UNIVERSITY OF CAPE COAST

EFFECT OF EXCHANGE RATE VOLATILITY ON ECONOMIC GROWTH IN GHANA: AN EMPIRICAL INVESTIGATION

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DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

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Supervisor's Declaration

I hereby declare that the preparation and presentation of this dissertation were supervised in accordance with the guidelines on supervision of dissertation laid down by the University of Cape Coast.

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ABSTRACT

The study investigates the relationship between exchange rate volatility and economic growth in Ghana using quarterly data from 1990 to 2012, by means of the Autoregressive Distributed Lag (ARDL) approach and the Granger causality test. The study found a unique cointegrating relationship between economic growth and exchange rate volatility. The regression results show that exchange rate volatility exerts negative and statistically significant effects on economic growth both in the short-run and long-run suggesting that exchange rate volatility adversely influences economic growth in Ghana. The Granger causality test results revealed unidirectional causality between exchange rate volatility and economic growth with the causality running from exchange rate volatility to economic growth. It is therefore recommended that Bank of Ghana ensures a stable exchange rate in order to stimulate economic growth in Ghana.

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DEDICATION

I dedicate this work to my wife Mrs. Vida Buabin and my children.

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LIST OF ACRONYMS

ADF	Augmented Dickey Fuller
AERC	African Economic Research Consortium
AR	Auto Regressive
BOP	Balance of Payment
FDI	Foreign Direct Investment
FE	Fixed Effects
FE-IV	Fixed Effects-Instrumental Variable
GDP	Gross Domestic Product
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GMM	Generalized Method of Moments
GMM-IV	Generalized Method of Moments-Instrumental Variable
ILO	International Labour Organisation
IMF	International Monetary Fund
IOM	International Organisation for Migration
JFE	Joint Facility for Elective
MTOs	Money Transfer Operators
NELM	New Economics of Labour Migration
ODA	Official Development Assistance
OECD	Organisation for Economic Corporation and Development
OLS	Ordinary Least Squares
RE	Random Effects
SSA	Sub-Saharan Africa
US$	Unites States dollar
WDI	World Development Indicators

CHAPTER ONE

INTRODUCTION

Background to the Study

Exchange rate volatility is a crucial element that needs to be considered for developing countries that depend extensively on international trade. Traditionally, it has been argued that exchange rate volatility may hinder the flow of international trade centred on the notion that exchange rate volatility represents uncertainty and will impose costs on risk-averse commodity traders.

From the theoretical point of view, there is no clear consensus which exchange rate regime is more favourable for macroeconomic performance (Prasad, 2007). Proponents of fixed exchange rate regime argue that exchange rate stability promotes economic performance through higher trade and enhanced macroeconomic stability, which could favour foreign investment and growth. This regime also affects investment and saving decisions (and therefore the current account balance) and financial development. In contrast, proponents of flexible exchange rate regimes emphasize the advantage of exchange rate flexibility to correct for domestic and external disequilibria in the face of real asymmetric shocks (Arratibel, Furceri, Martin, & Zdzienicka, 2011).

Before the introduction of the economic recovery program in Ghana in 1983, exchange rate policy had involved the maintenance of a fixed exchange rate regime with occasional devaluation, and exchange rationing. But the country adopted the flexible exchange rate regime i.e. managed float, and with this the national currency has experienced instability for most part of its existence (Mumuni & Owusu-Afriyie, 2004).

Statement of the Problem

In Ghana, some studies conducted have focus on the effects of exchange rate volatility on stock market performance (for example, Adjasi, Haervey& Agyapong, 2008; Kyereboah-Coleman &Agyire-Tettey, 2008 and Frimpong& Adam, 2010).Studies that have specifically investigated the relationship between exchange rate volatility and economic growth in Ghana (example, Adu-Gyamfi, 2011) used annual data and employed models such as the Ordinary Least Squares (OLS) and Vector Autoregressive (VAR) models in their analyses other than the Autoregressive Distributed Lag (ARDL) approach. This study therefore uses quarterly data and employs the ARDL model to establish the long-run and short-run relationships between the variables of interest. This is because annual data does not adequately address the behaviour of exchange rate volatility so it is important to use high frequency data such as quarterly data while the ARDL approach can establish long-run and short-run relationships between the variables (Peseran, Shin & Smith, 2001).

Objectives of the study

The general objective of this study is to investigate the relationship between exchange rate volatility and economic growth in Ghana over the period 1990Q1-2012Q4.

Specifically the study seeks to:

1. Establish the long-run relationship between exchange rate volatility and economic growth

2. Examine the short-run relationship between exchange rate volatility and economic growth

Hypotheses

This study seeks to test the following hypotheses based on research objectives

1. Ho: There is no long-run relationship between exchange rate volatility and economic growth

   H1: There is long-run relationship between exchange rate volatility and economic growth
2. Ho: There is no short-run relationship between exchange rate volatility and economic growth

   H1: There is short-run relationship between exchange rate volatility and economic growth

Significance of the Study

The significance of this study is based on the score that among the research works conducted on the effect of exchange rate volatility on economic growth in Ghana (Adu-Gyamfi, 2011) used annual data which does not adequately address the behaviour of exchange rate volatility. This study seeks to add to the existing body of literature by using quarterly data and the ARDL methodology.

This study will also assist the government in designing an exchange rate policy framework that will ensure the reduction in uncertainties and variations in the exchange rate to enhance the flow of trade and investment most especially capital inflow to facilitate economic growth and increase the welfare of the people.

Scope of the Study

This study is based on the Ghanaian economy over a 92 quarterly period that is between 1990Q1 and 2012Q4. This is purposely to capture the period within which the economy witnessed a highly volatile exchange rate due to the 2007/2008 global financial crises and that the country recorded its highest cedi depreciation in 2000, a depreciation of over 20% and to check for structural changes within the period. Also due to data constraints data from the 1970s and 80s could not be used. Economic growth (which will be measured by per capita income) our dependent variable of interest is due to the fact that economic growth is a measure of the wellbeing (welfare) of the population which is actually an indicator of an improvement in the standard of living of the population.

Organization of the Study

The study is organised into five chapters. Chapter one, presents a background to the study, statement of the problem, objectives of the study, hypotheses, significance and scope of the study as well as organisation of the study. Chapter two presents review of related literature, both theoretical and empirical that underpins the relationship between exchange rate volatility and economic growth in developing countries and Ghana. Chapter three presents the procedure followed in conducting the study. Chapter four presents and discusses the results with reference to the literature. Chapter five finally presents the summary, conclusions and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

This chapter presents the review of relevant literature on the relationship between economic growth and exchange rate volatility. The first section presents overview of exchange rate episodes in Ghana. The second section discusses the review of theoretical and empirical literature.

Overview of Exchange Rate Situation in Ghana

Ghana's exchange rate policies have been influenced by contrasting political regimes that have been in place since 1957. Table 1 shows that from 1957 to 1992, Ghana adopted different exchange rate regimes in her exchange rate management. During this period the Ghana Cedi was pegged to the main convertible currencies notably, the British Pound and the US Dollar. The exchange rate was pegged by a decree and a series of administrative control such as import license was instituted to deal with any possible excess demand for foreign currency.

In the Economic Recovery Programme (ERP) era, government embarked on a series of devaluation of the Cedi between 1983 and 1986. In particular, the Cedi was devalued in stages from ¢2.75: US $1.00 in 1983 to ¢90.00: US $1.00 by the third quarter in 1986. The new foreign exchange policy was characterised by a scheme of bonuses on exchange receipts and surcharges on exchange payment. A multiple exchange rate of ¢23.38: US $1.00 in 1983 and ¢30.00: US $1.00 was applied to specified payment and receipts. The two official rates were eventually unified at ¢30.00: US $1.00 in

October1983. A real exchange rate rule cost in the purchasing power parity framework was introduced. In December 1984, a policy of more periodic exchange rate devaluations was adopted in place of quarterly adjustment mechanism because the real exchange rate was thought to be overvalued.

Table 1: Exchange rate episodes in Ghana (1957-date)

Episode	Period	Policy
1	1957-1966	Fixed to British pound
2	1966-1982	Fixed to American dollar
3	1983:2-1986:3	Multiple exchange rate system
4	1986:4-1987:2	Dual exchange rate system-auction
5	1987:3-1988:1	Dutch auction system
6	1988:2-1989:4	Foreign exchange bureau
7	1990:1-1992:1	Wholesale and interbank auction system. Interbank market. The Bank of Ghana selling and buying rates are determined by average daily retail rate of commercial banks
8	1992:2-date	Interbank market

Source: Bank of Ghana Annual Reports (Various Issues)

In September 1986 the government adopted an auction market approach to achieve the objective of trade liberalization. The new arrangement was made up of two windows. Window one was operated as a fixed as a fixed exchange rate pegged at ¢90.00: US$1.00. Window two was determined by demand and supply in a weekly auction conducted by Bank of Ghana. The two systems were unified in February 1987. In March 1990, the wholesale auction was introduced to replace the weekly retail auction. Under this system, a composite exchange rate system was operated, namely the interbank and the wholesale systems. With the wholesale auction system, the authorized dealer banks and the eligible forex bureaus were allowed to purchase foreign exchange from the Bank of Ghana for sales to their end-user customers and to meet their own foreign exchange needs. The wholesale auction system was abolished in April 1992 and replaced by the inter-bank market and since then both commercial and forex bureaux have operated in a competitive environment.(Bank of Ghana Annual Reports Various Issues)

Review of Theoretical Literature

This section deals with the review of basic theories on the transmission channels of movements of exchange rate on economic growth. It begins with the review of theories of the impact of exchange rate volatility on investment, followed by the impact of exchange rate volatility on trade and the eventual impact of the exchange rate volatility on economic growth. Exchange rate can affect economic growth through two identified channels:

i. Through investment and

ii. Through international trade.

Exchange Rate Volatility and Investment

Exchange rate volatility impacts on growth through investments decisions by all the agents in the economy. The impact of exchange rate volatility on investment and hence on economic growth is not a recent source of concern. It is noted in most literature that uncertainty reduces investment in the presence of adjustment costs and when the investment process includes irreversibilities. Real exchange rate volatility creates an uncertain environment for investment decisions and therefore, investors delay their investment decisions to obtain more information about the real exchange rates if investments are irreversible and exerts negatively on economic performance (Cote, 1994).

In studying the link between exchange rate volatility and investment, Campa and Goldberg (1999), Nucci and Pozzolo (2010), Harchaoui, Tarkhani and Yuen (2005) with only small differences in their formulations used discrete dynamic optimization problems with a standard adjustment-cost model of a firm which operates in an imperfect uncertain environment. With the assumptions that the firm sells one part of its production in the domestic market and exports the other part outside. Within these markets the firm possesses a mark-up power, meaning it is able to influence the prices. The firm also imports some part of its inputs from abroad. The common findings of these theoretical works can be classified into three (3) categories:

First, exchange rate volatility affects investment through domestic and export sales. With currency depreciation, goods domestically produced become less expensive compared to foreign ones. This results in an increase in demand for domestic goods. In the same vein, exports will increase because they have become cheaper. For a given capital and labour, marginal revenue products of capital and labour increase as a result of convenient demand situations. Firms response by increasing their investment in capital and consequently, labour (Campa & Goldberg, 1999).

Second, exchange rate volatility acts on investment through the price of imported inputs. Depreciation raises total production costs which results in lower marginal profitability. The effect of the exchange rate on the marginal profitability is proportional to the share of imported inputs into production (Nucci & Pozzolo, 2010).

Third, Harchaoui et al. (2005) shows that exchange rate can also affect investment through the price of imported investment via adjustment cost.

Depreciation causes an increase in investment price, resulting in higher adjustment costs and lower investment. Overall, it is important to note that the global impact of exchange rate on investment is not obvious because it depends on which of these previous effects prevail and the values of elasticities of demand.

Exchange Rate Volatility and International Trade

Exchange rate volatility impacts on growth through trade flows. The effects of exchange rate variability on trade flows are analyzed in terms of risk/uncertainty. Exporters are either very risk-averse or less-averse and therefore would react differently to changes in the real exchange rates. The variability of exchange rates is the source of exchange rate risk and has certain implications on the volume of international trade, consequently on the balance of payments. Hooper and Kohlhagen (1978) have analyzed theoretically the relationship between higher exchange rate volatility and international trade transactions. They argued that higher exchange rate volatility leads to higher cost for risk-averse traders and to less foreign trade. This is because the exchange rate is agreed on at the time of the trade contract, but payment is not made until the future delivery actually takes place. If changes in exchange rates become unpredictable, this creates uncertainty about the profits to be made and, hence, reduces the benefits of international trade. Exchange rate risk for all countries is generally not hedged because forward markets are not accessible to all traders. Even if hedging in forward markets were possible, there are limitations and costs.

However, later theoretical studies revealed that this prediction is based on restrictive assumptions about the form of the utility function (De Grauwe, 1988). Even under the maintained hypothesis of risk aversion, the sign of the effect becomes ambiguous once the restrictions were relaxed. As pointed out by De Grauwe (1988), an increase in risk has both a substitution and an income effect. The substitution effect per se decrease export activities as an increase in exchange rate risk induces agents to shift from risky export activities to less risky ones. The income effect, on the other hand, induces a shift of resources into the export sector when expected utility of export revenues declines as a result of increase in exchange rate risk. Hence, if the income effect dominates the substitution effect, exchange rate volatility will have a positive impact on export activity. In addition, an increase in exchange rate volatility can create profit opportunity for firms if they can protect themselves from negative effects by hedging or if they have the ability to adjust trade volumes to movements in the exchange rate. Frankel (1991) and Paya, Venetis and Peel (2003) demonstrated that an increase in exchange rate volatility can increase the value of exporting firms and thus can promote exporting activities.

De Grauwe (1996) showed that an increase in exchange rate volatility can increase the output and thus the volume of trade if the firm can adjust its output in response to price changes. Broll and Eckwert (1999) demonstrated that an international firm with huge domestic market base has the ability to benefit from exchange rate movements by reallocating their products between domestic and foreign market. Thus, higher volatility can increase the potential benefits from international trade. Moreover, from the political economy point of view, Brada and Mendez (1988) noted that exchange rate movements facilitate the adjustment of the balance of payments in an event of external shocks and thus reduce the use of trade restrictions and capital controls to achieve the equilibrium, and this in turn encourages international trade.

The theoretical results are conditional on the assumptions about attitudes towards risk, functional forms, type of trader, and presence of adjustment costs, market structure and availability of hedging opportunities. Ultimately, the relationship between exchange rate volatility and trade flows is analytically indeterminate. Thus, the direction and magnitude of the impact of exchange rate volatility on trade hence growth becomes an empirical issue.

Review of Empirical literature

This section deals with the review of empirical literature on the effect of exchange rate volatility on economic growth. Just like the pattern for the theoretical review, this part begins with the review of empirical works on the impact of exchange rate volatility on investment followed by that of exchange rate volatility and international trade and finally that of exchange rate volatility and economic growth.

Exchange Rate Volatility and Investment

A large fraction of studies have examined the relation between exchange rate, its volatility and investment both in developed and developing countries. For developed countries almost all studies are at the industry-level. Campa and Goldberg (2002) studied the linkage between exchange rates and investment, emphasizing the role of producer exposure through export sales and through inputs into production. Using two estimates of exchange rate volatility that is (i) the ratio of the standard deviation to the mean of the exchange rate index over the previous twelve quarters (ii) the standard deviation of the first differences of the logarithm of the exchange rate over the twelve previous quarters. With the use of two-stage least squares (2SLS) regressions; they discovered that the effects of exchange rate and its volatility on investment in the United States were more visible in the 1980s than in the 1970s. In the 1980s, the dollars had significant differentiated impacts on industries. While the dollars had ambiguous effects on non-manufacturing industries, its depreciations (appreciations) decreased (increased) investment in manufacturing non-durables sector.

Campa and Goldberg (1999) surveyed four countries using annual panel data sets of manufacturing industries and employing the three-stage least square technique. They found that exchange rate appreciation in the USA has a positive effect on investment that decreased with export share and increased with import input share; with a 10% appreciation of the US dollar leading to an overall increase of around 1-2% in investment due to the increasing importance of imported inputs into manufacturing in the USA. Japanese industry generally showed a lower level of response, but with an overall increase in investment also expected following appreciation. For both these countries, groupings of industries classified as “high-mark-up” showed weaker or relatively insufficient effects compared with those classified as “low-mark-up”. However, Campa and Goldberg (1999) were unable to find any statistically significance in the exchange coefficients for the UK and Canada, which they found surprising in the light of the size and extent of the external orientation of Canadian manufacturing. These authors suggested that the differences between countries were due to cross-country distinctions in industry composition and patterns of external exposure and concluded that further research was needed to identify industry and country- specific factors.

Also Nucci and Pozzolo (2010) investigated the relationship between exchange rate fluctuations and the investment decisions of a sample of Italian manufacturing firms. They used firm-level panel data and employed the generalized method of moments (GMM) estimation procedure. They came up with the findings that support the view that a depreciation of the exchange rate has a positive effect on investment through the revenue channel, and a negative effect through the cost channel. The magnitude of these effects varies over time with changes in the firm's external orientation as measured by the share of foreign sales over total sales and the reliance on imported input. Also this study showed that the effect of exchange rate fluctuations on investment is stronger for firms with low monopoly power, facing a high degree of imported penetration in the domestic market and of a small size and that the degree of substitutability between domestically produced and imported inputs influences the effect through the expenditure side.

Nucci and Pozzolo (2010) found that the degree of import penetration in the domestic market was significant when added to the specifications. Dummy variables representing industry classifications of firm were also included in the panel data estimations and were found to be jointly significant, indicating the importance of industry differences in determining the effects of the exchange rate variations.

Harchaoui et al. (2005) used industry-level data for 22 Canadian manufacturing industries to examine the relationship between real exchange rate and investment during the period 1981-1997. The empirical results show that the overall effect of exchange rates on total investment was statistically insignificant. Further investigation revealed the non-uniform investment responses to exchange rate movements in three channels. The result empirically was consistent with earlier results in Campa and Goldberg (1999) that the overall effect of the exchange rate on total investment was statistically insignificant for Canadian manufacturing sector between 1981 and 1997. This notwithstanding, they also found that depreciations (appreciations) tend to have a positive (negative) impact on investment when the exchange rate volatility is relatively low. The results highlighted the importance of differentially investment response between a high and low exchange rate variability regime and that not only the level of the exchange rates but also the volatility matters for the firm's total investment decisions.

Empirical investigations of the relation between the exchange rate, its volatility and investment in developing countries use, in general, OLS, Two-Stage Least Squares, Fixed effects, GMM and system GMM. Oshikoya (1994) results illustrate that exchange appreciation had a positive impact on private investment for four African middle-income countries (Cameroon, Mauritius, Morocco and Tunisia). For the effects of real effective exchange rate (REER) volatility, a significant negative impact of exchange rate volatility on investment is reported by the major part of the studies (Bleaney & Greenaway, 2001 & Serven, 2002). The impact of exchange rate instability on investment is nonlinear. The effect is large when, firstly, volatility is high and secondly, when there is large trade openness combined with low financial development. Contrary, in an environment with low openness and high financial development, exchange rate volatility tends to act positively on investment (Serven, 2002). Furthermore, Guillaumont, Jeanney and Brun (1999) found that "primary" instabilities (climatic, terms of trade and political instabilities) act on Africa growth through the negative effect that "intermediate" instabilities (instability of real exchange rate and instability of the rate of investment) exert on growth.

Exchange Rate Volatility and Trade

Given the inconclusive results of the theoretical models on the effect of exchange rate volatility on trade as a channel to economic growth, several studies have attempted to quantify the effects of exchange rate volatility on trade and eventually on growth. Frankel and Wei (2007) estimated a panel of 63 countries over the years 1975, 1980, 1985 and 1990; a total of over 1000 country pairs were examined. Using switching regressions, he found that, for country pairs with large potential trade, exchange rate volatility had a negative and significant effect on bilateral trade among the countries considered. Dell' Arricia (1999) examined the effect of exchange-rate volatility on bilateral trade of European Union members plus Switzerland over the period 1975-1994 using several definitions of volatility. In the basic OLS regression, exchange rate volatility had a small but significant negative impact on trade; reducing volatility to zero in 1994 would have increased trade by an amount ranging from ten to thirteen percent, depending on the measure of volatility used. Using both fixed and random effects, the impact of volatility was still negative and significant, but smaller in magnitude. He found that elimination of exchange rate volatility would have increased trade by about 3.5% in 1994.

Asseery and Peel (1991) examined the impact of volatility on multilateral export volumes of five industrial countries using error correction framework. They argued that the non-robust results found in previous empirical work may be due to the fact that the export variable and some of its determinants were potentially non-stationary integrated variables. The volatility measure was based on the residuals from an ARIMA process for the real exchange rate. For all countries except the United Kingdom, they found that volatility has a significant positive effect on exports over 1973 to 1987 periods.

Kroner and Lastrapes (1993) examined the effect of volatility on multilateral export volumes and prices in a particular study utilizing a joint estimation technique in the context of a parameterized model of conditional variance (multivariate GARCH-in-mean model). In contrast with conventional two-step estimation procedures, the model imposes rationality on the variance forecasts. The model restricts the variance that affects trade to be the same as generated by the data. The conditional variance has a statistically significant impact on the reduced- form equations for all countries (based on likelihood ratio tests). For the individual coefficients, the effect of volatility on volumes was estimated with greater precision for the United States. The sign and magnitude of the effects differ widely across the countries, the magnitude being generally stronger for prices. For the United States, France and Japan, the effect of volatility was found to be only temporary. Volatility had a negative effect on trade volumes only for the United States and the United Kingdom. For the other countries, the coefficient was positive. For export prices, volatility had a negative effect in U.S and German equations, and a positive effect in others. They showed that the results were not robust to using the conventional estimation strategy (estimating the export equation separately and substituting the GARCH measure by a six-month rolling sample variance).

Lastrapes and Koray (1990) used VAR models to examine the effect of exchange rate volatility on trade. The major advantage of this approach was that it did not impose exogeneity on the variables in the system. Exchange rate volatility may affect variables other than trade and, at the same time, it may be affected by some macro variables. In their first paper, they examined the link between real exchange rate volatility and U.S. bilateral imports from five countries, including Canada. Estimations were made separately for a fixed (1961-71) and a flexible (1975-85) exchange rate periods. In addition to real exchange rate volatility, each model contained U.S. and foreign money supplies, output, prices and interest rates and the nominal exchange rate (for the fixed rate period).

Koray and Lastrapes (1989) concluded that, although the effect of exchange rate volatility on trade increased from the fixed to the flexible rate regime, the relationship between volatility and trade was weak. This conclusion was based the observation that a fairly small proportion of the variance in U.S. imports is explained by innovations in volatility. For U.S. imports from Canada, the estimated contribution was about 4%. The largest effect was obtained in the Japanese case (about 11%). It is worth noting, however, that although these contributions may appear small, they are often similar or greater than those of the other variables in the system. Except for France, permanent shocks to volatility tend to depress imports. The results also suggested that exchange rate volatility is not a purely exogenous source of instability, as in all cases, at least one macro variable explains a significant proportion of the error variance of volatility.

Lastrapes and Koray (1990) used a similar approach but focused on U.S. multilateral exports and imports during the flexible rate period. They drew the same general conclusions. Compared to the other variables in the system, exchange rate volatility plays a relatively minor role in explaining imports, exports and real output. The responses to volatility shocks were small and statistically insignificant. As well, the state of the economy strongly affects volatility. Innovations in money, interest rates and prices make a particularly large contribution. These results supported the view that exchange rate volatility is a symptom of macroeconomic instability rather than an independent cause.

De Grauwe and Verfaille (1988) attempted an explanation on the reason that despite the apparent success of the EMS in stabilizing exchange rate over the 1979-85 periods and the evidence suggesting that misalignments among the EMS currencies appeared smaller than those between floating currencies, intra-EMS trade grew at a substantially slower pace than trade among the other industrialized countries. Bilateral export volumes of 15 industrial countries were used. Exports are a function of demand and supply (foreign and domestic income), relative prices, a dummy for customs union (assumed to work through a higher income elasticity on the import side), a measure of long-term real exchange rate volatility (the variance of the annual changes of the exchange rate), and misalignment as an indicator of protectionist pressure. Both exchange rate variability and misalignment had a negative and significant effect on export growth. In terms of magnitude, De Grauwe and Verfaille found that income and exchange rate volatility were the most important factors in explaining export growth. Volatility was estimated to have reduced the growth rate of exports outside the European Monetary System (EMS) by 8 to 10 percent over the 1979 to 1985 period, while intra-EMS trade was reduced by just 0.7%. There were two reasons for the slower trade growth within the EMS: weaker income growth and a lower income elasticity of export demand, as the trade integration process levelled off. The authors noted that the question remains as to whether low exchange rate variability is correlated with low growth of output. Melitz (1988) held that there were a number of serious shortcomings in their approach. In particular, he argued that their measure of volatility (based on consecutive monthly observations of annual changes) was insignificant, as it used overlapping observations and therefore could not measure annual volatility properly.

The study by Brada and Mendez (1988) differs from the previous ones in that it examined the effect of exchange rate regime, rather than volatility per se, on the volume of trade. Its results contradicted those of De Grauwe and Verfaille (1988). The study used a gravity model of bilateral trade flows, which included domestic and foreign incomes, population, distance between countries, and dummy variables for the exchange rate system and trade arrangements. The model was estimated with data on 30 developed and developing countries for each year from 1973 to 1977. With one exception, the coefficients on the exchange rate regime were significant at 5%. In all cases, trade flows were larger between countries with floating rates than between countries with fixed rates.

The reduction in trade under a fixed rate regime ranges from 27 to 61 percent. The authors concluded that even though exchange rate volatility reduces trade among countries, its effects are less than those of the restrictive commercial policies often imposed under fixed rates systems. Instead of relying on exchange rate movements to achieve payments equilibrium, fixed exchange rate countries must rely on changes in domestic incomes and prices, or impose trade restrictions. As the latter are more acceptable politically than the former, the demand for imports is often controlled by tariff and non-tariff barriers in countries with overvalued currencies.

Frankel and Wei (2008) also used a gravity model of bilateral trade flows to test the effect of nominal and real exchange rate volatility. Regressions were estimated for 1980, 1985 and 1990 using a data set covering 63 countries. Given the likelihood of simultaneity bias in the regressions – governments may deliberately try to stabilize bilateral exchange rates with their major trading partners – they reported instrumental variable (IV) estimations in addition to ordinary least squares. The bias seems to be confirmed by data, as the magnitude of the estimated effect of exchange rate volatility reduced considerably with the IV method.

Frankel and Wei (2008) found that nominal and real volatility had a negative and significant impact on trade flows in 1980. The effect was positive but insignificant in 1985. It remained positive and became statistically significant in 1990. The change in sign could indicate that the development of exchange risk hedging instruments has diminished the negative effect of volatility over time. In all cases, the magnitude was very small. Their preferred estimate suggested a doubling of exchange rate volatility within Europe, as would happen if variability returned from its 1990 to its 1980 level, would reduce the volume of trade within the region by 0.7 percent. Given that their results did not appear very robust, they concluded that the effect, if it was there at all, was small in magnitude.

Savvides (1992) used a two-step estimation method to test the assumption that only the unanticipated component of exchange rate volatility affects trade. Annual data for 62 industrial and developing countries were used to estimate regressions over the 1973 to 1986 period. The degree of openness and terms of trade shocks were found to have a significant effect on real exchange rate volatility. The effect of expected and unexpected variability, based on the equation results, was tested on export volumes. Only the latter was negative and significant. Nominal exchange rate variability did not have a significant effect either. The author presented results for industrial countries and lesser-developed countries separately. The same conclusion holds concerning the impact of volatility. Although it was not mentioned in the text, the results for industrial countries were not too convincing, as the income and relative price terms were insignificant (the income term even has the wrong sign.) And in the study by Kumar and Whitt (1992), who tested his assumption regarding the differential effect of volatility on intra-industry versus net trade. Equations are estimated for the United Stated, Japan and Germany. The results partly support Kumar’s assumptions. Risk increases intra-industry trade and reduces net trade in the United States, as predicted by the model. For Japan, risk reduces net trade but does not affect intra-industry trade, while for Germany; it increases intra-industry trade but does not affect net trade.

In conclusion, most of the empirical works done in this regard gives the evidence that the effect of exchange rate volatility is mixed. Results of the different studies are difficult to compare since the sample period, countries and more importantly the measure of risk vary widely. In several cases, long –run measure are used that may be a better proxy for trend changes in the exchange rate than volatility. But overall, a larger number of studies appear to favour the conventional assumption that exchange rate volatility depresses the level of trade which may impact on growth too in the same direction (De Grauwe and Verfaille 1988, Koray and Lastrapes 1989, Peree and Steinherr 1989). With the exception of De Grauwe and Verfaille, the magnitude of that effect would be rather small. On the other hand, Asseery and Peel (1991) and Kroner and Lastrapes (1993) find evidence of a positive effect of volatility on export volumes of some industrial countries (the two studies, however, get conflicting signs for the United Kingdom). There is some indication that unanticipated volatility has a more significant impact.

Exchange Rate Volatility and Economic Growth

Having indicated the channels through which effects of exchange rate volatility is pass on to growth performance in an economy. What is the eventual effect of exchange rate volatility on growth? Empirical evidences have shown strong effect of short-run and long-run adverse effect of exchange rate swings on economic growth performance through the trade channel likewise the investment channel. In fact, evidence of the link from exchange rate volatility to growth is less than definitive. While Ghosh et al. (1997) found no relationship between observed exchange rate volatility and economic growth for a sample of 136 countries over the period 1960-1989. Bailliu et al. (2003) reported a positive association between the degree of exchange rate flexibility and economic growth. A further problem with much of this literature is that it focuses on the nominal rather than the real exchange rate: Dollar

(1992) did report evidence of a negative relationship between real exchange rate volatility and growth in a sample of 95 developing countries covering the period 1976-85. Belke and Kaas (2004) found the same thing focusing on employment growth, the Central and Eastern European transition economies, and a subsequent period.

Bleanney and Greenaway (2001) exploring the relationship between real exchange rate volatility and growth in different developing country samples found little evidence of a relationship. Potential explanations include different country samples, different periods, different controls, different ways of measuring the real exchange rate volatility and different degrees of omitted-variables and simultaneity bias.

Using panel estimations for more than 180 countries, Edwards and Levy- Yeyati (2005) found evidence that countries with more flexible exchange rates grow faster. Eichengreen and Leblang (2003) found strong negative relationship between exchange rate volatility and growth for 12 countries over a period of 20 years. They conclude that the results of such estimations strongly depend on the time period and the sample. Schnabl (2008) also found robust evidence that exchange rate stability is associated with more growth in the European Monetary Union (EMU) periphery.

Aghion et al. (2009) have examined the impact of real exchange rate variability not on factor accumulation but on factor productivity. They found that a more variable exchange rate is negatively associated with productivity growth in financially underdeveloped economies, but not in countries with deep financial markets. The implication is that financial development provides hedging instruments and opportunities enabling firms to guard against this risk.

This result is consistent with the intuition that less developed economies find it more difficult to embrace greater exchange rate flexibility because firms and households lack the instruments needed to manage risks. Whether this result is robust to alternative definitions of real exchange volatility is yet to be seen. But the larger point, that any effect of real exchange rate volatility on investment and growth is likely to be contingent on circumstances, is strongly valid.

Vieira et al. (2013) assessed the role of Real Exchange Rate (RER) volatility on long-run economic growth for a set of 82 advanced and emerging economies, using a panel data set ranging from 1970 to 2009. With an accurate measure for exchange rate volatility, their results for the two-step system Generalized Method of Moments (GMM) panel growth models show that a more (less) volatile RER has a significant negative (positive) impact on economic growth. Their results were also robust for different model specifications.

It must be emphasized that empirically the results of the impact of exchange rate volatility on economic growth is mixed and inconclusive. The nature of the effect as indicated by some country specific studies is positive (Mahmood, Ehsunullah & Ahmed, 2011 in Pakistan; Danmola, 2013 in Nigeria) while others indicates a negative direction (Sanginabadi & Heidari 2012 in Iran; Pokhariyal et al., 2012 in Kenya) and yet still others find that there is no relationship (Ghosh *et al*., 1997) making the issue more of an empirical one. Therefore this work seeks to find out the situation with Ghana.

Conclusion

This chapter has reviewed relevant literature on the channels through which exchange rate volatility affects economic growth both theoretical and empirical and finally brought to bear the various exchange rate policies undertaken by Ghana over the years from fixed to flexible and eventually the managed float. Despite that, the results indicated in the studies were mixed. Due to the inconclusiveness in the results concerning the relationship between exchange rate volatility affects economic growth, this study therefore attempts to add and partially fill in the gaps to the current exchange rate volatility-economic growth literature by examining the effects of exchange rate volatility on economic growth in Ghana having included a larger set of determinants of growth.

CHAPTER THREE

METHODOLOGY

Introduction

This chapter presents the methodology employed in the study. Specifically, it gives a detailed description of the research design, specification of the model, definition and measurement of variables in the model, estimation technique, sources of data and tools for data analysis.

Research Design

The study followed the positivist paradigm within the framework of classical and neoclassical economics. The positivist philosophy favours the use of quantitative approach to research used in this study. Also, this philosophy is suitable for the development of mathematical models to measure relationship between quantitative measurements. Therefore, quantitative method was used in this study. This calls for a suitable model to be employed to examine the effect of exchange volatility on economic growth in Ghana. In this regard, this study adapted Solow growth model in a form of Cobb-Douglas production function. This model is modified to include other variables to analyse the relationship between exchange volatility and economic growth using time series quarterly data from 1990 to 2012 in Ghana. This is due to the fact that the study is a macro study and involves trends analysis

Model Specification

The study adopts the Solow growth model in a form of Cobb-Douglas production function to capture the relationship between exchange rate volatility and economic growth as shown in equation (1).

$$Y_t = K_t^{\alpha}(A_t L_t)^{\beta}\ell^{\varepsilon} \qquad (1)$$

For the purpose of the study and followingVieira et al. (2013), we define the total factor productivity (A) in equation (1) as;

$$A_t = f(Vol_t, TO_t, GE_t, CPI_t) = Vol_t^{\beta_1} TO_t^{\beta_2} GE_t^{\beta_3} CPI_t^{\beta_4} \qquad (2)$$

Where Y_t = per capita GDP, Vol_t = exchange rate volatility, TO_t =TradeOpenness, GE_t =Government Expenditure, CPI_t =Consumer Price Index, L_t = Labour force and K_t = Gross Fixed Capital Formation.

Substituting equation (2) into (1) we get

$$Y_t = \eta K_t^{\alpha}(Vol_t^{\beta_1} TO_t^{\beta_2} GE_t^{\beta_3} CPI_t^{\beta_4} L_t^{\beta_5})\ell^{\varepsilon} \qquad (3)$$

Taking logarithm of the variables, differencing per capita GDP we get:

$$\ln Y_t = \beta_0 + \beta_1 Vol_t + \beta_2 \ln TO_t + \beta_3 \ln GE_t + \beta_4 \ln CPI_t + \beta_5 \ln L_t + \alpha \ln K_t + \varepsilon_t \quad (4)$$

Where $\ln\eta = \beta_0$, $\ln\ell$ =1, In = natural logarithm. Equation (4) is subsequently modeled with optimal lags of the variables to depict the ARDL representation.

Expected Sign of the variables

The coefficients $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ and α in equation (4) are the various elasticities of the respective variables. β_0, t and ε are the drift component, time and error term. The a priori signs for the coefficient in equation (4) are $\beta_1 < 0, \beta_2 > 0, \beta_3 > 0, \beta_4 < 0, \beta_5 > 0$ and $\alpha > 0$. The choice of the variables included in the above model is based on the literature, economic theory, data availability and their significance in the model chosen for the study.

Definition and measurement of variables

For the purpose of this study, the following operational definitions and measurements will be used for the variables being examined.

Economic Growth (Y)

Economic Growth refers to steady increases in the economy's real gross domestic product or national product overtime. Following standard practice, we use real per capita GDP growth as the measure for economic growth (Levine et al., 2000). Real GDP per capita is real gross domestic product divided by population.

Exchange rate volatility (*Vol*)

A variety of measures have been employed in numerous empirical studies to represent exchange rate volatility like the standard deviation of the first difference of the log real exchange rate (SD) (Adu-Gyamfi, 2011), the moving average standard deviation (MASD) of the quarterly log of bilateral real exchange rate and the conditional volatility of the exchange rates estimated using General Autoregressive Conditional Heteroscedasticity Model (GARCH) (Insah, 2013) but there is no consensus on the appropriate measure.

Following Heidari & Hashemi Pourvaladani (2011) we use generalized autoregressive conditional heteroscedasticity (GARCH) models to generate time varying conditional variance of exchange rate as a standard measure of exchange rate volatility. This is because the study used quarterly data which is high frequency data hence the use of GARCH. GARCH (1, 1) model can be defined as follows:

$$\ln RER_t = a + a_1 \ln RER_{t-1} + \varepsilon_t \qquad (5)$$

$$\varepsilon_t \sim iid(0, \delta^2)$$

$$\delta^2 = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \phi\delta_{t-1}^2 \quad (6)$$

The above conditional variance of *RER* is a function of three terms (i) the mean, γ_0, (ii) news about volatility from the previous period, measured as the lag of the squared residual from the mean equation, ε_{t-1}^2 (ARCH term), and (iii) the last period's forecast error variance, $\phi\delta_{t-1}^2$ (the GARCH term) as shown in equation (6).The basis for the use of GARCH for this study is the fact that there exists exchange rate volatility in Ghana as found by Insah (2013) noting that a GARCH (1,1) model explained real exchange rate.

Trade Openness (TO)

Trade openness was measured as the sum of value of exports and imports to nominal GDP.

Government Expenditure (GE)

Government Expenditure was measured as ratio of government expenditure to GDP. It is commonly used as indicator of macroeconomic stability. Government expenditure, according to the Keynesian proposition is expected to raise economic growth. It could, however, reduce economic growth because of the crowding out effect on private investment and the inflationary pressures it can lead to (Allen & Ndikumana, 2000).

Consumer Price Index

CPI is the index of prices used to measure the change in the cost of basic goods and services in comparison with a fixed base period. The annual percentage change in the cost to the average consumer of acquiring a fixed basket of goods and services that may be fixed or changed at specified intervals, such as yearly is used to measure inflation. It is a reflection of macroeconomic instability. A high rate of inflation is generally unattractive to foreign investors because it raises the cost of borrowing and thus lowers the rate of capital investment. Inflation is therefore used as an indicator to capture macroeconomic instability, (Asiedu & Lien, 2004; Asiedu, 2006).

Capital (K)

Capital stock was measured as the ratio of gross fixed capital formation to GDP.

Labour (L)

Labour force was measured as the proportion of the population aged between 15 years and 65 years and is active and productive.

Estimation Technique

This study first investigates the time series properties of the data using the Augmented Dickey-Fuller (ADF) and the Philip-Perron (PP) tests. The unit root test was used to check the stationarity properties of the data. The study then proceeded to test for the long-run and short-run relationships among the variables using the Autoregressive Distributed Lag (ARDL) approach.

Sources of Data

This study relied strongly on secondary data coming from the World Bank database, and the Bank of Ghana quarterly bulletins and annual reports. This study employed quarterly data on the chosen variables from the period 1990:Q1 – 2012:Q4. Ghana's exchange rate values against the U.S dollar were obtained from both the Bank of Ghana website and World Development Indicators. Data on growth rates and control variables were equally obtained from the World Development Indicators. Quarterly series of the control variables – trade openness, government expenditure, CPI, capital stock and labour force were generated from annual series using Gandolf (1981) algorithm.

Unit Root Tests

Since macroeconomic time series data are usually non-stationary (Nelson &Plosser, 1982) it is very important to test for the stationarity properties of the data. This testing requires the test of the order of integration of the data set which is the unit root tests. A time series is stationary if its moments such as the mean, variance, and autocovariances are independent of time (Gujarati, 2012). A stationary series is said to be integrated of order (d) if it achieves stationarity after being differenced (d) times. Many studies have shown that models with non-stationary variables tend to produce spurious regressions and make the usual test statistics (t, F, DW, and R^2) unreliable (Al-Yousif, 2002). So, if the non-stationary variables are differenced properly, they become stationary. The appropriate number of differencing is called the order of integration. Therefore, if a time series, for example, Y becomes stationary after being differenced d times, Y is said to be integrated of order d, denoted by $Y \sim I(d)$.

In line with empirical literature, the study employed the ADF and PP tests to inspect the stationarity properties of the variables included in the model. These tests actually involve two separate steps. First, they test the model with constant but no linear time trend, and second, with both constant and linear trend in order to determine the degree of integration of the data series. The main reason for conducting these two tests is to be sure that, the series enter the model to be estimated in non-explosive form and also to address the issue of tests with low power. The ADF and PP tests are similar except that they differ with regard to the way they correct for autocorrelation in the residuals. For instance, the PP (non-parametric) test generalizes the ADF procedure, allowing for less restrictive assumptions for the time series in questions. That is, it relates the assumptions pertaining to autocorrelation and heteroskedasticity. Both ADF and PP tests, test the null hypothesis that the variables under investigation have unit root against the alternative hypothesis of no unit root. Moreover, in each of these tests, the optimal lag length is chosen using the Swartz Information Criterion (SIC). Here, the sensitivity of the ADF test to lag selection renders the PP test an important and essential additional tool for making inferences about unit roots. The basic formulation of the ADF is given as:

$$\Delta Y_t = \mu + \delta_t + \rho Y_{t-1} + \sum_{i=1}^{p} \psi_i \Delta Y_{t-i} + \varepsilon_t \text{.................(7)}$$

Where Y_t denotes the series at time t, Δ is the difference operator, μ, δ, ρ, and ψ are the parameters to be estimated and ε is the stochastic disturbance term.

The hypothesis testing is given as:

$H_0 : \rho = 0$ (Series contain unit root- non stationary)

$H_1 : \rho \neq 0$ (Series contain no unit root - stationary)

From the hypothesis test, if the tau (τ) value or test statistic is more negative than the critical values, then, we reject the null hypothesis and conclude that the series is stationary. However, if the tau (τ) value is less negative than the critical value, we fail to reject the null hypothesis and conclude that the series is non-stationary.

Cointegration Test

In the face of non-stationary series with unit roots, first differencing appears to provide the appropriate solution to the problems. However, first differencing tends to eliminate all the long- run information which economists are invariably interested in. Thus, such differencing may result in a loss of low frequency information or long-run characteristics of the series data. Nevertheless, Engle and Granger (1987) disclosed that, if there is an equilibrium relationship between such variables, then for this relationship to have any meaning, a linear combination of these variables, the disequilibrium error should fluctuate around zero (that is, it should be stationary). Thus, two time series integrated of the same order d are said to be co-integrated if one unique linear combination of these series exists which is integrated in an order inferior to (d-b) with ≥ 1. After establishing that variables are stationary, it is necessary to determine whether or not there is any long-run relationship between them, and this leads to co-integration testing.

The Bounds Testing/ARDL Procedure

In fact, a number of time series studies have used the Johansen's co-integration technique to determine the long-run relationship between variables of interest. This technique actually remains the choice for many researchers who argue that, this is the most accurate method to apply for I (1) variables. However, a series of studies by Peseran and Peseran (1997), Peseran and Shin (1999), and Peseran et al. (2001) have introduced an alternative co-integration technique known as the Autoregressive Distributed Lag (ARDL) bounds test. This technique has a number of advantages over the Johansen's co-integration technique. First, the ARDL Approach is the more statistically significant technique to determine the co-integration relations in small samples (Ghatak & Siddiki, 2001), while the Johansen's co-integration technique requires large data samples for validity. Second, while other techniques require all the regressors to be integrated of the same order, the ARDL approach can be applied whether the regressors are I (1) or I (0). This means that, the ARDL approach avoids the pre-testing problems associated with standard co-integration, which requires that the variables already be classified into I (1) or I (0) (Peseran et al., 2001). In addition, Tang, (2006) stated that, the ARDL approach is also applicable when the explanatory variables are endogenous and is sufficient to simultaneously correct for residual serial correlation.

Bahmani-Oskooee and Kandil (2007) explained that, the first step in any co-integration technique is to determine the degree of integration of each variable in the model but this depends on which unit root test one uses because different unit root tests could lead to contradictory results. For example, applying the conventional unit root tests such as the Augmented Dickey-Fuller and the Philips-Perron tests, one may incorrectly conclude that a unit root is present in a series that is actually stationary around one-time structural break (Perron, 1997). Thus, the ARDL approach is useful since it avoids all these problems. Another difficulty of the Johansen's co-integration technique which the ARDL approach avoids concerns the large number of choices which must be made including decisions regarding the number of endogenous and exogenous variables to be included in the model, the treatment of deterministic elements, as well as the order of VAR and the optimal number of lags to be used. Finally, with the application of the ARDL approach, it is possible that different variables have different optimal number of lags, while in Johansen's technique, this is not permitted.

According to Peseran and Peseran (1997), the ARDL approach requires the following two steps. In the first step, the existence of any long-run relationship among the variables of interest is determined using an F-test. The second step of the analysis is to estimate the coefficients of the long-run relationship and determine their values, followed by the estimation of the short-run parameters of the variables with the error correction representation of the ARDL model. By applying the error correction model (ECM) version of ARDL, the speed of adjustment to equilibrium will be determined. In order to apply the bounds test procedure for co-integration, the following restricted (conditional) version of the ARDL models are estimated to test the long-run relationships between exchange rate volatility and economic growth. This framework is implemented by modeling equation (3) as a conditional ARDL as:

$$\Delta \text{InY}_t = \alpha_0 + \sum_{i=1}^{p} \lambda_{1i} \Delta \text{InY}_{t-i} + \sum_{i=1}^{p} \lambda_{2i} \Delta Vol_{t-i} + \sum_{i=1}^{p} \lambda_{3i} \Delta \text{In}T_{t-i} + \sum_{i=1}^{p} \lambda_{4i} \Delta \text{In}G_{t-i} +$$
$$\sum_{i=1}^{p} \lambda_{5i} \Delta \text{In}CPI_{t-i} + \sum_{i=1}^{p} \lambda_{6i} \Delta \text{InL}_{t-i} + \sum_{i=1}^{p} \lambda_{7i} \Delta \text{In}K_{t-i} + \eta_1 \text{InY}_{t-i} + \eta_2 Vol_{t-i} +$$
$$\eta_3 \text{In}T_{t-i} + \eta_4 \text{In}G_{t-i} + \eta_5 \text{In}CPI_{t-i} + \eta_6 \text{In}L_{t-i} + \eta_7 \text{In}K_{t-i} + v_t \ldots\ldots\ldots\ldots\ldots (8)$$

Where $\Delta's$ are the first difference operators, $\eta_1 \ldots\ldots\ldots\ldots \eta_7$ are the long run multipliers, $\lambda's$ are the short run coefficients to be estimated through the error correction framework in the ARDL models, α_0 is the constant term (drift) and v is the white noise error term.

The first step in the ARDL approach is to estimate equations (5) by applying OLS. The second step is to test the null hypothesis of no long run relationship among the variables in equation (5) against the alternative hypothesis of the presence of a long run relationship among the variables using F-test denoted by F_Y (Y|Vol, TO, GE, CPI, L, K)and it is given by:

$$H_0 : \eta_1 = \eta_2 = \eta_3 = \eta_4 = \eta_5 = \eta_6 = \eta_7 = 0$$

$$H_1 : \eta_1 \neq \eta_2 \neq \eta_3 \neq \eta_4 \neq \eta_5 \neq \eta_6 \neq \eta_7 \neq 0$$

Given that the asymptotic distribution of F-statistic is non-standard without considering the independent variables being I(0) or I(1), Peseran et al. (2001) generated and presented the appropriate critical values according to the number of independent variables I the models of presence or absence of constant term or time trend in the models. Therefore, the calculated F-statistic is compared with two sets of critical values developed on the basis that the independent variables are I(d)-where $0 \leq d \leq 1$.Here, the lower critical bound assumes that all variables are I (0) whereas the upper critical bound assumes that the variables are I(1). If the calculated F-statistic exceeds upper critical value, then the null hypothesis of no co-integration is rejected irrespective of whether the variables are I (0) or I (1). This signifies that, there are long-run relationships among the variables. On the other hand, if the F-statistic falls below the lower bound then the null hypothesis of no cointegration cannot be rejected. Additionally, if the F-statistic lies within the lower critical and upper critical bounds, then, the test is inconclusive (Peseran & Peseran, 1997). However, when all the variables are integrated of order zero (i.e. I(0)), then the null hypothesis of no co-integration is rejected implying that there exist long-run relationships among the variables, otherwise they are not co-integrated.

For optimal lag length for each variable, the ARDL methodology estimates $(m+1)^{k+1}$ number of regressions, where m is the maximum number of lags and k is the number of variables in the equations. The orders of the lags of the ARDL models are chosen using one of the following information criteria: Schwarz-Bayesian Criterion(SBC), Alkaike Information Criterion (AIC), the $\overline{R}^2$ Criterion or the Hannan and Quinn (HQ) Criterion.

Long-run and Short-run Dynamics

Once co-integration is established, the next step is that, the following ARDL $(p, q_1, q_2, q_3, q_4, q_5, q_6)$ models are estimated in order to obtain the long run coefficients (estimates). These are given by:

$$\text{In}Y_t = \lambda_0 + \sum_{i=1}^{p}\eta_1 \text{In}Y_{t-i} + \sum_{i=0}^{q_1}\eta_2 Vol_{t-i} + \sum_{i=0}^{q_2}\eta_3 \text{In}TO_{t-i} + \sum_{i=0}^{q_3}\eta_4 \text{In}GE_{t-i} + \sum_{i=0}^{q_4}\eta_5 \text{In}CPI_{t-i} + \sum_{i=0}^{q_5}\eta_6 \text{In}L_{t-i} + \sum_{i=0}^{q_6}\eta_7 \text{In}K_{t-i} + \mu_t \text{..(9)}$$

When there is a long run relationship among the variables, then the unrestricted ARDL error correction representations (short run) are estimated as:

$$\Delta\text{In}Y_t = \alpha_0 + \sum_{i=1}^{p}\lambda_{1i}\Delta\text{In}Y_{t-i} + \sum_{i=0}^{q_1}\lambda_{2i}\Delta Vol_{t-i} + \sum_{i=0}^{q_2}\lambda_{3i}\Delta\text{In}TO_{t-i} + \sum_{i=0}^{q_3}\lambda_{4i}\Delta\text{In}GE_{t-i} + \sum_{i=0}^{q_4}\lambda_{5i}\Delta\text{In}CPI_{t-i} + \sum_{i=0}^{q_5}\lambda_{6i}\Delta\text{In}L_{t-i} + \sum_{i=0}^{q_6}\lambda_{7i}\Delta\text{In}K_{t-i} + \phi ECT_{t-i} + \mu_t \text{....................(10)}$$

From equation (10) the $\lambda's$ are the coefficients relating to the short run dynamics of the convergence to equilibrium, ECT_{t-i} is the error correction term resulting from the estimated long run equilibrium relationship, and ϕ is the coefficient denoting the speed of adjustment to long run equilibrium when there is a shock in the system. Here, the residuals from the co-integration equation, lagged one (1) period is defined as:

$$ECT_t = \ln Y - \alpha_0 - \sum_{i=1}^{p}\phi_{1i}\Delta \text{In} Y_{t-i} - \sum_{i=0}^{q_1}\phi_{2i}\Delta Vol_{t-i} - \sum_{i=0}^{q_2}\phi_{3i}\Delta \text{In} TO_{t-i} -$$
$$\sum_{i=0}^{q_3}\phi_{4i}\Delta \text{In} GE_{t-i} - \sum_{i=0}^{q_4}\phi_{5i}\Delta \text{In} CPI_{t-i} - \sum_{i=0}^{q_5}\phi_{6i}\Delta \text{In} L_{t-i} - \sum_{i=0}^{q_6}\phi_{7i}\Delta \text{In} K_{t-i} \ldots\ldots\ldots\ldots(11)$$

Engle and Granger(1987) explained that when variables are cointegrated, their dynamic relationship can be specified by an error correction representation in which an error correction term (ECT) computed from the long-run equations must be incorporated in order to capture both the short-run and long-run relationships. The error term indicates the speed of adjustment as stressed above to long-run equilibrium in the dynamic models. In other words, its magnitude shows how quick the variables converge to equilibrium when they are being disturbed. It is expected to be statistically significant with a negative sign. The negative sign indicates that any shock that occurs in the short-run will be corrected in the long-run. Therefore, the larger the coefficients of the error correction term in absolute terms, the faster the convergence to equilibrium.

To ensure the goodness of fit of the models, the diagnostic and stability tests are also conducted. The diagnostic test examines the serial correlation, functional form, normality, and heteroskedasticity associated with the selected models. Peseran and Peseran (1997) suggested that conducting stability test is of great importance. This technique is also known as cumulative sum

(CUSUM) and cumulative sum of squares (CUSUMSQ). The CUSUM and CUSUMSQ statistics are updated recursively and plotted against the breaks points. If the plots of CUSUM and CUSUMSQ statistics stay within the critical bounds of five percent level of significance, the null hypothesis of stable coefficients in the given regression cannot be rejected (Peseran and Peseran, 1997)

Granger Causality Test

The study of causal relationships among economic variables has been one of the main objectives of empirical econometrics. According to Engle and Granger (1987), cointegrated variables must have an error correction representation. One of the implications of Granger representation theorem is that if non-stationary series are cointegrated, then one of the series must granger cause the other (Gujarati, 2012). To examine the direction of causality in the presence of co-integrating vectors, Granger causality is conducted based on the following specifications:

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta Y_{t-i} + \sum_{i=0}^{p} \phi_{1i} \Delta Vol_{t-i} + \nu_t \text{......................}(12)$$

$$\Delta Vol_t = \delta_0 + \sum_{i=1}^{p} \beta_{2i} \Delta Vol_{t-i} + \sum_{i=0}^{p} \phi_{2i} \Delta Y_{t-i} + u_t \text{..................}(13)$$

Where ΔY and ΔVol are our non-stationary dependent and independent variables, *p* is the optimal lag order while the subscripts *t* and *t-i* denote the current and lagged values. To find out whether the independent variable (*Vol*) granger-causes the dependent variable (*Y*) in equation (12), we examine the joint significance of the lagged dynamic terms by testing the null hypothesis:

$H_0 : \phi_{1i} = 0$, implying that the independent variable (*Vol*) does not granger-cause the dependent variable (*Y*), against the alterative hypothesis that

$H_1 : \phi_{1i} \neq 0$, implying that the independent variable (*Vol*) granger-causes the dependent variable (*Y*).

Similarly, to find out whether the dependent variable (*Y*) granger-causes the independent variable (*Vol*) in equation (13), we examine the joint significance of the lagged dynamic terms by testing the null hypothesis:

$H_0 : \phi_{2i} = 0$, implying that the independent variable (*Y*) does not granger-cause the dependent variable (*X*), against the alterative hypothesis that

$H_1 : \phi_{2i} \neq 0$, implying that the independent variable (*Y*) granger-causes the dependent variable (*X*).

Using the standard F-test or Wald statistic, four possibilities exist: First, rejection of the null hypothesis in equation (12) but failing to reject the null in equation (13) at the same time implies unidirectional causality running from *Vol* to *Y*. Second, a rejection of the null hypothesis in equation (13) but at the same time failing to reject the null in equation (12) implies unidirectional causality running from *Y* to *Vol*. Third, simultaneous rejection of the two null hypotheses in equations (12) and (13) indicates bi-directional causality. Fourth, simultaneous failure to reject the two null hypotheses in both equations indicates independence or no causality between the variables of interest.

Conclusion

This chapter presented the methodological framework suitable for conducting the study. The study adopted the Solow growth model in a form of Cobb-Douglas production function to capture the relationship between economic growth and exchange rate. The study followed the standard literature of Vieira et al. (2013) to specify the econometric model for economic growth. Quarterly time-series data on economic growth, exchange rate volatility, trade openness, government expenditure, CPI-rate of inflation, labour force, and capital from 1990 to 2012 were used for the study. Stationarity test was conducted using Augmented Dickey–Fuller (ADF) and Phillip-Perron (PP). Moreover, Autoregressive Distributed Lag (ARDL) econometric methodology was used to examine the long-run and short-run dynamics among the variables. Finally, the chapter highlighted on the Granger-causality technique to determine the direction of causality between economic growth and exchange rate volatility.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter presents and discusses the estimation results. The results of the descriptive statistics of the variables, both ADF and PP unit root tests, the ARDL approach to cointegration and Granger-causality test are presented and discussed in relation to the hypotheses of the study.

Descriptive Statistics

It can be seen from Table 1 that all the variables have positive average values (means) with the exception of exchange rate volatility. The minimal deviation of the variables from their means as shown by the standard deviation gives indication of slow growth rate (fluctuation) of these variables over the period. Most of the variables were positively skewed implying that the majority of the values are less than their means.

Table 1: Summary Statistics of the Variables

	lnY	Vol	lnTO	lnGE	CPI	lnL	lnK
Mean	0.813	-0.127	5.320	5.233	0.924	3.977	5.359
Median	0.838	0.020	4.255	5.139	0.983	3.983	5.289
Maximum	1.270	1.912	16.939	6.537	1.568	4.708	6.652
Minimum	0.428	-5.798	1.664	4.025	0.343	2.912	4.109
Std. Dev.	0.173	0.908	3.278	0.290	0.327	0.161	0.288
Skewness	0.058	-3.125	1.475	1.175	-0.302	1.448	1.019
Kurtosis	2.807	19.313	4.988	11.312	1.985	28.517	11.731
Sum	74.81	-11.682	489.465	481.425	84.993	365.909	493.016
Sum Sq. Dev.	2.709	75.093	977.856	7.669	9.7188	2.364	7.587
Observations	92	92	92	92	92	92	92

Note: Std. Dev. represents Standard Deviation while Sum Sq. Dev. represents Sum of Squared Deviation.
Source: computed by the author using Eviews 6.0 Package

It is evident from the Table 1 that only variables, that is exchange rate volatility and consumer price index, are negatively skewed implying that majority of the values are greater than their means.

Unit Root Tests

Although the bounds test (ARDL) approach to cointegration does not necessitate the pretesting of the variables for unit roots, it is however vital to perform this test to verify that the variables are not integrated of an order higher than one. The aim is to ascertain the absence or otherwise of $I(2)$ variables to extricate the result from spurious regression. Thus, in order to ensure that some variables are not integrated at higher order, there is the need to complement the estimated process with unit root tests.

For this reason, before applying Autoregressive Distributed Lags approach to cointegration and Granger-causality test, unit root test was conducted in order to investigate the stationarity properties of the data. As a result, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were applied to all variables in levels and in first difference in order to formally establish their order of integration. In order to be sure of the order of integration of the variables, the test was conducted first with intercept and no time trend, and second with intercept and time trend in the model. The optimal number of lags included in the test was based on automatic selection by Schwarz-Bayesian Criterion (SBC). The study used the P-values in the parenthesis in tables 2 and 3 to make the unit root decision, (that is, rejection or acceptance of the null hypothesis that the series contain unit root) which arrived at similar conclusion with the critical values.

The results of ADF test and PP test for unit root with constant only in the model for all the variables are presented in Table 2and Table 3 respectively. The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of the null hypothesis for the test is based on the MacKinnon (1991) critical and probability values.

Table 2: Results of Unit Root Test with constant only: ADF Test

Levels			First Difference			
Variables	ADF-Statistic	Lag	Variables	ADF-Statistic	Lag	*I(0)*
lnY	-3.163[0.256]	1	ΔlnY	-5.001[0.000]***	0	*I*(1)
Vol	-1.877 [0.336]	0	ΔVol	-4.102[0.000]***	2	*I*(1)
lnTO	-2.825 [0.588]	1	ΔlnTO	-6.452[0.000]***	0	*I*(1)
lnGE	-0.508 [0.986]	5	ΔlnGE	-4.592[0.000]***	1	*I*(1)
CPI	-2.776[0.658]	4	ΔCPI	-7.263[0.000]***	3	*I*(1)
lnL	-3.251 [0.205]	5	ΔlnL	-7.551[0.000]***	4	*I*(1)
lnK	-0.437 [0.983]	4	ΔlnK	-14.228[0.004]***	3	*I*(1)

Note: *** indicate the rejection of the null hypothesis of non stationary at 1% level of significance, Δ denotes first difference, and *I(0)* is the order of integration. The values in parenthesis are the P-values.

Source: computed by the author using Eviews 6.0 Package

Table 3: Results of Unit Root Test with constant only: PP Test

Levels			First Difference			
Variables	PP-Statistic	Bwd	Variables	PP-Statistic	Bwd	*I(0)*
lnY	-2.542[0.109]	2	ΔlnY	-5.010[0.000]***	1	*I*(1)
Vol	-1.192 [0.321]	1	ΔVol	-4.093[0.005]***	2	*I*(1)
lnTO	-2.573[0.102]	4	ΔlnTO	-6.485[0.000]***	2	*I*(1)
lnGE	-2.444 [0.133]	5	ΔlnGE	-3.791[0.009]***	1	*I*(1)
CPI	-1.792 [0.382]	4	ΔCPI	-5.143[0.006]***	1	*I*(1)
lnL	-1.658 [0.438]	1	ΔlnL	-4.063[0.005]***	0	*I*(1)
lnK	-0.083 [0.957]	2	ΔlnK	-5.245[0.004]***	2	*I*(1)

Note: *** indicate the rejection of the null hypothesis of non stationary at 1% significance levels, Δ denotes first difference, Bwd is the Band Width, and *I(0)* is the order of integration. The values in parenthesis are the P-values.

Source: Computed by the author using Eviews 6.0 Package.

Table 4:Results of Unit Root Test with constant and trend: ADF Test

Levels			First Difference			
Variables	ADF-Statistic	Lag	Variables	ADF-Statistic	Lag	*I(0)*
lnY	-2.322[0.137]	1	ΔlnY	-6.144[0.000]***	0	*I*(1)
Vol	-2.869[0.178]	1	ΔVol	-4.713[0.001]***	0	I(1)
lnTO	-2.529[0.313]	1	ΔlnTO	-6.589 [0.000]***	0	*I*(1)
lnGE	-1.752 [0.719]	1	ΔlnGE	-4.565 [0.002]***	0	*I*(1)
CPI	-1.905 [0.641]	5	ΔCPI	-7.133[0.000]***	3	*I*(1)
lnL	-2.858 [0.181]	3	ΔlnL	-4.083 [0.000]***	2	*I*(1)
lnK	-2.981 [0.143]	0	ΔlnK	-7.558[0.000]***	3	*I*(1)

Note: *** indicate the rejection of the null hypothesis of non stationary at 1% significance level, Δ denotes first difference, and *I(0)* is the order of integration. The values in parenthesis are the P-values.
Source: computed by the author using Eviews 6.0 Package

From the unit root test results in Table 4, it can be seen that all the variables are non-stationary at levels. This is because the P-values of the ADF statistic are not statistically significant. However, when the variables are differenced for the first time they become stationary. This is because the null hypothesis of the presence of unit root (non-stationary) is rejected at 1 percent significant levels. Table 5 presents the unit root test results obtained for the PP test with both constant and trend in the model.

Table 5:Results of Unit Root Test with constant and trend: PP Test

Levels			First Difference			
Variables	ADF-Statistic	Lag	Variables	ADF-Statistic	Lag	*I(0)*
lnY	-2.269 [0.243]	3	ΔlnY	-6.129 [0.000]***	1	*I*(1)
Vol	-1.941 [0.624]	4	ΔVol	-4.678 [0.002]***	2	*I*(1)
lnTO	-1.109 [0.921]	5	ΔlnTO	-6.471[0.000]***	2	*I*(1)
lnGE	-2.047 [0.568]	2	ΔlnGE	-3.156 [0.012]***	1	*I*(1)
CPI	-2.809 [0.198]	5	ΔCPI	-11.493[0.000]***	13	*I*(1)
lnL	-2.692 [0.242]	6	ΔlnL	-4.566 [0.002]***	2	*I*(1)
lnK	-2.364 [0.299]	4	ΔlnK	-6.687 [0.000]***	3	*I*(1)

Note: *** indicate the rejection of the null hypothesis of non stationary at 1% significance level, Δ denotes first difference, and *I(0)* is the order of integration. The values in parenthesis are the P-values.

Bounds Test for Cointegration

It is important to establish the existence of a long run relationship between the variables by employing the bounds testing approach to cointegration (Pesaran, Shin, & Smith, 2001). Cointegration test helps to verify the long run and short-run relationships among the variables of interest. The results are presented in Table 6 below.

Table 6: Bounds Test for Cointegration

Critical value Bounds	90% Level		95% Level		99% Level	
Intercept with no trend	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
K=6	2.141	3.250	2.476	3.646	3.267	4.450
Dependent Variable lnY						
$F_{\ln Y} = F_{\ln Y \mid Vol, \ln TO, \ln GE, \ln CPI, \ln L, \ln K}$		F-Statistic			4.676	

K is the number of regressors. Note: Critical values were obtained from Pesaran and Pesaran (1997).

Source: Computed by Author using Microfit 4.1

As indicated in Table 6, the joint null hypothesis of lagged level variables (that is, variable addition test) of the coefficients being zero (no cointegration) is rejected at 1 percent significance level when the intercept without trend is included in the model. This rejection is necessitated by the fact that the calculated F-statistic value of 4.676 (i. e. $F_{\ln Y}(.) = 4.676$) exceeds the upper bound critical value of 4.450 at 99% level.

As a result of the existence of Cointegration among the variables in Table 6, the long run and short run estimates of the ARDL models were estimated to obtain the long and short run coefficients and their standard errors. The estimation was done using Schwarz Bayesian Criterion (SBC).

As shown in Table 7, all the estimated coefficients have their a priori expected signs except trade openness and labour force. From the results, the coefficient of exchange rate volatility is statistically significant at 10 percent significance level implying that 1 percent increase in volatility will decrease economic growth by approximately 0.02 percent. This result confirms theoretical literature and most findings in much empirical literature.

The coefficient of trade openness is statistically significant at 1 percent level, indicating that if Ghana were to increase her trade openness by 1 percent, economic growth will decrease by approximately 0.05 percent in the long run. This means that Ghana imported more than it exported over the study period. This negative effect of trade openness on economic growth lends support to the argument that with an import inelastic country like Ghana greater openness to trade is likely to hurt economic growth.

In addition, the coefficient of government expenditure is statistically significant at 10 percent level, indicating that if government expenditure were to increase by 1 percent economic growth will increase by approximately 0.3 percent in the long run. This means that government expenditure positively affect economic growth in Ghana.

Furthermore, the coefficient of inflation carried the expected negative sign and is statistically significant at 1 percent significance level. Thus, if the country's rate of inflation increases by 1 percent, economic growth will reduce by approximately 0.04 percent in the long-run. That is, inflation which captures macroeconomic instability has had a significant adverse effect on economic growth in Ghana. This result is in line with theory and empirical literature.

Finally, even though the coefficient of labour force had it expected positive sign, it is not statistically significant. This means that labour force do not significantly affect economic growth in the long run in Ghana. The coefficient of capital had it expected positive sign and is statistically significant at 5 percent level. This means that capital positively affect economic growth in Ghana.

Having established the existence of long-run relationship between economic growth and exchange rate volatility, the ARDL cointegration method is then used to estimate long-run parameters of equation (9) in chapter 3.

Table 7: Long-Run Coefficients Estimates using the ARDL Approach

ARDL(2, 0, 2, 2, 2, 0, 2) selected based on SBC			Dependent Variable: lnY	
Regressor	Coefficient	Standard Error	T-Ratio	P-values
Constant	-1.8835	0.7572	-2.4872**	[0.015]
Vol	-0.0163	0.0083	-1.9643*	[0.053]
LnTO	-0.0454	0.0154	-10.467***	[0.000]
LnGE	0.2980	0.1541	1.9333*	[0.057]
CPI	-0.0442	0.0033	-13.314***	[0.000]
LnL	0.0664	0.1784	0.3723*	[0.068]
LnK	0.3226	0.1561	2.0668**	[0.042]

Note: ***, ** and * denote significance levels at 1%, 5% and 10% respectively
Source: Computed by the author using Microfit 4.1

The long-run results indicate that any disequilibrium in the system as a result of a shock can be corrected in the long-run by the error correction term. Hence, the error correction term that estimated the short-run adjustments to equilibrium is generated as follows:

$$ECM = \ln Y + 0.0163*Vol + 0.0454*\ln TO - 0.0393*\ln GE + 0.0442*CPI - 0.0664*\ln L - 0.3226*\ln K + 1.8835*Constant$$

Short Run Relationship

Once the long-run cointegrating model has been estimated, the next step is to model the short-run dynamic relationship among the variables within the ARDL framework. Thus, the lagged value of all level variables (a linear combination is denoted by the error-correction term, ECM_{t-1} is retained in the ARDL model. Table 8 presents the results of the estimated error-correction model of economic growth for Ghana using the ARDL technique. The model is selected based on the Schwarz Bayesian Criterion.

Table 8: Estimated Short-Run Error Correction Model using the ARDL Approach

ARDL(2, 0, 2, 2, 2, 0, 2) selected based on SBC Dependent Variable: ΔlnY

Regressor	Coefficient	Standard Error	T-Ratio	P-values
Constant	-0.5830	0.26166	-2.2283**	[0.029]
ΔlnY(-1)	0.8117	0.0604	13.4315***	[0.000]
ΔVol	-0.0431	0.0010	-42.481***	[0.000]
ΔlnTO	-0.0357	0.0025	-0.0502***	[0.000]
ΔlnGE	0.3037	0.0501	6.0531***	[0.000]
ΔCPI	-1.4307	0.1254	-11.404***	[0.000]
ΔlnL	0.2939	0.0685	4.2915***	[0.000]
ΔlnK	0.0554	0.0258	2.1497**	[0.035]
ECM(-1)	-0.1718	0.0289	-5.9432***	[0.000]

R-Squared	0. 7248	R-Bar-Squared	0.6309
S.E. of Regression	0.13835	F-stat. F(8, 79) 8.1242	[0.000]***
Mean of Dep. Variable	0.0337	S.D. of Dep. Variable	0.1767
Residual Sum of Squares	1.7473	Equation Log-likelihood	55.0684
Akaike Info. Criterion	44.068	Schwarz Bayesian Criterion	30.4430
DW-statistic	2.0726		

Note: ***, **, and * denote significance level at 1%, 5% and 10% respectively
Source: Computed by the author using Microfit 4.1

The results from the ARDL model as displayed in Table 8 suggest that the ultimate effect of previous period value of economic growth on current values of economic growth in the short-run is positive and statistically significant at 1 percent significant level. The implication is that current values of economic growth are affected by previous quarters' values of economic growth in Ghana. This is expected in that previous growth and expansion in the economy serves as an indication of prosperity and may attract more investment leading to more growth. This result is in line with findings in the empirical studies by Levine et al.(2000) as well as Vieira et al. (2013).

The results also showed the expected negative sign of error correction term lagged one period ($ECM_{t-1)}$ and it is highly significant at 1 percent significant level. This confirms the existence of the cointegration relationship among the variables in the model yet again. The ECM stands for the rate of adjustment to restore equilibrium in the dynamic model following a disturbance. The coefficient of the error correction term (ECM) is around – 0.1718. In other words, the significant error correction term suggests that a deviation from the long-run equilibrium subsequent to a short-run shock is corrected by about 17% at the end of each quarter in a year. The rule of thumb is that, the larger the error correction coefficient, that is, in absolute terms, the faster the variables equilibrate in the long-run when shocked.

Consistent with the long-run results, the coefficient of exchange rate volatility has the theorized negative impact on economic growth in the short-run. From the results, a 1 percentage point increase in volatility will reduce economic growth by approximately 0.04 percent in the short-run. We realise that volatility has higher impact in the short than long run.

With the control variables, the coefficient of trade openness has a negative impact on economic growth in the short-run. The coefficient of trade openness is statistically significant at 1 percent significant level. From the results, a 1 percentage point increase in trade openness will reduce economic growth by approximately 0.04 percent in the short-run. This confirms the results in the long run model.

In addition, the coefficient of government expenditure is statistically significant at 1 percent level, indicating that if government expenditure were to increase by 1 percent economic growth will increase by approximately 0.3 percent in the short run. This also corroborates the long run model results.

Again, the coefficient of inflation also maintained its negative sign and is statistically significant at 1 percent significant level which is consistent with the long-run results. The result therefore suggests that if inflation goes up by 1 percent, economic growth will decrease by approximately 1.4 percent in the short-run. Thus, the short-run and long-run results indicate that inflation has been a discouragement for economic growth in Ghana. The negative effect of inflation on economic growth seems more severe in short-run (-1.4) than in the long-run (-0.04). The results indicate how important it is to control inflation in the Ghanaian economy by putting in the appropriate policies. Its impact in both the short and long run appears to be debilitating as inflation generally proxy macroeconomic instability. This result is consistent with in the empirical literature.

Finally, inconsistent with the long-run estimate, the coefficient of labour force maintained its positive sign but statistically significant at 1 percent significant level. The results indicate that a 1 percentage point increase in labour force will increase economic growth by about 0.3 percentage points in the short run. The results suggest that labour force is important for economic growth in short-run than in the long-run. The coefficient of capital had it expected positive sign and is statistically significant at 5 percent level. This means that capital positively affect economic growth both in the short and long run in Ghana.

The R-Square shows that around 72 percent of the variations in economic growth are explained by the regressors in the model. It can be seen that the R-Square value 0.72 is less than the Durbin DW-statistic value of 2.07 indicating that the results are not spurious.

Model Diagnostics and Stability Tests

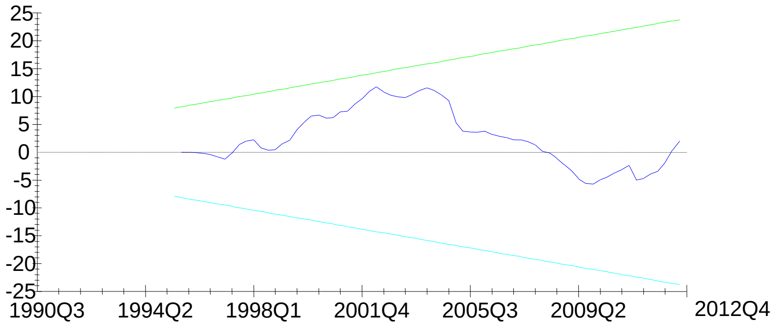
In order to check for the estimated ARDL model, the significance of the variables and other diagnostic tests such as serial correlation, functional form, normality, heteroskedasticity and structural stability of the model are considered. As shown in Table 9, the model generally passes all diagnostic tests in the first stage. The diagnostic test shows that there is no evidence of autocorrelation and the model passes the normality test indicating that the error is normally distributed. Additionally, the model passes the white test for heteroskedasticity as well as the RESET test for correct specification based on the probability values in parentheses.

Table 9: Model diagnostics

Diagnostics	LM-Version	F-Version
Serial correlation	$\chi^2_{Auto}(4)$ 2.597 [0.627]	F(4, 68)=1.624[.178]
Functional Form	$\chi^2_{RESET}(1)$ 0.547 [0.459]	F(1,71) =7.019[0.207]
Normality	$\chi^2_{Norm}(2)$ 0. 536[0.765]	Not Applicable
Heteroskedasticity	$\chi^2_{White}(1)$ 2.500[.114]	F(1,88)= 2.514[.116]

Source: Computed by Author using Microfit 4.1

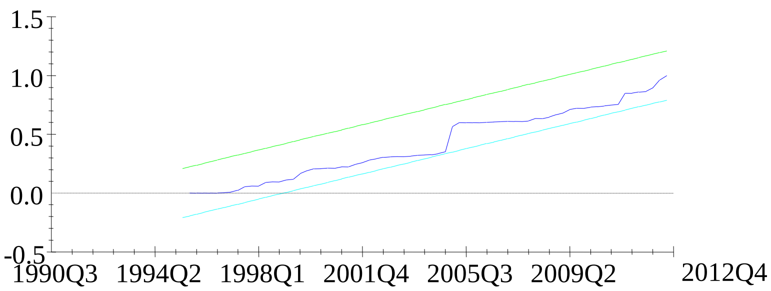
Finally, when analyzing the stability of the coefficients, the Cumulative Sum (*CUSUM*) and Cumulative Sum of Squares (*CUSUMQ*) are applied. Following Pesaran and Pesaran (as cited in Bahmani-Oskooee, 2004), the stability of the regression coefficients is evaluated by stability tests and they can show whether or not the parameter estimates are stable over time. This stability test is appropriate in time series data, especially when one is uncertain about when structural change might have taken place. The result for *CUSUM* and *CUSUMQ* are shown in Figures 1 and Figure 2.The null hypothesis is that the coefficient vector is the same in every period and the alternative is that it is not (Bahmani-Oskooee, 2004). The *CUSUM* and *CUSUMQ* statistics are plotted against the critical bound of 5 percent significance level. According to Bahmani-Oskooee (2004), if the plot of these statistics remains within the critical bound of the 5 percent significance level, the null hypothesis that all coefficients are stable cannot be rejected.



The straight lines represent critical bounds at 5% significance level

Figure 1: Plot of Cumulative Sum of Recursive Residuals

Note: The variable on the vertical axis is residuals whiles the variable on the horizontal axis is years in quarters.
Source: Generated by the author using Microfit 4.1



The straight lines represent critical bounds at 5% significance level

Figure 2: Plot of Cumulative Sum of Squares of Recursive Residuals

Note: The variable on the vertical axis is the square of the residuals whiles the variable on the horizontal axis is years in quarters.
Source: Generated by the author using Microfit 4.1

As shown in Figures 1 and 2, the plot of both the *CUSUM* and *CUSUMSQ* residuals are within the 5 percent critical bound (boundaries). That is to say that the stability of the parameters has remained within its critical bounds of parameter stability. It is clear from both graphs in Figures 1 and 2 that both *CUSUM* and *CUSUMQ* tests confirm the stability of the coefficients.

Granger Causality Test (Results for the third objective)

After establishing cointegration among the variables, Granger causality test was then applied to measure the linear causation between economic growth and exchange rate volatility. The results of the test are presented in Table 10.

Table 10: Results of Bivariate Granger causality test

Null Hypothesis:	F-Statistic	Prob.
Vol does not Granger Cause Y	5.71985	0.0447**
Y does not Granger Cause Vol	1.95333	0.1481

Note: **, and * denote significance level at 1%, 5% and 10% respectively
Source: Estimated by the author using E-views 6.0

The bivariate Granger causality test results in Table 10 reject the null hypothesis that the Vol does not Granger cause real GDP at 5 per cent level. The rejection of the null hypothesis indicates that exchange rate volatility causes growth in real GDP. However, the null hypothesis that real GDP does not Granger cause the exchange rate volatility cannot be rejected even at the conventional level. The results of Granger causality tests confirm causation from exchange rate volatility to economic growth.

Conclusion

This chapter has examined the time series properties of the data used for estimation, presented and discussed the results. Unit root test employing both the ADF and the PP techniques essentially showed that all the series had to be differenced once to achieve stationarity. This implied that all the series are integrated of order one, *I*(1). The presence of non-stationary variables implied the possibility of the presence of a long-run relationship among the variables, which the study verified using ARDL bounds test.

The results of the ARDL (2, 0, 2, 2, 2, 0, 2) model selected based on SBC show the presence of long-run and short-run relationship between economic growth and exchange rate volatility while controlling for trade openness, government expenditure, inflation, labour force and capital. Whereas exchange rate volatility, trade openness and inflation exerted negative and statistically significant impact on economic growth, a positive effect from government expenditure, labour force and capital to economic growth was found. However, labour force did not have any significant effect on economic growth in the long run. The take home message or the major finding of the study is that exchange rate volatility dampens or reduces economic growth of Ghana. Therefore policy must be targeted at reducing exchange rate volatility.

Also, the results of the ARDL (2, 0, 2, 2, 2, 0, 2) model selected based on SBC show that the error correction term (ECM_{t-1}) for economic growth carried the expected negative sign. The significant error correction term suggests that a deviation from the long-run equilibrium subsequent to a short-run shock is corrected by about 17% at the end of each quarter in a year.

The diagnostic and parameter stability tests revealed that the model passes the tests of serial correlation, functional form for misspecification, non-normal errors and heteroskedasticity at conventional levels of significance and the graphs of the CUSUM and CUSUMSQ indicate the absence of any instability of the coefficients because the plots of these graphs are confined within the 5 percent critical bounds of parameter stability suggesting that all the coefficients of the estimated ARDL model are stable over the study period. The Granger causality test results revealed a unidirectional causality from exchange rate volatility to economic growth.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The purpose of this chapter is to present the summary, conclusions and recommendations. The summary presents a brief overview of the research problem, objective, methodology and findings. The conclusions capture the overall outcomes regarding the findings of the study in light of the hypotheses. Recommendations also present specific policies to be implemented by financial policy makers. The chapter also presents the limitations of the study and make suggestions for future research.

Summary

This study specified an empirical model of economic growth for Ghana with specific focus on the role of exchange rate volatility. Specifically, the study investigated the long run, short run and the causal relationship between economic growth and exchange rate volatility while controlling for other growth determinants using quarterly time series data from 1990Q1 to 2012Q4.

In order to investigates the long and short run relationship between exchange rate volatility and economic growth, the Autoregressive Distributed Lag (ARDL) approach to cointegration and error correction was preferred to other techniques because of it several advantages over other alternatives.

Granger-causality test was employed to examine the direction of causality between exchange rate volatility and economic growth. The results of the Granger-causality test suggest that there is a unidirectional relationship between economic growth and exchange rate volatility with causality running from exchange rate volatility to economic growth.

The diagnostic tests results show that the model passes the test of serial correlation, functional form misspecification, non-normal errors and heteroscedasticity at conventional levels of significance. The graphs of the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) show that there is stability of the parameters.

Conclusions

The following conclusions are made from the study.

- The study in line with the empirical literature has shown that there exist a long-run and short-run relationship exchange rate volatility and economic growth with volatility negatively influencing growth.
- Again, the results presented in this study imply that capital, labour, trade openness, government expenditure and inflation are statistically important determinants of economic growth.
- Moreover, the study found a unidirectional causality between exchange rate volatility and economic growth. This means that exchange rate volatility leads to economic growth.

Recommendations

Taking into consideration the findings from the study, the following recommendations are proposed. Bank of Ghana needs to ensure a stable exchange rate in order to stimulate economic growth in Ghana. Thus, the Bank of Ghana needs to put measures in place to ensure a stable exchange rate for a long time.

Government of Ghana needs to improve her export or diversify her exports so that Ghana can export more than it imports to enhance growth. Another policy implication of the study is that the Government of Ghana needs to ensure that low inflationary rate is maintained in Ghana. Finally, Government of Ghana needs to spend on capital goods to enhance economic growth.

Limitations of the Study

One major limitation of this study was the availability of daily, weekly or monthly data on all variables from the Bank of Ghana and the World Bank.

Suggestions for Future Research

Since exchange rate is a high frequency phenomenon, daily, weekly or monthly data must be used when investigating the effect of exchange rate on macroeconomic variables. Future research can also look at how exchange rate volatility impact directly on international trade and investment in Ghana.

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