower rate of 3% compared to the initial 6% without the break. This could be accounted for by the fact that the floating exchange rate policy makes the nominal rate of exchange responsive to other market forces which can influence its speed of adjustment.

On the average, the magnitude of impact of the respective variables on exchange rate in the short run increased slightly. Money supply was the only macroeconomic variable that remained significant in the long run, however, real GDP became an insignificant determinant of the nominal exchange rate with the inclusion of breaks while the exclusion of the breaks it prove otherwise. The economic implication is that only output was sensitive to the change in policy framework.

The policy change (i.e. the shift from the fixed to floating regime) represented by FER was found to be insignificant in the long and short run. The implication is that the change in the policy framework from the fixed to the floating exchange rate regime does not have any significant impact on the dynamics in the nominal exchange rate both in the long run and short run. Thus the depreciation or appreciation of the domestic currency per the study cannot be attributed to the change in policy from the fixed to the floating exchange rate regime.

4.6 General Diagnostic and Stability Tests

To ensure the robustness of the outcomes of the results, it becomes prominent to ensure the stability and the avoidance of serial correlation, heteroscedasticity and multicollinearity. This would ensure the recording of spurious results. The study uses the Jacque Berra and Ramsey reset to test for the stability of the variables of interest.

4.6.1 Serial Correlation test

Testing for the serial correlation amongst the residuals confirms the absence of serial correlation since the F-Statistic of 0.157 was statistically insignificant.

Table 4.8: Breusch-Godfrey Serial Correlation Test

	F-statistic	Obs*R-squared
Coefficient	0.157941	0.336934
Probability	(0.8540)	(0.8540)

Source: Author's Estimation (2015)

4.6.2 Test for Heteroscedasticity

The premise of no heteroscedasticity amongst the error term is when the variance of the error term is not constant over time. The table 4.9 below confirms the no existence of heteroscedasticity due to the insignificance of the f-statistic at about 0.9 significance level.

Table 4.9: ARCH Test for Heteroscedasticity

	F-statistic	Obs*R-squared
Coefficients	0.005916	0.005986
Probability	(0.9388)	(0.9383)

4.6.3 Normality test

From the outcome of the normality test, the significant outcome (see Appendix A) tells of the fact that the variables are not normally distributed thus deviating from the normality assumption of normal distribution. The dataset was skewed more to the left; this deviation from the normality assumption would not affect the outcome of the study since the number of observations is more than 30. It is based on the premise that a sample size greater than thirty approximates normality.

4.6.4 Multicollinearity Test

Using the Variance Inflation Factor (VIF) to test for the presence of multicollinearity amongst the variables, there was clear evidence of no multicollinearity since all the VIF coefficients were all less than 10 (see Appendix A). This is an indication of the absence of high correlation amongst the independent variables hence the appropriate combination of the independent variables in the regression.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter gives a conclusion of the study by summarizing the major findings. The chapter further provides recommendations based on the findings obtained.

5.1 Summary of Findings

The main objective of the study was to assess the determinants of exchange rate behavior in the economy of Ghana. Specifically the study sought to find out the long run and short run impact of inflation, money supply, interest rate and the real GDP on the dynamics in the nominal exchange rate in Ghana. The outcome of the study was

based on the Autoregressive Distributed lagged (ARDL) Model on time series dataset on quarterly frequencies spanning the period 1970 to 2012.

On the average, the study found the continuous increase in the nominal exchange rate over the years under study specifically after 1983. It was however very stable before this period. This continuous ascension was amidst substantial upswings and downswings; it was attributed to the adjustment of the economy to the major structural changes that took place including the Economic Recovery Programs (ERP) and the Structural Adjustment Program (SAP).

The rates of inflation was stationary at level whiles the other variables were stationary at their first difference. There was evidence of a long run relationship amongst the variables. The major findings based on the application of the ARDL model are as follows;

Firstly, the study found a positive relationship between inflation and the nominal exchange rate in both the short run and long run. All the same, inflation did not have any statistically significant impact on the behavior of the exchange rate though correctly signed. The null hypothesis was therefore not rejected for inflation's impact on exchange rates. Inflation, economic wise, can lead to the depreciation of the domestic currency due to its positive relations. Money supply and the real GDP on the other hand were found to be significant in the exchange rate behavior both in the long run and short run. Interest rate was significant in the short run but not in the long run. The null hypothesis is thus rejected, that money supply, output and interest rate do not affect exchange rate in the short run.

Secondly, it was noted however that money supply causes appreciation of the cedi in the short term but gradually lead to depreciation in the long run. Whiles the real GDP causes depreciation in the short run but eventually causes appreciation of the cedi in the

long run. Money supply becomes a crucial target in the long run but GDP is crucial in the short run when it comes to stabilization of the domestic currency.

Lastly, it was worth noting that the change in the exchange rate regime from the fixed to the floating did not have any significant impact on the trends and path currently taken by the domestic currency. Real GDP was the only force that became sensitive to the policy change in the long run thus becoming an insignificant determinant of the exchange rate in the long run.

5.2 Conclusions

It should be noted that for policy purposes, the distinction between short and long run is justified. The variables which are relevant in the short run and long run as opposed to those which are not, should be distinguished.

In the short run the behavior of the nominal exchange rate is explained by interest rate, money supply and real GDP alone. Inflation was not relevant in the short run. If policy makers target inflation as policy tool for reducing the rate at which the cedi is depreciating, it would be impotent due to their insignificant nature. Policy makers should rather target interest rate, money supply and real GDP as main tools for stabilizing the behavior of the exchange rate in the short run.

In the long run also, the dynamics in exchange rate was not explained by the rates of interest on investments together with the rates of inflation. Interest rates though can be targeted in the short run, it should not be a target for exchange rate stabilizations in the long run.

Furthermore, in the short run, monetary expansion, reducing interest rate and reducing the level of output would be potent in the appreciation of the domestic currency. In the long run also, monetary contraction and increasing level of output would lead to the

appreciation of the domestic currency, the inverse of these policies would lead to the contrary.

Money supply and the real GDP are thus prominent policy tools in both the long and short run when it comes to the behavior of the exchange rate confirming a mixture of monetary and structural factors in the explanation of the behavior of the domestic currency.

5.3 Recommendations

In line with the findings in the study, the following policy recommendations are offered;

First and foremost, policy makers should increase the supply of money in the economy at the initial stages and gradually contracts the amount in the economy in the long run. Since in the short run monetary expansion causes appreciation but eventually leads to depreciation of the cedi per the study.

Secondly, policy measures should be put in place which will cause output to increase over time since in the long run economic growth causes appreciation of the cedi.

Lastly interest rates on investments is recommended to be moderately fixed rather than increasing it, in order to attract foreign investment since it leads to depreciation rather than appreciation of the domestic currency.

5.4 Limitations of the Study

In an attempt to examine the introduction of the floating exchange rate regime by separately running regressions to cover the period before (1970Q1-1983Q4) and the periods after (1984Q1-2012Q4), the small size of 14 for the „period before“ the floating regime was a great limitation as the outcome did not make any economic meaning. For further research, the time period should be expanded to capture more aspects of the fixed exchange rate regime.

Also another limitation was the absence of a broad-up-to-date data as the analysis was based on quarterly dataset between 1970Q1 and 2012Q4. The inclusion of a much more current dataset could have had some significant impact on the outcome of the results.

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APPENDIX

DESCRIPTIVE STATISTICS

	LNEXR	LNCPI	LNIR
Mean	-4.006285	0.232475	2.794683
Median	-3.301606	0.948564	2.930515
Maximum	0.634741	4.798407	3.882212
Minimum	-9.190683	-6.214608	1.386506
Std. Dev.	3.625211	3.570289	0.651667
Skewness	-0.285183	-0.496266	-0.223996
Kurtosis	1.494725	1.952058	2.114580
Jarque-Bera	18.57005	14.93033	7.056773
Probability	0.000093	0.000573	0.029352
Sum	-689.0811	39.98569	480.6855
Sum Sq. Dev.	2247.309	2179.731	72.61845
Observations	172	172	172

COINTEGRATION TEST

ARDL Bounds Test

Date: 12/10/15 Time: 12:26

Sample: 1970Q2 2012Q4

Included observations: 171

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.612001	4

Critical Value Bounds

Significance	I0 Bound	I1 Bound
--------------	----------	----------

10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

LONG AND SHORT RUN RESULTS WITHOUT STRUCTURAL BREAK

ARDL Cointegrating And Long Run Form

Dependent Variable: LNEXR

Selected Model: ARDL(1, 0, 1, 1, 1)

Date: 12/10/15 Time: 12:26

Sample: 1970Q1 2012Q4

Included observations: 171

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
			0.111622	
D(LNINF)	0.002588	0.023181		0.9113
D(LNM2_)	-0.510056	0.234431	-2.175723	0.0310
D(LNIR)	0.328100	0.095357	3.440749	0.0007
D(LNRGDP)	2.418739	1.187382	2.037035	0.0433
CointEq(-1)	-0.065934	0.027594	-2.389422	0.0180

$$(0.0392*LNINF + 1.2155*LNM2_ + \\ \text{Cointeq} = LNEXR \\ 0.5050*LNIR \\ -4.4337*LNRGDP + 26.4087)$$

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNINF	0.039244	0.361311	0.108615	0.9136
LNM2_	1.215497	0.306499	3.965746	0.0001
LNIR	0.505035	0.603757	0.836487	0.4041
LNRGDP	-4.433676	2.602437	-1.703664	0.0904
C	26.408676	20.777967	1.270994	0.2056

Long and Short run Estimates with Structural Break

ARDL Cointegrating And Long Run Form

Dependent Variable: LNEXR
 Selected Model: ARDL(1, 1, 0, 1, 1, 0)
 Date: 02/24/16 Time: 06:17

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNM2_)	-0.502954	0.236638	-2.125417	0.0351
D(LNINF)	0.001337	0.023725	0.056346	0.9551
D(LNIR)	0.332623	0.097152	3.423751	0.0008
D(LNRGDP)	2.521639	1.252856	2.012714	0.0458
D(D1970)	-0.033070	0.125143	-0.264257	0.7919
CointEq(-1)	-0.058194	0.040296	-1.444152	0.1506

Sample: 1970Q1 2012Q4
 Included observations: 171

$$\text{Cointeq} = \text{LNEXR} - (1.3559 \cdot \text{LNM2}_- + 0.0230 \cdot \text{LNINF} + 0.5612 \cdot \text{LNIR} - 5.4571 \cdot \text{LNRGDP} - 0.5683 \cdot \text{D1970} + 34.4079)$$

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN2M2_	1.355926	0.720829	1.881065	0.0618
LNINF	0.022971	0.411847	0.055776	0.9556
LNIR	0.561247	0.718079	0.781595	0.4356
LN2RGDP	-5.457079	5.507539	-0.990838	0.3233
D1970	-0.568272	2.451419	-0.231813	0.8170
C	34.407880	43.307977	0.794493	0.4281

DIAGNOSTIC TEST

Ramsey RESET Test

Equation: UNTITLED

Specification: LNEXR LNEXR(-1) LNINF LN2M2_ LN2M2_(-1) LNIR LNIR(-1)
LN2RGDP LN2RGDP(-1) C

Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.541016	161	0.5892
F-statistic	0.292698	(1, 161)	0.5892

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.008902	1	0.008902
Restricted SSR	4.905730	162	0.030282
Unrestricted SSR	4.896827	161	0.030415

Unrestricted Test Equation:

Dependent Variable: LNEXR

Method: ARDL

Date: 12/10/15 Time: 12:27

Sample: 1970Q2 2012Q4

Included observations: 171

Maximum dependent lags: 2 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (2 lags, automatic):

Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNEXR(-1)	0.955416	0.048189	19.82660	0.0000
LNINF	-0.000968	0.024143	-0.040092	0.9681
LN2M2_	-0.512570	0.234990	-2.181243	0.0306
LN2M2_(-1)	0.598166	0.236707	2.527029	0.0125
LNIR	0.346571	0.101481	3.415122	0.0008

LNIR(-1)	-0.304866	0.100864	-3.022538	0.0029
LNRGDP	2.595697	1.234117	2.103284	0.0370
LNRGDP(-1)	-2.974321	1.276909	-2.329313	0.0211
C	2.413095	1.593058	1.514757	0.1318
FITTED^2	0.002178	0.004025	0.541016	0.5892
R-squared	0.997794	Mean dependent var		-3.975967
Adjusted R-squared	0.997671	S.D. dependent var		3.613922
S.E. of regression	0.174399	Akaike info criterion		-0.598240
Sum squared resid	4.896827	Schwarz criterion		-0.414517
Log likelihood	61.14951	Hannan-Quinn criter.		-0.523693
F-statistic	8093.123	Durbin-Watson stat		1.952317
Prob(F-statistic)	0.000000			

HETEROSCEDASTICITY

Heteroskedasticity Test: ARCH

F-statistic	0.005916	Prob. F(1,168)	0.9388
Obs*R-squared	0.005986	Prob. Chi-Square(1)	0.9383

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

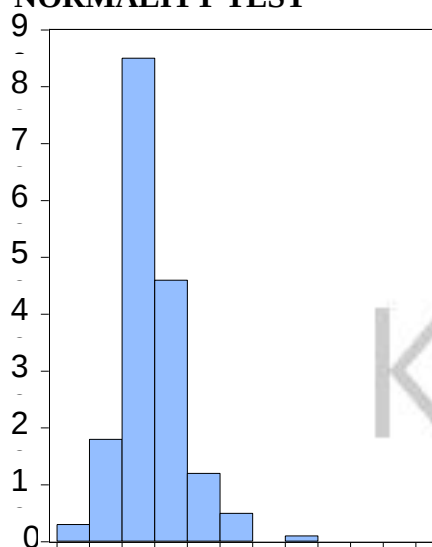
Date: 12/10/15 Time: 12:28

Sample (adjusted): 1970Q3 2012Q4

Included observations: 170 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.028678	0.019505	1.470313	0.1433
RESID^2(-1)	0.005934	0.077150	0.076917	0.9388
R-squared	0.000035	Mean dependent var		0.028849
Adjusted R-squared	-0.005917	S.D. dependent var		0.251908
S.E. of regression	0.252652	Akaike info criterion		0.098087
Sum squared resid	10.72395	Schwarz criterion		0.134979
Log likelihood	-6.337424	Hannan-Quinn criter.		0.113058
F-statistic	0.005916	Durbin-Watson stat		2.000026
Prob(F-statistic)	0.938781			

NORMALITY TEST



Series:
Residuals
Sample 1970Q2
2012Q4
Observations
171

Mean 5.03e-15
Median -0.015806
Maximum 1.811767
Minimum -0.237488
Std. Dev. 0.169874
Skewness 7.316504
Kurtosis 77.20603
Jarque-Bera 40759.70
Probability 0.000000

-0.2 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8

TEST FOR SERIAL CORRELATION

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.157941	Prob. F(2,160)	0.8540
Obs*R-squared	0.336934	Prob. Chi-Square(2)	0.8450

Test Equation:

Dependent Variable: RESID

Method: ARDL

Date: 12/10/15 Time: 12:31

Sample: 1970Q2 2012Q4

Included observations: 171

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNEXR(-1)	0.001086	0.030604	0.035478	0.9717

LNINF	-0.000443	0.023821	-0.018617	0.9852
LN2M2_	0.003586	0.235988	0.015196	0.9879
LN2M2_(-1)	-0.004291	0.237095	-0.018099	0.9856
LNIR	0.002661	0.096017	0.027709	0.9779
LNIR(-1)	-0.003552	0.100156	-0.035467	0.9718
LN2RGDP	-0.017304	1.198910	-0.014433	0.9885
LN2RGDP(-1)	0.015740	1.189074	0.013238	0.9895
C	0.022795	1.011065	0.022545	0.9820
RESID(-1)	0.022294	0.084135	0.264982	0.7914
RESID(-2)	-0.039298	0.082836	-0.474409	0.6359
R-squared	0.001970	Mean dependent var		-15
				5.03E
Adjusted R-squared	-0.060406	S.D. dependent var		0.169874
S.E. of regression	0.174930	Akaike info criterion		-0.586700
Sum squared resid	4.896064	Schwarz criterion		-0.384605
Log likelihood	61.16285	Hannan-Quinn criter.		-0.504698
F-statistic	0.031588	Durbin-Watson stat		2.004516
Prob(F-statistic)	0.999999			

MULTICOLLINEARITY Variance

Inflation Factors

Date: 12/10/15 Time: 12:31

Sample: 1970Q1 2012Q4

Included observations: 171

Variable	Coefficient	Uncentered	Centered
	Variance	VIF	VIF
LNEXR(-1)	0.000761	125.9143	55.96402
LNINF	0.000537	31.52682	2.102177
LN2M2_	0.054958	8735.836	5040.632
LN2M2_(-1)	0.055570	8667.614	5097.071
LNIR	0.009093	424.5998	21.21334
LNIR(-1)	0.009785	454.3351	23.42506
LN2RGDP	1.409876	498084.9	1580.750
LN2RGDP(-1)	1.387647	489112.9	1513.487
C	0.991308	5597.782	NA