THE IMPACT OF REAL EXCHANGE RATE VOLATILTY ON ECONOMIC GROWTH: EVIDENCE FROM UGANDA

BY

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DECLARATION

I Ssemyalo William declare that this report is my original work and it is as a result of my own effort and experience as a student at the School of Economics and has never been submitted to any University or Institution of higher learning for acquisition of similar awards.

The information that has been used in this report is acknowledged.

…….. ……..

Ssemyalo William **Date:**

APPROVAL

The undersigned certify that they have read this dissertation titled “the impact of real exchange rate volatility on economic growth: evidence from Uganda” in the process of guiding the author and therefore recommend it for submission to the directorate of research and graduate training in partial fulfillment of the requirements for the award of a Masters of Arts Degree in Economics of Makerere University.

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DEDICATION

To my parents who have supported me both financially and emotionally through my education journey.

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LIST OF ACRONYMS

BOU	:Bank of Uganda
G2S	:General To Specific Model
GARCH	:Generalized Auto-Regressive Conditional Heteroscedasticty
GDP	:Gross Domestic Product
lnG	:Log of Government Expenditure
lnE	:Log of Exports
lnI	:Log of Imports
lnL	:Log of Labor
lnV	:Log of Real Effective Exchange Rates Volatility
lnY	:Log of GDP Per Capita
NEER	:Nominal Effective Exchange Rates
REER	:Real Effective Exchange Rates
REERV	:Real Effective Exchange Rates Volatility
VECM	:Vector Error Correction Model
WDI	:World Development Indicator

ABSTRACT

The study examined the impact of real effective exchange rate volatility on economic growth in Uganda. The study used quarterly time series data for the period of 1993 to 2015. The Johansen cointegration and vector error correction model was used to determine the impact real exchange rate volatility on economic growth in Uganda. The explanatory variables in this study were real exchange rate volatility, government expenditure, labor, exports and imports. Results from the study revealed that real effective exchange rate volatility, labor, government expenditure and exports were found to be statistically significant in explaining economic growth of Uganda in the long run with all having positive relationship. However imports were found to have a negative relationship with economic growth in the long run. In the short run real effective exchange rate volatility and imports had negative relationship with economic growth. From the regression results study recommends that in order to spur economic growth the government should introduce import substitution both in the short run and long run. The government should also intervene in foreign exchange market only in the short run. The government should take significant steps to increase the standard of exported goods to make smooth balance of trade. There should be an increase in government expenditure in human capital because this will spur economic growth in the long run.

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CHAPTER ONE

INTRODUCTION

1.0 Background to the study

After the breakdown of Bretton Woods system, the effect of exchange rate volatility on economic growth has gained considerable attention (Bakhromov, 2011; De Grauwe, 1998; Kouri, 1976; Narayan, 2006; Krugmam, 2008). Since most developing economies have fragile financial systems and are highly vulnerable to external shocks (Aghion et al., 2009) exchange rate volatility is a major concern to their governments. Empirical studies have also found mixed results on the impact of exchange volatility on economic growth (Aghion et al., 2009; Arratibel et al., 2011 ; Schnabl, 2008 ,2009;). Some have found no impact of exchange volatility on economic growth (Bleaney and Greenway, 1998) while others have found a negative impact on economic growth (Arratibel et al., 2011; Boar, 2010 ; Schnabl, 2008, 2009). In Africa, evidence of exchange rate volatility on economic growth is scarce and also has mixed results. Musyoki et al. (2012) found a negative significant effect of real exchange rate volatility on economic growth of Kenya. While Adewuyi and Akpokodje (2013) found a significant positive effect when they used panel data on African countries .

In Uganda's case studies mainly have been done on impact exchange rates on inflation[1], non-traditional export performance[2] and economic development[3] but few have been done on impact of exchange rate volatility on economic growth. For instance only one study has so far been done on the impact of exchange rate volatility on economic growth by Katusiime et al. (2016) who found that exchange rate volatility positively

[1] Policy, E. R. Inflation: The Case of Uganda, by Barbara Mbire. *Research Paper*, *59*.

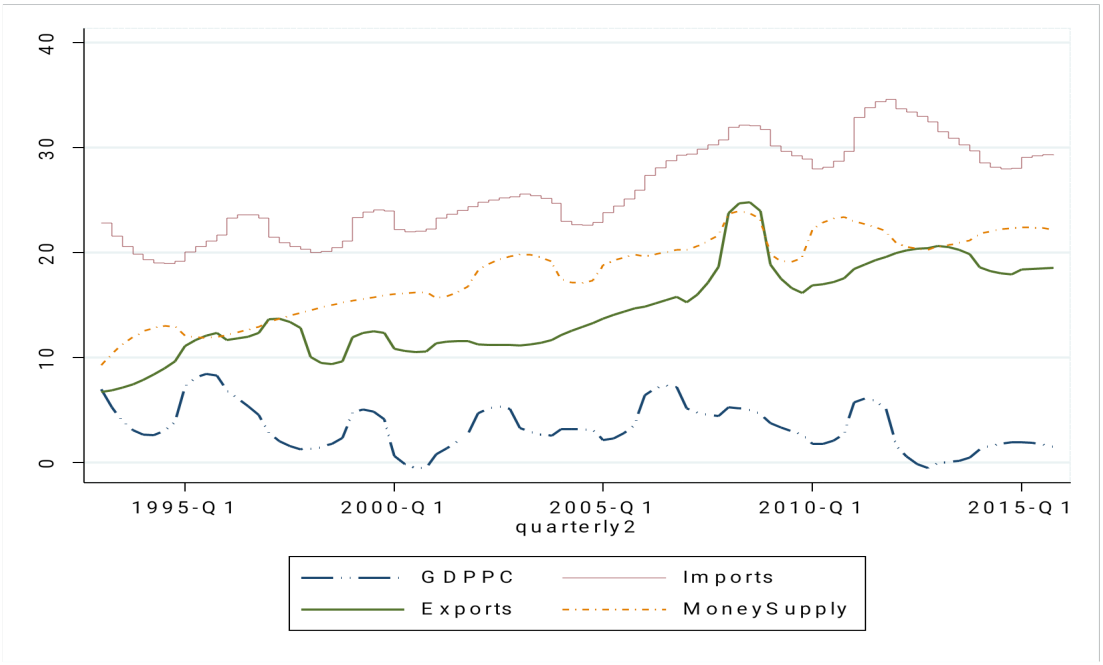
[2] Atingi-Ego, M., & Sebudde, R. K. (2004). *Uganda's equilibrium real exchange rate and its implications for non-traditional export performance* (pp. 1-43). African economic research consortium (AERC).

[3] Kasekende, L., & Ssemogerere, G. (1994). Exchange rate unification and economic development: The case of Uganda, 1987–92. *World Development*, *22*(8), 1183-1198.

affects economic growth in Uganda both in the short run and long run. This study gives a reason for another study focusing on Uganda under the flexible exchange rate system running 1993Q1 to 2015Q4 in contrary to Katusiime et al. (2016) study which was carried out under different exchange regimes thereby bringing out the fact that different exchange rate regimes yield different economic outcomes which the earlier study ignored.

In 1993 the dual foreign exchange rates were unified by introducing interbank currency auctions. Also in 1993 the Uganda Revenue Authority was established to improve tax revenue collection and the Bank of Uganda was given autonomy in supervising commercial banks. Finally in November 1995 to 1999 a managed float for official markets was introduced which was characterized by market determined official rates and intervention into the market to stabilize and meet specific objectives (Atingi-Ego et al. 2004). However, these monetary reforms in Uganda being done and introduction of authorities like Uganda Investment Authority which promotes and facilitates investments have had little impact on economic growth of Uganda. This is indicated by the performance key macroeconomic indicators against economic growth a shown in Figure 1 below.

Figure 1: GDP PER CAPITA GROWTH RATE, MONEY SUPPLY , EXPORTS, IMPORTS OF UGANDA (1993 to 2015)



Source: WDI (2017)

The real exchange rate (RER) compares the relative price of two countries' consumption baskets. From a theoretical perspective it has been well established that real exchange rate disequilibrium and heighted uncertainty regarding RER behavior have negative effects on economic performance (Willet, 1986). Eichengreen et al. (2003) argue that in the presence of foreign debt, swings in the real exchange may have important wealth effects and it is an important determinant of macroeconomic volatility. This is because the size of wealth will depend on how persistent the shocks are perceived to be. Also evidence by Hausman and Rodrik (2003) reveal that that the level of real exchange rate is a strong predictor of growth accelerations possibly because it favors self discovery process. Cote (1994) notes that RER volatility can cause uncertainty of profits on contracts denominated in foreign currency which reduces economic growth to levels below what they would have been if uncertainty was removed.

1.2 Statement of the Problem

Uganda is a small open economy which liberalized the exchange rate regime in 1993 for current account and in 1997 for capital account. Since the adoption of the floating exchange rate system, where market forces determine the value of the shilling in relation to other foreign currencies. The Uganda shilling has depreciated against major currencies especially the dollar. This worried many people in the business community because they are concerned about the developments in the exchange rates. Over the course of the 2014/15 fiscal year the Uganda shilling depreciated against the dollar by 27 per cent. This caused export commodity prices to fall and demand in key export markets to weaken which made it difficult to mobilize capital on international markets. The depreciated shilling saw an increase in the operational and production costs for big businesses which conduct their businesses in US dollars as well as the importers had to import their goods expensively. This has made Uganda's economy to grow at a slower pace hence reducing its impact on poverty. This is seen by the decline in the average annual growth of 7 per cent which was achieved during the 1990s and early 2000s to 4.5 per cent average annual growth which was achieved in the five years to 2016 according the world bank (2018) so a need for a study on the impact exchange rate volatilities on economic growth. Therefore this study is aimed at adding on the empirical literature of Uganda and also to inform policy makers and help they make informed decisions about our monetary instruments.

1.3 Research Objectives

The main objective of this study is to identify the effect of exchange rate volatility on economic growth in Uganda. The study will specifically focus on the following specific objectives:

I. To investigate the impact of real exchange rate volatility on economic growth.

1.4 Justification and significance of the study

Exchange rate volatility generally affects the performance of the economy (Willet, 1986). In Uganda's case a few studies have been done and the most recent one being done by Katusiime et al., (2016) who used annual data, nominal exchange rate and

ARDL method to investigate the effect of exchange rate volatility on economic growth. They found that exchange rate volatility positively affects economic growth in both the short run and the long run. The current study is going to add on literature by focusing on only the flexible exchange regimes since Katusiime et al.(2016) study said that different exchange rate regimes provide different growth outcomes but their study did not provide different results for the different exchange rate regimes. This is the gap this study wants to fill by focusing on the flexible exchange rate regime using the vector error correction model (VECM) because all the variables are stationary at first difference and VECM has nice interpretations with long term and short term equations. General to specific (G2S) model, impulse response functions (IRP) and the variance decomposition will also be used as estimation techniques. The study will also use the real exchange rate as opposed to nominal exchange rate because it the one that affects the long run external equilibrium position of a country (i.e., current account). Finally for countries with relatively low levels of financial development (Uganda inclusive), exchange rate volatility generally reduces growth where as for financially advanced there is no significant effect (Aghion et al., 2009) which renders Katusiime's research results contradictory. It is this gap that I want to fill and the research will help policy makers to make policies that will advocate for macroeconomic stability since this contributes positively to economic growth.

1.5 Hypothesis

H_0: **Real Exchange rate volatility has a significant impact on economic growth.**

H_0: **Real exchange rate volatility does not have a significant impact on economic growth**

1.6 Scope

The study is going to focus on Uganda using time series quarterly data of 89 observations on real effective exchange rates, government expenditure, GDP per capita, labor, exports and imports got by interpolation using STATA which is going to run from 1993Q1 to 2015Q4.

1.7 Organization of the study

Chapter 1 provides the introduction and background to the study. Chapter 2 reviews both theoretical and empirical literature pertaining to the relationship between the real exchange rates volatility and economic growth in Uganda from 1993 to 2015. Chapter 3 presents the methodology. Chapter 4 presents the estimation techniques and interpretations of the results. Chapter 5 presents a summary conclusions and policy recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Literature

This section presents the reviewed literature on exchange rate volatility and economic growth from both developing and developed countries. The literature is broadly categorized into theoretical and empirical literature and ends with a summary to highlight the existing gap which this study intents to fill.

2.1 Theoretical Literature

The traditional flow model defines exchange rate as the product of the interaction between the demand for and supply of foreign exchange. The model attains equilibrium when supply equals demand for foreign exchange. There is adjustment of exchange rates to balance the demand for foreign exchange which depends on the demand a

domestic resident has for domestic goods and assets. This takes place on the assumption that the foreign demands for domestic goods is determined essentially by domestic income, relative income which play a role in determining exchange rate under the flow model. Domestic and foreign interest rates differential is other major determinants of the exchange rate in this frame work.

Furthermore under the traditional flow model for example the balance of payments model, the exchange rate is assumed to equilibrate the flow of supply and demand of foreign currency. The balance of payments by deficits in current account is offset by surplus in the capital account. The major limitation of the traditional model include the over-shooting of the exchange rate target and the fact that substitutability between money and financial asset may not be automatic and this led to the development of the monetary approach.

This approach identifies exchange rate as a function of relative shift in money stock. The Purchasing Power Parity (PPP) is also a major component of the monetary approach. The monetary approach is a recent development in the theory exchange rate determination which views the exchange rate as being the relative prices of two assets which is determined primarily by the relative supplies and demand for those monies and that is the equilibrium exchange rate is attained when the existing stocks of the two monies which are willingly held. The monetary approach therefore argues that a theory of exchange rate should be stated conveniently in terms of the supplies of and demands for these monies. This new theory of exchange rate determination can be presented in one or two terms and that is the monetary approach or the asset market approach of exchange rate determination. These are several versions of the monetary approach to exchange rate determination. The early flexible price model is based on the price monetary model as based on the assumptions of continued purchasing power parity and the existence of stable money demand functions for the domestic and foreign economies.

This flexible price model was extended to create the sticky price monetary model which

allows accommodation of short-term deviation from PPP in other words, the sticky price model accepts the fact that there may be deviations from PPP in the short-run and the long-run but the deviations will tend to disappear. The sticky-price monetary theory takes interest rate differentials as captured by exchange rate deviation. Price exchange is an automatic and in response to changes are automatic and in response to exchange rate changes. Inflation therefore depresses the exchange rate unlike the BOP model where the effect of GDP on exchange rate is positive. It is negative in the sticky-price monetary theory

Purchasing power parity theory of exchange rate determination which assumes the absence of the trade barriers and transactions cost and existence of the purchasing power parity (PPP). The purchasing power parity (PPP) equates the equilibrium exchange rate of the ratio of domestic to foreign price level.PPP being is a major element of the monetary approach, the PPP between the two currencies as provided by Cassel (1998) is the amount of the purchasing power. The PPP is long-term approach used in the determination of equilibrium exchange rate. It is often applied s a proxy for the monetary model in exchange rate analysis.

The elasticity approach's success depends on devaluation in order to improve the balance of trade taking into account the balance of payment depends upon the demand elasticity of import and export of the devaluing country. Improvement in the balance of trade will depend upon whether the demand for imports and exports is elastic. Devaluation makes import of the devaluing country costlier than before and in case her demand for imports is elastic, a higher amount will be adversely the balance of payment of the devaluing country. However, if her demand for exports is elastic then with a fall in the prices of exports as a result of devaluation there will an increase in demand of her exports by other countries since they have become cheaper. The imports of the country will also be significantly reduced by devaluing country.

The Portfolio model defines exchange rate as the result of the substitution between money and financial assets. The monetary approach gives no room for current movements to play a role in the determination exchange rate. Thus monetary approach cannot explain the often observed tendency of the currency of a country with a current account deficit to depreciate or appreciate. This apparent shortcomings of the monetary approach is said to be related to its rather narrow view of an exchange rate as the relative price of two monies in addressing this shortcoming the portfolio balance approach posits that an exchange rate as determined at least in short run by the supply and demand in the markets for a wide range of financial assets. The model assumes that individual allocate their wealth which is fixed at a point in time among alternative assets. Domestic money domestically issued and foreign money denominated in foreign currency in a simple one-country model.

Theories of economic growth provide the empirical framework for the study, the classical theory of economic growth assumed the existence of a perfectly competitive economy where invisible hand allocates resources efficiently. The classical economists consider capital accumulation as key of economic development. The Harrods Domar growth model is that net investment has a dual effect in that, on one hand it constitutes a demand for output and the other hand it increase the total productive capacity of the economy. The mechanism through which economic development is accomplished is net investment. Both Harod as well as Domar assume fixed capital output ratio, for example a rigid relationship between capital stock and output.

The neoclassical growth theory on the other hand stresses efficiency in the allocation of resources and largely ignores social and political factors in economic growth. Disregarding of growth in national output relative to poverty and imbalance among sector continued to increase. The structural change theories of which Arthur Lewis two sector surplus labor theory addressed these structural distortions. The expected growth of output and employment in the modern sector may both be realized. This is so when capital stock embodying labor saw technical progress which is used in the modern sector in such a situation the expected transfer of the assumed surplus labor from the

traditional to the modern sector has often failed to nationalize structural change theory, therefore emphasize the desegregation of the economy to facilitate greater understanding of the development process. In traditional neoclassical growth theory the emphasis on capital formation has favored the use of more capital relative to labor in order to increase output. Capital formation has been emphasis as it related to the production of capital goods, like machines, plants and equipment. To measure economic growth economist use data on Gross Domestic product (GDP) which measures the total income of everyone in the economy, the real GDP per person, also observed large differences in the standard of living among countries.

The Solow growth model shows how growth in the labor force and advances in technology interact and how they affect output. The first steps in building the model, we examine how the supply and demand for goods determine the accumulation of capital. To do this, we hold the labor force and technology fixed later we relax these assumptions, fixed by introduction changes in technology. The Solow growth model enables us to describe the production, distribution and allocation of the economy's output at a point in time. More so, the Solow growth model shows how savings, population growth and technological process affect the growth of output over time. The supply of goods in the Solow model is based on the low familiar production function Y=F (K, L). Output depends on the capital stock and the production function has constant returns to scale.

However the new endogenous growth model propounded that technological changes is endogenous to growth because it is responsible to the signal as price and profits in the economic system, the endogenous growth theorists introduced the concept of human capital as a factor for growth, these new growth theorist include Mankiw, Romar and well, Arrow, Villanueva Rebelos AK Model. The increasing returns theorist opposed the one classical growth theory that are subject to decreasing return and said that the investment in some new area, product, and power source or production technology proceeds through time that each new increment or investment is more productive than the previous increment, the source of these increasing return can be seen through cost

and ideas. Investment in the early stages of development may create new skill and attitudes in the work force whose cost may be lower than the previous investment at the initial stage. Also each investor may find environment that are conducive to invest because of the infrastructure that has been created by those who came before.

2.2 Empirical literature

Literature argues that exchange rate volatility impacts negatively some of the key variables that determine economic growth such as trade and investment this is seen by Goldberg and Kolstand (1994) who found that extermination or delay in investment may be caused by excessive exchange rate volatility especially when costs of adjustment to exchange rate volatility are high or irreversible. Many studies show negative impact of exchange rate volatility on investment (Aghion et al., 2009; Arratibel et al., 2011). Other studies have found no effect of exchange rate volatility on investment (Bleany and Greenaway, 1998). There also those who have shown positive effect on investment (Goldberg and Kolstand, 1994). Furthermore international trade may be reduced because of exchange rate volatility as investors direct their investments to less risky ventures (Clark, 1973). However new opportunities may be created as market participants are directed to new opportunities due to exchange rate volatility resulting into increase in trade. McKenzie (1999) generalized that literature did not suggest an equilibrium vocal link between exchange rate volatility and trade.

Literature provides mixed views on the context of effect of exchange rate volatility on economic growth. A study by Polodoo et al. (2007) investigated the impact of exchange rate volatility on macroeconomic performance in small island developing states. The result revealed that exchange rate volatility positively impacts on economic growth. Azee et al. (2012) examined the effects of exchange rate volatility on macroeconomic performance in Nigeria for a period of 25 years ranging from 1986 to 2010. The result found that the RER volatility contributes positively to GDP in the long run. Also Mahmood and Ali (2011) examined the impact of exchange rate volatility on macroeconomic performance of Pakistan using ordinary least squares method and found a positive relationship between exchange rate volatility and economic growth.

Investigation of the impact of exchange rate volatility on economic growth on small open economies at the European Monetary Unity (EMU) periphery was conducted by Schnabl (2007). He performed both GLS and GMM and the result provided evidence that exchange rate volatility has negative impact on economic growth. Eichengreen and Leblang (2003) found strong negative relationship between exchange rate stability and growth for 12 countries over a period of 120 years. The link between growth and exchange rate volatility was examined by Holland et al (2011) for a set of 82 advanced and emerging economies using a panel data set ranging from 1970 to 2009. They also found out that a more volatile RER has significant negative impact on economic growth and the results are more robust for different model specification. Also Arritibel et al. (2011); Boar, (2010) and Schabl, (2008, 2009) found that exchange rate volatility impacts negatively on economic growth.

Using panel estimations for more than 180 countries Edwards and Levy Yeyati (2003) found evidence that countries with more flexible exchange rate grow faster. In assessing the impact of exchange rate regime on growth, Levy Yeyati (2003) conducted a study for a sample of 183 countries over post-Bretton wood period (1974-2003). They found out that fixed exchange rate regimes has negative impact on economic growth especially for developing countries as opposed to flexible exchange rate regime which is associated with higher economic growth. Huang and Molhorta (2004) investigated the impact of exchange rate regime on economic growth rates for developing Asian and advanced European countries. Their findings indicated that the importance choice of exchange rate regime depends on the level of economic development of a country. For developing economies, fixed exchange and managed float is associated with high economic growth. However, for advanced economies, regime choice has no significant impact on economic growth. Yoon (2009) showed that the real exchange rate demonstrates different patterns of behavior depending on the exchange rate regime in place.

Azid et al (2005) studied the impact of exchange rate volatility on growth and economic performance for Pakistan for the period 1973 to 2003. They were not able to find evidence suggesting that economic growth is affected by exchange rate volatility. This difference in results is argued to have been caused by the differences in country

specific factors like human capital, physical capital and institutional setting (Schnabl, 2008; Frankel, 1999; Husain, Mody and Rogoff, 2005).

For the case of Africa literature on impact of exchange rate volatility on economic growth is very sparse and their conclusions are ambiguous. Ghura and Grennes (1933) and Bleany and Greenway (2001) using sub-Saharan countries found that economic growth is not significantly affected by exchange rate volatility. However Adewuyi and Akpokodje (2013) found positive and significant effect of exchange rate on economic growth when they used panel data on African countries running from 1986 to 2011 and found that non-francophone countries including Uganda had more significant effects than the francophone countries. In Uganda only one study has so far been done by Katusiime et al. (2016) and found that exchange rate volatility positively affects economic growth (using nominal exchange rates)both in short run and long run. In contrast a study in Kenya by Musyoki et al. (2012) found that real exchange volatility has a significant negative impact on economic growth of Kenya.

2.3 Summary

The empirical literature gives us a clear indication that consensus has not yet been reached in regards to the impact of RER volatility on economic growth. This is seen by some studies showing a significant positive relationship between RER volatility and economic growth (Polodoo et al. (2007); Azee et al. (2012); Mahmood and Ali (2011)) while others are having a significant negative relationship (Arritibel et al. (2011); Boar, (2010), Eichengreen and Lebrang (2013) and Schnabl, (2008,2009)). Some studies also have found no relationship (Azid et al (2005)). In Uganda's case there are few studies which have been conducted in with the latest being done by Katusiime et al. (2012). They used ARDL approach to investigate the effect of exchange rate volatility on economic growth in Uganda using annual data. Therefore this study aims to provide further evidence on the impact of real exchange rate volatility on economic growth with evidence from Uganda by using GARCH based measure to capture exchange rate volatility because of its ability to capture non-constant time varying conditional variance and describe volatility clustering. It will employ the VECM and will use quarterly data

instead of annual data used before because high frequency data easily captures volatility. This study will run from 1993Q1 to 2015Q4 which is the post liberalization period.

CHAPTER THREE

METHODOLOGY

3 Introduction

This chapter presents the methodology used in the study in investigating the impact of exchange rate volatility on economic growth of Uganda. The chapter comprises five sections. Section 3.1 presents the analytical framework that explains the impact of exchange rate volatility on economic growth. Section 3.2 presents the empirical model for the analysis of the impact of exchange rate volatility and selected macroeconomic variables on economic growth. Section 3.3 presents the measure of volatility using GARCH. Section 3.4 presents the data sources and the measurement of the study variables. Section 3.5 presents the estimation strategy while the last section provides the summary for the chapter.

3.1 Analytical Strategy

The study employed a Cobb-Douglas production augmented with knowledge capital (NK) as in the Romer (1990) and Grossman and Helpman (1991a) type of models. The augmented Cobb-Douglas production function with constant returns to capital but with constant or increasing returns to knowledge capital is:

$$Y = AK_t^{\beta}L_t^{\alpha}(NK)_t^{\gamma}e_t^{\mu} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where Y is output, NK is knowledge capital with $Y \geq 1$, K is physical capital, L is labor, A

is the technical efficiency and e is the error term. We introduced the shift variables into the endogenous specification as NK is the vector of the shift variables. The shift variables in our study include V which is the real effective exchange rate volatility, I is imports, G is government expenditure and E are exports. These variables are used because they are standard control variables used in empirical models.

$$Y_t = AK_t^{\beta}L_t^{\alpha}\left(V^{\gamma_1}I^{\gamma_2}G^{\gamma_3}E^{\gamma_4}\right)_t e_t^{\mu} \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

From the theoretical model we took logs of the variables which gave us the estimated model which is specified as follows.

$$\ln Y_t = \ln A+\beta\ln K_t+\alpha\ln L_t+\gamma_1\ln V_t+\gamma_2\ln I_t+\gamma_3\ln G_t+\gamma_4\ln E_t+e_t \ldots(3)$$

The shift variables in our study include V which is the real effective exchange rate volatility got by using GARCH, I is imports measured as percentage of GDP, G is government expenditure measured gross final government consumption, L is labor measured as growth rate of productive workforce (ages 18 to 60years) and E is exports measured as percentage of GDP. These variables are used because they are standard control variables used in empirical models[4].

3.2 Definitions and Measurements Of the Study Variables.

Economic Growth(Y)

Y is the GDP per capita which is the measure of a country's economic output that accounts for its number of people according WDI 2019. It divides the county's gross

[4] As Sala-i Martin (1997) indicated, 60 variables can be found that are significant in growth regressions. We selected our control variables following Temple (1999) and some empirical growth studies such as Loayza and Ranciere. (2006), and Levine *et al.* (2000). We do not include terms of trade and inflation because terms of trade is highly correlated with our main variable of interest, inflation is generally considered as a short term determinant of growth as in Temple (1999).

domestic product by its total population.

Real Exchange Rate Volatility (V)

Other studies have used standard deviation method but it has two weaknesses one being the assumption of empirical distribution of RER being normal and secondly the distinction between unpredictable and predictable elements in the exchange rate process is ignored. Further the use of standard deviation methodology has been discouraged as measure of RER volatility because RER data has a tendency to be skewed in terms of distributions or volatility clusters.

Therefore this study is going to use the Generalized Auto-Regressive Conditional Heteroscedasticty (GARCH) method. Bollerslev (1986) extended the ARCH class to produce the Generalized Auto-Regressive Conditionally Heteroskedastic (GARCH) model. If the real effective exchange rate follows an ARCH (1, 1) process, then it permits the use of the GARCH series as a measure of REER volatility on the assumption that the error term is not auto-correlated. The variance is shown below in the case of GARCH (k, m).

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2\varepsilon_{t-2}^2 + \ldots + \alpha_m\varepsilon_{t-m}^2 + \beta_1\sigma_{t-1}^2 + \beta_2\sigma_{t-2}^2 + \ldots + \beta_k\sigma_{t-k}^2 \ldots.(4)$$

Where σ_{t-j}^2 for j= 1, 2 ….k denotes last period forecast variance. Before computing volatility using ARCH, the study tested for the presence of ARCH effects. The study then generated a measure of volatility using the GARCH (1, 1) model.

Capital (K)

Capital is a factor of production or input into the process of production such machinery, buildings or computers. In the study capital is measured as gross capital formation as a percentage of GDP.

Labor (L)

Labor is the amount of physical, mental and social effort used to produce goods and services in an economy. The study uses population as the proxy for labor and is measured as the growth rate of productive work force (ages 18 to 60).

Government Expenditure (G)

Government expenditure refers to the purchase of goods and services, which include public consumption and public investment, transfer payments consisting of income transfers and capital transfer. In the study government expenditure is measured as the gross final government consumption.

Exports (E)

Exports are goods and services produced in one country and are purchased by residents of another country. The study measures E as exports of goods and services as a percentage of GDP.

Imports (I)

Imports are foreign goods and services bought by residents of a country. The study measures I as imports of goods and services as a percentage of GDP.

3.3 Data source

The study uses secondary data from World Development Indicators. The study runs from 1993Q1 to 2015Q4 using quarterly data.

3.4 Estimation Strategy

3.5 Unit root test

Since we have used time series in our equation 4 above, we need to investigate the

integration properties of the series before we carry out the estimation. A unit root test is carried out because the co integration tests can only be applied on variables that are non stationary at levels (contain a unit root). A time series is said to be stationary if its mean, variance and covariance remain constant over time, Thomas (1997).

Dickey and Fuller (1979, 1981); and Said and Dickey (1984) developed a method (Augmented Dickey-Fuller test (ADF) to test for unit root. Tests conducted, include drift term both with and without a trend. Inclusion of a trend allows testing whether the series is trend or difference stationary (Amnedo and Pozo (2001), Sinha (1999); Pesaran and Smith (1998). However, if the underlying time series are non-stationary it can lead to spurious regression (Granger and Newbold, 1974). This leads to the rejection of the results and the series should be dropped until when you get series that are stationary.

ADF regression is based on the following equation;

$$\Delta y_t = \alpha_0 + \pi y_{t-1} + \sum_{j=1}^{\rho} \beta_j \Delta y_{t-j} + \varepsilon_t \quad \text{..... (5)}$$

Where y_t represents the variable whose time series properties are being investigated, Δ is the difference operator and ε is the error term and is $\approx iid\ (0, \delta_2)$ with t=1…n and was assumed to be Gaussian white noise. The augmented terms added convert the residuals into white noise without affecting the distribution of the test statistics under the null hypothesis of a unit root against the alternative of trend stationarity.

Phillip Perron Test

Phillips and Perron (1988) suggested a non-parametric method of controlling for higher order autocorrelation in a series. This approach relaxes the assumptions about autocorrelation and hetroscedasticity as compared to its ADF counterpart. It's advantages over the ADF in that PP tests are robust to general forms of hetroscedasticity in the error term and the user does not have to specify a lag length for test regression. Besides, the PP test deals with potential serial correlation in the errors by employing a correction factor that estimates the long run variance of the error process with a variant of the Newey-West formula. The test therefore was based on the

following first order Auto-regressive [AR (1)] process;

$$\Delta y_t = \beta D_t + \pi y_{t-1} + \varepsilon_t \quad \ldots\ldots (6)$$

Where y_t is the variable of interest, D_t is the deterministic component (constant or constant and trend) and ε is I (0) and may be heteroscedastic. The PP test corrects for any serial correlation and heteroscedasticity in the errors. This estimation is based on Barlett Kernel. The optimum bandwidth in the PP equation was selected based on Newey-West (1994) method. The critical values tabulated by Mackinnon (1996) are used in making inferences regarding the time series properties of the variables.

The Cointegration Test

After testing for stationary of the variables and ascertaining their order of integration, a cointegration test is carried out. The concept of cointegration is based on the idea that although economic time series individually exhibit non stationary behavior, an appropriate linear combination between trending variables could remove the trend component and thus the time series could be cointegrated. This is relevant to the problem of determination of a long run or steady state equilibrium between economic relationships, where economic forces are in balance and there is no tendency to change. Upon being detected, the long run relationship can be tested for its validity.

In this study, the Johansen's Cointegration test is carried out. This is done in order to test the rank or number of cointegrating relations as opposed to the Engle Granger Methodology which only assumes one cointegrating equation regardless of the number of the series. The Johansen and Juselius (1990) methodology is used because it allows us to estimate multiple long run relationships between a series of non-stationary

variables through cointegrating vectors. Given a vector Y_t of n variables which can be represented as

$$Y_t = \phi_0 + \sum_{i=1}^{p} \phi_i Y_{t-i} + \varepsilon_t \quad \text{Where } \varepsilon_t \approx ii(0, \delta^2) \ldots\ldots\ldots \quad (7)$$

The Johansen cointegration representation of Y_t is expressed as below;

$$\Delta Y_t = \phi_0 + \sum \phi_i \Delta Y_{t-1} + \alpha\beta' Y_{t-k} + \varepsilon_t \ldots\ldots\ldots \quad (8)$$

Where Δ is the difference operator, ϕ_0 represents the intercept and ε_t is the vector of the white noise processes. The matrix β consists of the r cointegrating vectors where $(r \leq n-1)$. Similarly, the matrix ϕ is a vector of error correction parameters. In equation 7 above, the null hypothesis is that the matrix $(\pi = \alpha\beta')$ has a reduced rank of $(r \leq n-1)$. The alternative hypothesis on the other hand is that $(\pi = \alpha\beta')$ has a full rank. The Johansen's cointegration procedure produces two likelihood ratio test statistics namely, the trace statistics and the maximum Eigen value. The number of significant non zero Eigen value determines the number of cointegrating vectors in the system.

After completion of unit root testing on the time series and assuming that all the series are integrated of the same order, a bivariate Johansen cointegration test is conducted between each of the variables in the model. The Johansen process is a maximum likelihood method that determines the number of cointegrating vectors in a non-stationary time series Vector Auto-Regression (VAR) with restrictions imposed Johansen and Juselius (1990).

Granger Causality Test

The Granger causality test is a statistical hypothesis for determining whether one time series is useful in forecasting another. Ordinarily, regression reflects "mere" correlations, but Granger (1969) argued that certain set of tests reveal something about causality. A time series X is said to Granger-cause Y if it can be shown on lagged values of X (and with lagged values of Y also included), that those X values provide statistically significant information about future values of Y. The idea of Granger causality is that, whenever there is a shock in the explanatory variable that leads to a later increase in the

outcome variable, we call this variable Granger causal and is said to granger cause the other. Thus, the Granger-causality model is specified as follows;

$$\Delta y_t = \delta_1 + \sum_{i=1}^{n} \alpha_{11} \Delta y_{t-n} + \sum_{i=1}^{n} \beta_{12} \Delta x_{t-n} + \varepsilon_{1t} \quad (9)$$

$$\Delta x_t = \delta_2 + \sum_{i=1}^{n} \alpha_{21} \Delta y_{t-n} + \sum_{i=1}^{n} \beta_{22} \Delta x_{t-n} + \varepsilon_{2t} \quad (10)$$

Where n is the maximum lag-length; and ε_{1t} and ε_{2t} are additive stochastic error terms, which are by assumption normally distributed with zero mean and a constant variance. In light of equations (9) and (10), we can deduce two testable hypotheses:

$\sum \beta_{12} = 0$ While $\sum \alpha_{11} \neq 0$, that is X does not Granger-cause Y (no causality from X to Y), while

$\sum \beta_{22} \neq 0$ While $\alpha_{21} = 0$, that is Y does not Granger-cause X (no causality from Y to X)

Acceptance of either hypotheses would suggest the existence of unidirectional causality between X and Y and the feedback between X and Y may be implicit to exist if $\sum \beta_{i2} \neq 0$ and $\sum \alpha_{i1} \neq 0$.

Error Correction Model (ECM)

The Error Correction Model (ECM) by Granger (1986) is used to model the short-run effects of real exchange rate volatility on economic growth and also provide the short run dynamics necessary to obtain the long run equilibrium.

The ECM within the VAR framework takes the form;

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{i=0}^{p} \beta_i \Delta X_{t-i} + \lambda_Y ECT_{-1} + \varepsilon_t \quad (11)$$

Where is ΔY_t is the GDP per capita growth in first difference at time t, ΔX_{t-i} represents the matrix of traditional first differences of some regressors at lag t-i. ECT_{-1} is the error

correction term at first difference while P is the optimal lag length. λ_y is the measure of speed of adjustment once the variables are not in equilibrium.

Other Tests in VECM

Impulse Response Function (IRF)

According to Pesaran and Shin (1998), the impulse response function traces out the responses the direction of current and future values of each of the variables to a unit increase in the current value of the VAR errors. The analysis assumes that the error returns to zero in subsequent periods and that all other errors are equal to zero. These shocks affect several periods in the future and the implied thought experiment of changing one error while holding the others constant makes most sense when the errors are uncorrelated across equations. Suggested error bands indicate the level of significance. If the error bands are both lying in the same positive quadrant, that implies a significant positive relationship but if the error bands are both lying in the same negative quadrant, it implies a significant negative relationship; otherwise the relationship is insignificant.

Variance Decomposition Function (VDF)

Variance decomposition is a measure used to study the relative importance of shocks in explaining the variations in the response variable at different time horizons (Narayan, 2006). It is used to identify the most fundamental variables that explain the behavior of the dependent variable in question and the variable that generates the highest percentage is more fundamental in explaining a phenomenon. Sims (1980) concluded that in the analysis of variance decomposition as a measure, the last time horizon is preferred and that is if its own shock contributes about 95% in variations in that same

variable in question. Then the variable is said to be exogenous, otherwise, it is endogenous. However, the limitation with this measure is that the conclusions are prone to variable ordering but the study adopts this measure because of its reliability in measuring the percentage of the variance of the error made in forecasting a variable due to a specific shock at a given time horizon and it is equivalent to partial R^2 in the VAR framework.

3.6 Summary

This chapter presented the theoretical and empirical methodology which was employed to answer a question addressed by this study. This study set out to investigate the impact of real effective exchange rate volatility on economic growth; evidence from Uganda for the period 1993 to 2015. The study employed a Cobb-Douglas production augmented with knowledge capital as Romer (1990) and Gross man et al. (1991a) type of models for their simplicity, availability of data of their variables and their straight forwardness. The volatility of the real effective exchange rate was estimated using the Generalized Autoregressive Conditional Heteroscedasticity GARCH (1, 1) approach. The study then used the, descriptive analysis, cointegration, vector error correction model, general to specific model, impulse Response and the Variance Decomposition to establish the relationship and the effect of the real effective exchange rate volatility and other factors on the economic growth using quarterly data from 1993Q1 to 2015Q4 in Uganda. Furthermore, the chapter highlighted data sources, variables definition employed by this study.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter presents and discusses the study findings on the exchange rate volatility and economic growth in the case of Uganda taking into consideration other selected macroeconomic variables for the study period. The chapter is subdivided into four sections. Section 4.0 gives the introduction of the chapter and section 4.1 presents the descriptive evidence, section 4.2 presents the empirical results, gives the interpretation and discussion of the study findings, while the last section summarizes the chapter.

4.1 Descriptive results

Table 2 presents the summary statistics for the study in their levels. All the variables have a small standard deviation relative to the mean meaning that they are clustered around the mean.

From the results normality of the variables was also established as skewness and kurtosis are clearly observed for all the variables which indicate departure from normality[5]. Likewise, the Jarque- Bera (J-B) statistics which is a test for normality also confirms the rejection of the null hypothesis for all the variables with a probability of less than 5 percent. In summary, most of the variables do not confirm to normal distribution but display positive skewness (i.e. the distribution has a long right tail) for Government expenditure, labor, GDP and real effective exchange rate volatility and negative skewness (the distribution has a long left tail) for capital and exports. However imports are normally distributed with skewness of 0.

Table 2: Descriptive Statistics

stats	GDPPCln	exvar	GOVln	Kln	Lln	Eln	Iln

[5] In a normally distributed series, skewness is 0 and Kurtosis is 3. Positive or negative skewness indicates asymmetry in the series and less than or greater than 3 kurtosis coefficient suggest flatness and peskiness respectively in the data Abdalla (2012)

N	92	92	92	92	92	92	92
mean	5.890	0.040	28.72	3.030	3.880	2.630	3.240
sd	0.440	0.010	0.350	0.190	0.010	0.300	0.170
kurtosis	1.790	10.46	2.280	1.940	3.120	2.480	1.830
skewness	0.280	2.410	0.100	-0.160	1	-0.200	0
cv	0.080	0.300	0.010	0.060	0	0.120	0.050
min	5.110	0.030	28.07	2.670	3.870	1.910	2.940
max	6.600	0.110	29.42	3.320	3.900	3.210	3.540
range	1.500	0.080	1.350	0.640	0.030	1.300	0.600

Source: Author's Computations WDI (2017)

Before regressing the variables to achieve the study's main objective, we tested the variables against multicollinearity using the correlation matrix. The variables considered are the ones presented in the model that is the GDP per capita, real effective exchange rate volatility, labor, government expenditure, capital, exports and imports. The correlation matrix presented in Table 3 below describes the statistical correlation among the variables

Table 3: The correlation test of the variables

	GDPPCln	exvar	GOVln	Kln	Lln	Eln	Iln
GDPPCln	1						
exvar	0.0297 (0.779)	1					
GOVln	0.8808* (0.000)	-0.0233 (0.826)	1				
Kln	0.8806* (0.000)	-0.0260 (0.806)	0.9276* (0.000)	1			
Lln	0.6571* (0.000)	0.1422* (0.176)	0.4777* (0.000)	0.4223* (0.000)	1		
Eln	0.8925* (0.000)	-0.0489 0.643	0.8361* (0.000)	0.8663* (0.000)	0.3992* (0.0001)	1	
Iln	0.8165* (0.000)	0.00650 (0.951)	0.8707* (0.000)	0.9114* (0.000)	0.3821* (0.0002)	0.8799* (0.000)	1

*Significant at 5%

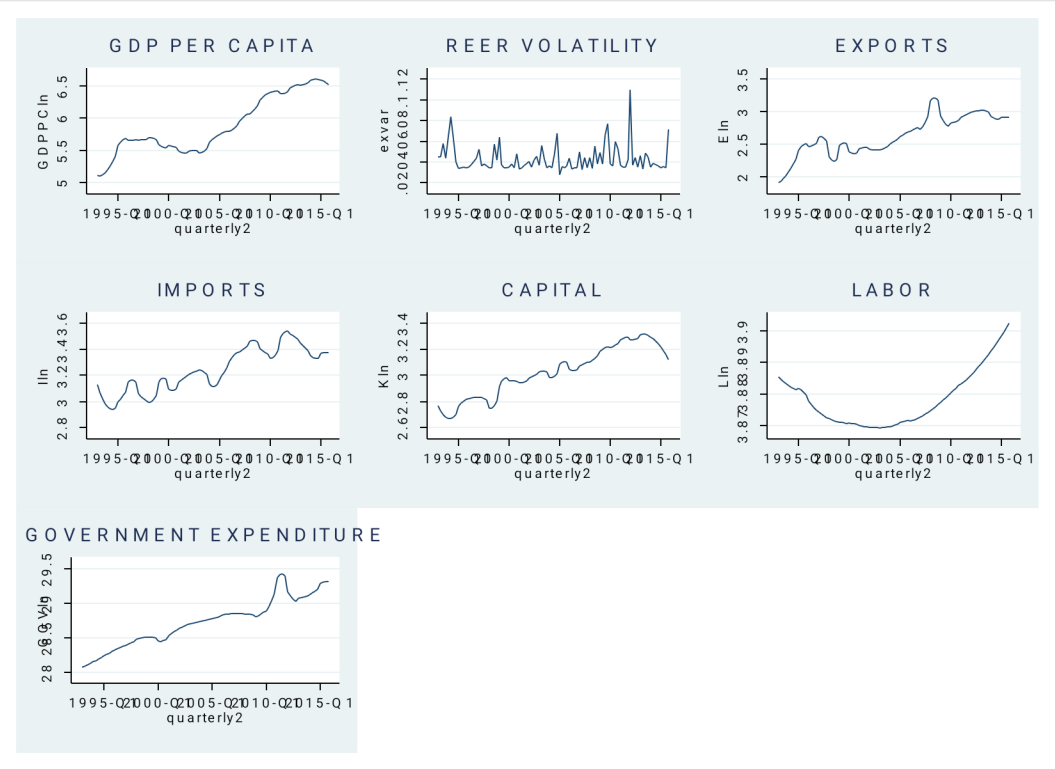
Source: Author's Computations WDI (2017)

A correlation check is important in time series analysis because, according to (Damodar N Gujarati (1995)) when the explanatory variables are highly correlated, they should not be used in the same model as regressors. The results as presented in Table 3 show that most of the variables are significant at 5% significant level which is the standard level to signify collinerity. However the study did not drop any of the variables because they are stipulated in the theoretical model.

4.2 Unit Root Test/Order of Integration

Before empirical model estimation, all variables are tested to ascertain if the series are stationary or non-stationary, and thus establish their order of integration. However before testing the series for unit root, the study makes a graphical exposition of the data series to observe the inherent data series features in Figure 2. This graphical exposition is used determine if the variables have a trend or a drift. As shown in Figure, it is clearly observable that GDP per capita growth (lnY), Government expenditure (lnG), Exports (lnE), Imports (lnI), capital (lnK), and Labor (lnL) have a trend whereas real effective exchange rate volatility has a drift . This implies that we have to transform them by differencing to become stationary.

Figure 2: Trend of the variables at levels



Source: Author's Computations WDI (2017)

Therefore both the Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) tests are applied to test for unit root. The ADF and Phillip Perron tests results are presented in Table 4. The unit root results reveal that all the variables are integrated of order one. The tests results of both the ADF and Phillip and Perron are shown in Table 4 below.

Table 4: Unit Root Test/Order of Integration

	Levels		First Difference			
Variable	ADF-Test	PP-Test	ADF-Test		PP-Test	
	Coefficient	Coefficient	Coefficient	P-value	Coefficient	P-value
lnGDPPC	-0.926	-1.463	-4.231***	0.004	-4.438***	0.002
lnGOV	-2.340	-3.276	-5.373***	0.000	-5.602***	0.000
lnE	-2.296	-2.915	-5.842***	0.000	-6.042***	0.000
lnK	-0.294	-1.847	-5.418***	0.000	-5.552***	0.000
lnREERV	-1.591	-0.875	-14.425***	0.000	-17.267***	0.000
lnI	-2.014	-2.934	-5.083***	0.000	-5.200***	0.000
lnL	1.114	0.583	-4.726***	0.001	-4.919***	0.000

*** Significant at 1% ** Significant at 5% * Significant at 10%

Figure 3: Trend of the variables at first difference

Source: Author's Computations WDI (2017)

The graphical results are as presented in Figure 3 and the variables don't show a time trend after differencing. The results of the unit root test in Table 4 also show that all the variables are integrated of order one which prompted the testing for cointegration.

4.2 Testing for Cointegration

Cointegration test is undertaken using the Johansen's cointegration procedure (1990) so as to ascertain whether the variables are cointegrated. The Johansen's cointegration procedure is used because it detects the rank or number of cointegrating relations as opposed to the Engle Granger (1987) which only assumes one cointegrating equation regardless of the number of series. The Johansen and Juselius (1990) allows us to estimate multiple long run relationships between a series of non-stationary variables through cointegrating vectors as well as many short run dynamics in these variables.

For the co-integration analysis, the lag length for the VAR model was established to enhance the multivariate co-integration test. The tests for criteria and the respective lag length are shown in Table 5. The lag length is identified by the selection criteria which comprise of the Sequential Modified LR test statistics (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) and Hanna-Quinn Information Criterion (HQ). These techniques are used to recommend the optimal lag length by making use of the lowest value in every criterion.

Table 5: Optimal lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	904.714	NA	2.02e-18	-20.877	-20.677	-20.797
1	1749.278	1532.001	1.87e-26	-39.379	-37.780	-38.735
2	1909.462	264.490	1.44e-27	-41.964	-38.968*	-40.758
3	1943.823	51.142	2.14e-27	-41.624	-37.229	-39.855
4	1974.568	40.755	3.66e-27	-41.199	-35.406	-38.868
5	2131.665	182.67	3.59e-28	-43.713	-36.521	-40.819
6	2301.172	169.507*	2.96e-29*	-46.516*	-37.925	-43.058*

Source: Author's Computations WDI (2017)

From Table 5, the results show that the optimal lag length is 6 because for the criteria (LR, FPE, AIC and HQ) show this lag length as having the lowest value. On the other hand SC recommends the optimal lag length of 2. The study is going to use lag 2 because it is supported by SC.

After establishing the lag length, the Johansen co-integration test was carried out to establish the long run relationships among the variables. The test gives us two test results that are the co-integration test results using the trace statistics and the maximum eigenvalue. The results are shown as follows:

Table 6: Johansen's Cointegration test Results

Johansen Trend	tests constant	for Number of obs	cointegration =	90		
Sample	1993-Q3	-	2015-Q4	Lags	=	2
5% maximum	trace	critical				

rank	parms	LL	Eigenvalue	statistic	value
0	56	1929	.	148.8	124.2
1	69	1954	0.419	99.88	94.15
2	80	1970	0.298	68.10*	68.52
3	89	1982	0.243	43.07	47.21
4	96	1994	0.227	19.94	29.68
5	101	2000	0.126	7.793	15.41
6	104	2004	0.0828	0.014	3.760
7	105	2004	0.0002		
5%					
maximum	max	critical			
rank	parms	LL	Eigenvalue	statistic	value
0	56	1929	.	48.87	45.28
1	69	1954	0.419	31.79	39.37
2	80	1970	0.298	25.02	33.46
3	89	1982	0.243	23.13	27.07
4	96	1994	0.227	12.15	20.97
5	101	2000	0.126	7.779	14.07
6	104	2004	0.0828	0.014	3.760
7	105	2004	0.0002		

Source: Author's Computations WDI (2017)

From Table 6, it's evident that at 5% level, the maximum Eigen value test and Trace test statistics suggest both at least 1 co-integrating equation among the seven variables. This means there is long run association among the variables which justifies us to go further and run our long run model. This means there is an independent long run relationship between real exchange rate volatility, economic growth, capital, labor, government expenditure, exports and imports.

Table 7 : Results of the Normalized Cointegrating Vector (The longrun Model)

lnGDPPC	lnREERV	lnExports	lnGOVexp	lnImports	lnCapital	lnLabor
1.000000	-21.631	-1.350	0.090	1.138	-1.046	-8.838
	(2.706)	(0.176)	(0.229)	(0.380)	(0.465)	(2.983)
	[-7.993]	[-7.652]	[0.392]	[2.992]	[-2.249]	[-2.963]

[ ] t-value, ( ) standard error

Source: Author's Computations WDI (2017)

The results from Table 7 indicate that most the variables are significant in the long run with the t-values being greater than 1.96 which is the 5% significance level except

government expenditure with t-value of 0.392. The results also show that labor has a positive effect on the economic growth with the coefficient of 8.8%. .Hence labor has an elastic relationship with economic growth in the long run. Therefore the results show that an increase in labor increases GDP per capita in the long run hence the government should invest in its human resource in order to increase economic growth. This is in line with earlier study done Katusiime et al. (2016) who found a positive relationship between labor and economic growth of Uganda in the long run. The results further show that capital has a positive effect on the economic growth with the coefficient of 1.05% which confirms to the expected predicted sign. It also shows that the relationship between capital economic growth is elastic in the long run.Therefore the results show that an increase in physical capital increases GDP per capita in the long run. This is in line with earlier study done Katusiime et al. (2016) who found a positive relationship between capital and economic growth of Uganda in the long run. The results also show that exports have a positive effect on the economic growth in the long run. One percent increase in exports will increase economic growth by 1.4% in the long run. This also shows that exports have an elastic relationship with economic growth in the long run. Hence the government should give subsidies and tax holidays to exporters in order to increase volume of exported goods because this will spur economic growth in the long run. This in line with earlier study done by Owen et al. (2012) who found out that increased exports increased GDP growth rate of the United States. However, imports have a negative effect on economic growth in the long run. One percent increase in imports will decrease economic growth by 1% in the long run. This shows that imports have an elastic relationship with economic growth since their coefficient 1.04>1 in the long run. Therefore the government should carry import substitution in order to reduce the volume of imported goods which will spur economic growth in the long run. This is in line with earlier study done by Owen et al. (2012) who found increased imports decreased GDP growth rate of United States in the long run.

Focusing on the objective of the study which set out to investigate the effect of the real effective exchange rate volatility on Uganda’s economic growth in order to inform policy

makers and help them make informed decisions about our monetary instruments. The results indicate a positive effect of the real effective exchange rate volatility on the economic growth in that a high volatility of the exchange rate increase Uganda's economic growth by 21.6% in long run. This shows that relationship between real exchange rate volatility and economic growth is elastic in the long run. Therefore Bank of Uganda and the government should not intervene in the foreign exchange markets in the long run in order to foster economic growth. This is in line with earlier study done Katusiime et al. (2016) who found a positive relationship between exchange rate volatility and economic growth of Uganda in the long run but it contradict with Musyoki et al. (2012) study on Kenyan economy who found a negative relationship between the two in the longrun.

4.3 VEC results

The vector error correction (VEC) model is a special case for the time series data that are stationary in their first differences. It takes into account any cointegrating relationship between the variables if cointegration has been detected between time series data. Therefore following the cointegration results, it was ascertained that in addition to the variables being non-stationary, they were integrated of the same order. This was a necessary condition for using the VECM in the analysis because the model defines along run relationship among the variables. The VECM was therefore necessary in order to find out the measure of the degree to which the variables respond to the deviation from the long run equilibrium relationship. However before presenting the estimation results, the study first analyzes the statistical adequacy of the results in sub section below.

Having estimated the empirical model, we next analyze the statistical adequacy of the results in this sections which are given by the serial correlation test of the residuals in section 4.3.1, and finally the VECM residual Heteroskedasticity Test in section 4.3.2.

4.3.1 The Serial Correlation test of the residuals

Serial correlation is a statistical term used to describe the situation when the residual is

correlated with lagged values of its self. In the case where the errors are correlated, there is serial correlation and this is not desirable. Misspecification of the errors may arise when choosing the short run model; therefore, to avoid such a problem, there are several types of model specification tests. Therefore for purposes of this study, we choose the Breush-Godfrey LM test for serial correlation in order to find out if VECM is adequately specified and the results are presented in Table 8.

Table 8: The Breush-Godfrey test for serial correlation in the residuals of the VECM regression.

Lags	LM-Stat	Prob
1	33.81132	0.9516
2	56.14046	0.2249
3	28.18293	0.9926

Source: Author's Computations

Therefore from Table 8, the Breush-Godfrey serial correlation test statistic for the null hypothesis of no serial correlation has probabilities at all the lag intervals which are greater than 0.05. Thus, we fail to reject the null hypothesis and this indicates that there is no presence of serial correlation in the residuals a sign that the VECM is adequately specified.

4.3.2 VECM Residual Heteroskedasticity Test

This test the null hypothesis of the errors being Homoscedastic which is desirable against the alternative that the errors are heteroskedastic. There for this study uses the white heteroskedasticity test to test the null hypothesis of the errors being Homoscedastic and the results are as shown they are not statistically significant at 5% level. Therefore from the results, we fail to reject the null hypothesis and this indicates that the VECM is adequately specified the results are presented in appendix .

4.4 Estimation Results

Table 9 summaries of the short run estimates of the VECM which shows that the speed of adjustment is statistically different from zero which means that economic growth and the volatility of the real effective exchange rate respond to the long run equilibrium.

Table 9: General to Specific Model using VECM

VARIABLES	D_GDPPCln	D_GDPPCln
ECM	-0.064***	-0.041***
	(0.017)	(0.012)
LD.GDPPCln	0.527***	0.547***
	(0.173)	(0.075)
L2D.GDPPCln	0.133	
	(0.177)	
LD.lnREERV	-1.158***	-0.823***
	(0.314)	(0.223)
L2D.lnREERV	-0.632***	-0.478***
	(0.216)	(0.178)
LD.lnGovermentExpenditure	-0.003	
	(0.09)	
L2D.lnGovermentExpenditure	0.084	
	(0.089)	
LD.lnExports	0.017	
	(0.063)	
L2D.lnExports	-0.032	
	(0.065)	
LD.lnImports	0.012	
	(0.158)	
L2D.lnImports	0.101	
	(0.157)	
LD.lnCapital	-0.112	
	(0.167)	
L2D.lnCapital	-0.195	
	(0.166)	
LD.lnLabor	-11.913	
	(19.759)	
L2D.lnLabor	9.323	

	(20.108)	
lnExports		0.014
		(0.043)
lnGovermentExpenditure		-0.097
		(0.061)
lnImports		-0.250**
		(0.105)
lnCapital		0.059
		(0.118)
lnLabor		2.009
		(3.734)
Constant	0.003	0.008***
	(0.003)	(0.003)
Observations	89	89
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Source: Author's Computations WDI (2017)

The Error Correction term

The General to specific model estimation results shows that the estimated coefficient of the error correction term (ECM) has a negative sign which means it converges in the long run. The ECM is also statistically significant at 4% significant level. This is an indication that there is approximately 4% adjustment of the estimated short run disequilibrium in the variables towards their long run values. This means that if there is a shock that pushes away the economic growth from equilibrium, exports, capital, imports, labor, real effective exchange rate volatility and government expenditure correct the discrepancy at a speed of 4% in the first quarter. Since the ECM is significant the VECM model is used because the variables have long run associationship.

The results presented in Table 8 above indicate that the real effective exchange rate volatility (REERV) is significant at 1% level and has a negative impact on economic growth with lags in the short run. The results indicate that the economic growth is explained by the real effective exchange rate volatility of the previous quarter. This

implies that a one percentage increase in real effective exchange rate volatility leads to a 0.8% decrease in the economic growth the following quarter holding other factors constant. This shows the REERV has an inelastic relationship with economic growth in the short run. Therefore from the short run and long run results, our conclusion is that the volatility of the real effective exchange rate volatility negatively impacts on the economic growth in the short run but positively affects it in the long run. The findings contradict with findings of previous authors (Polodoo et al., 2007; Schnabl, 2007;, Azee et al.,2012;, Katusiime et al., 2016 who found that exchange rate volatility positively impacts on economic growth in the short run. This may be a result of using real exchange rates as opposed to nominal exchange rates earlier used in earlier study (Katusiime et al., 2016).It is therefore necessary for the Government to design policies to reduce the volatility of the real effective exchange rate in the short run by intervening in the foreign exchange market with the aim of improving the economic growth.

The results in Table 9 show that imports are significant at 5% level and have a negative impact on the economic growth in the short run i.e. a one percentage increase in imports leads to 0.3% decrease in the economic growth the following quarter. This shows the relationship between imports and economic growth is inelastic in the short run. Therefore the government should carry import substitutions in order to spur economic growth in the short run and long run. This is in line Owen et al. (2012) study in the United States who found out that increased imports decreased GDP growth rate. Hence the government needs to carry out import substitution in order to reduce import volumes which will in turn increase economic growth.

The results from Table 8 show that a one period lag of economic growth is significant at 1% significant level and has a positive impact on the economic growth. A 1% increase in LD.lnGDPPC will lead to an increase in the economic growth by 0.5%. This shows an inelastic relationship in the short run. Hence the economic growth of the country will determined by its past GDP. This is in line with the earlier study done Katusiime et al. (2016) who found a positive relationship between one period lag of economic growth and economic growth of Uganda in the short run.

4.5 Other Tests in VECM

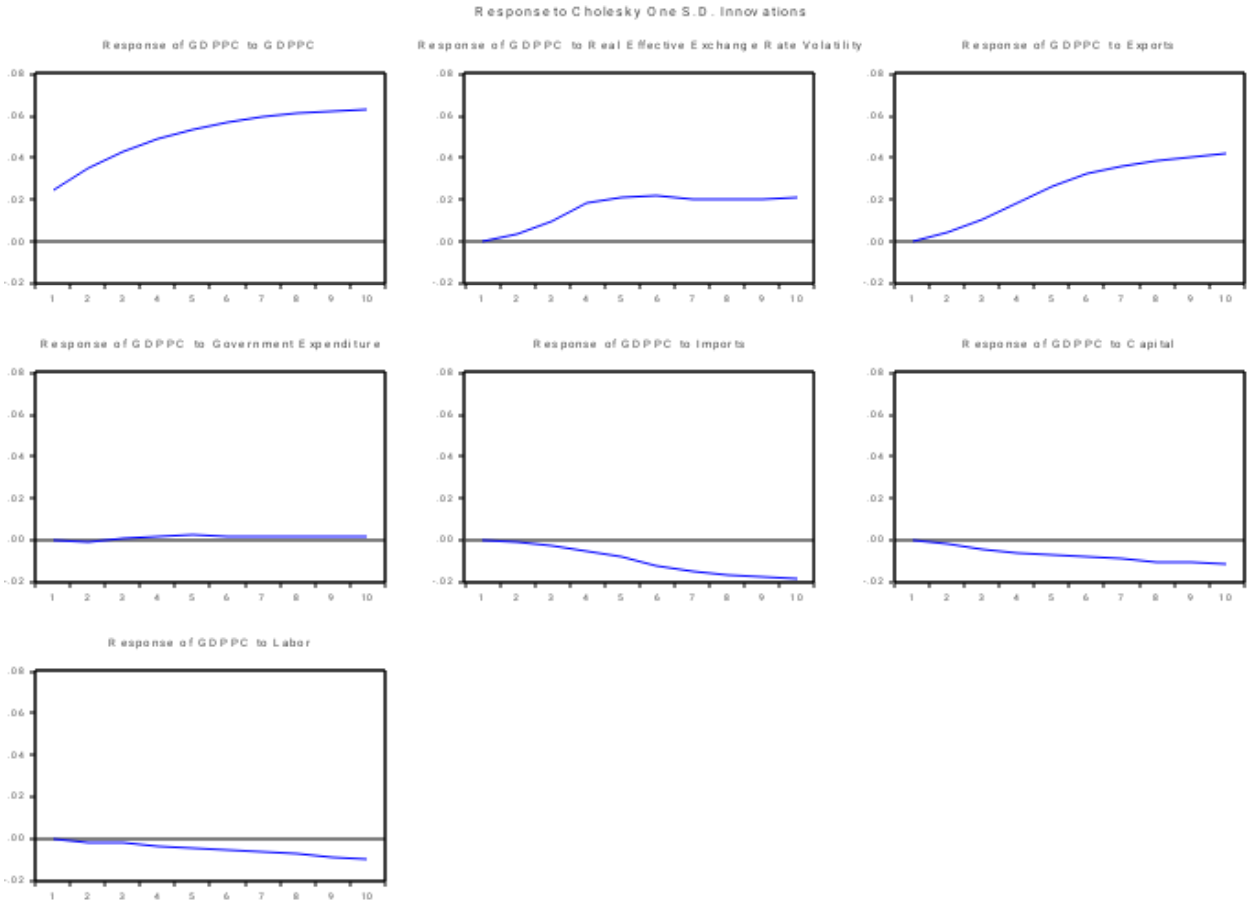
The other tests that are adopted for further inference when using the VECM are; the impulse response functions (IRF) and the Variance Decomposition (VDC). The IRF and the VDC enhance the dynamic interaction of the variables in the system as innovations in VAR can have comporaneous correlation and hence any shock in the variable can have effect on the other variables through the contemporaneous correlation with the innovation Ogutu (2014), Duasa (2007).

4.5. 1 Impulse Responses Analysis

The impulse response results allow us to see the shock from the impulse sector which is real effective exchange rate volatility, government expenditure, lag of economic growth, exports, imports, capital and labor against the response sector which is the economic growth .

Impulse response plots of economic growth to labor, imports, real effective exchange rate volatility, exports and government expenditure are shown in Figure 7 below. It presents the contemporaneous response of economic growth to Cholesky one squares variances shocks of labor, capital, exports, imports, real effective exchange rate volatility and government expenditure performance. As shocks in exports, economic growth, real effective exchange rate volatility and government expenditure arise the response of economic growth is positive showing a significant positive relationship. Shocks in imports, capital and labor make economic growth to respond negatively showing a significant negative relationship.

Figure 4: IMPULSE RESPONSE FUNCTIONS



Source: Author's Computations WDI (2017)

4.5.2 Variance decomposition function

Another useful procedure to illustrate the relationship of economic growth with other variables is the forecast error variance decomposition which decomposes the forecast error variance of the economic growth into parts due to each of the innovations in the

system. While impulse response functions trace the effects of a shock to each one of the endogenous variables on target variable in the VAR, variance decomposition separates the variation in the target variable into component shocks to the VAR. thus variance decomposition provides information about the relative importance of each random innovation in affecting variables in the VAR (Shao, 2008; Kamoto ,2006). The results of the variance decomposition are as presented in Table 10.

Table 10: Variance Decomposition

Period	S.E.	GDPPC	REERV	EXPORTS	GOVEXP	IMPORTS	CAPITAL	LABOR
1	0.024	100.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.043	98.151	0.529	0.931	0.034	0.098	0.122	0.134
3	0.063	93.378	2.432	3.100	0.0483	0.238	0.607	0.196
4	0.084	85.405	6.317	6.528	0.085	0.496	0.901	0.267
5	0.106	79.366	8.072	10.158	0.108	0.925	1.032	0.339
6	0.127	74.948	8.462	13.433	0.102	1.522	1.114	0.418
7	0.148	71.897	8.213	15.971	0.090	2.117	1.207	0.505
8	0.167	69.636	7.888	17.856	0.078	2.631	1.313	0.598
9	0.186	67.887	7.622	19.265	0.069	3.038	1.421	0.698
10	0.203	66.472	7.427	20.359	0.062	3.357	1.518	0.805

Source: Author's Computations WDI (2017)

From table above, most of the variation in the economic growth is accounted for by its own innovations in the first quarter (100%). However, the proportion explained by other variables increases slightly over time and they explain 30.4% 0f the variation after two years (8^{th} period) , the greatest impact is from exports which accounted for 17.86% after 8^{th} quarter , real effective exchange rate volatility were the second in importance with 8%, then imports with 2.6%, capital with 1.3%, labor with 0.6% and the government expenditure accounted for 0.08% thus implying that real effective exchange rate volatility is important in explaining the economic growth in Uganda.

4.6 Conclusion

This chapter presents the study findings. Descriptive analysis of all the variables was

carried out and found out that most of the variables did not confirm to normal distribution but displayed positive and negative skewness. A correlation test of the variable was carried and found out that some variables were highly correlated but study could not drop them because they were stipulated in the theoretical model. Stationarity tests were carried out and it was realized all that the variables were I (1). Co integration tests therefore followed which revealed that there is a long run equilibrium relationship among the variables used in the analysis. This was thus an indication of causality at least in one direction. Using E-granger we found a bi-directional causality therefore we used VECM to run our model. Our main conclusion is that there is a negative relationship between the economic growth and the real effective exchange rate volatility in the short run but a positive relationship in the long run.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter wraps up the study. It first provides a brief summary of the findings in section 5.1 which is followed by a conclusion and policy recommendations in sections 5.2 and 5.3 and finally the limitations that were encountered in the study and the suggested areas for further research in sections 5.4 and 5.5 respectively.

5.1 Summary of the findings

This study was set out to investigate the effect of real effective exchange rate volatility on Uganda's economic growth for the period 1993: Q1 to 2015:Q4.The study will follow the a Cobb-Douglas production augmented with knowledge capital as in Romer (1990) and Grossman et al.. (1991a) type of models for their simplicity, availability of data of their variables and their straight forwardness.

The co integration, vector error correction model and general to specific model were used to establish the relationship of the effect of the real effective exchange rate volatility and other factors on economic growth using quarterly data from 1993Q1 to 2015Q4 in Uganda.

Therefore the study established that the long run relationship existed between the real effective exchange rate volatility and economic growth. This relationship also comprised of government expenditure, one period lagged economic growth, capital, labor, exports and imports on economic growth. In addition the study found that the real effective exchange rate volatility had a positive effect on the economic growth in the

long run but a negative effect in the short run. Therefore there is need for policies to stabilize the Uganda shilling in the short run. Exports, capital and labor also had a positive effect on economic growth in the long run but were insignificant in the short run hence increasing exports, physical capital and labor will spur economic growth of Uganda in the long run. One period lagged economic growth had positive effect on economic growth in the short run and government expenditure was insignificant both in the short run and long run. Finally the study also found a negative relationship between the economic growth and imports in both the short-run and long run.

5.2 Conclusion

This study set out to investigate the impact of real effective exchange rate volatility on economic growth; evidence from Uganda for the period 1993 to 2015. The study employed a Cobb-Douglas production augmented with knowledge capital as Romer (1990) and Gross man et al. (1991a) type of models for their simplicity, availability of data of their variables and their straight forwardness. The volatility of the real effective exchange rate was estimated using the Generalized Autoregressive Conditional Heteroscedasticity GARCH (1, 1) approach. The study then used the cointegration, vector error correction model, general to specific model, impulse Response and the Variance Decomposition to establish the relationship and the effect of the real effective exchange rate volatility and other factors on the economic growth using quarterly data from 1993Q1 to 2015Q4 in Uganda. From the results, the real effective exchange rate volatility has a positive long run impact on Uganda's economic growth; however it has a negative impact in the short run.

5.3 Recommendations

The study found a negative relationship between economic growth and real effective exchange rate in the short run. Therefore the government should control the exchange rates of Uganda by using the fiscal means or the monetary means. For instance whenever there is a depreciation the government should sell treasury bills to the public or sell dollars in the market. Whenever there is appreciation of the currency the government should intervene by buying treasury bills from the public or by buying dollars from the market. This will reduce real exchange rate volatility which will spur

economic growth in the short run. However in the long run the government should not intervene in the foreign exchange market because volatility of exchange rates improves economic growth .

The study found a positive relationship between labor and economic growth in the long run. Therefore the government should invest in its human resource in order to improve its productivity. Therefore the government should increase its budgetary allocations to institutions of higher learning, tertiary institutions which will impact more skills to the population which will later improve the productivity of the workforce hence improving economic growth of Uganda in the long run.

The study also found out imports had a negative impact on economic growth in the short run and long run. Therefore the government should carry out import substitution in order to reduce on the volume of imported goods. Therefore the government should provide incentives to investors both foreign and local like free land, cheaper electricity in order to provide some of the goods that where formally imported and also to produce them at a low cost hence competing with the foreign goods. This will reduce the imports in the short run and long run which will spur economic growth.

Finally the study found a positive relationship between physical capital and economic growth in the long run. Therefore the government should increase its expenditure in physical capital investments. The government should improve this by increasing its budgetary allocations for construction of dams, roads. These will attract foreign and local investors because of cheap electricity to run the machines and ease of access of the markets due to the constructed roads which spur economic growth in the long run.

5.4 Limitation of the study

The study was limited in such a way that there were no complete monthly data sets for all the variables for the estimation period and so it had to rely on the interpolation method for manipulations which method has some statistical short comings like over

simplification of complete functions which ultimately results into interpolation errors. While doing the study data on real effective exchange rate volatility was not available so we used GARCH (1, 1) to generate it. However this had its limitations since the GARCH model fails to capture the leverage effects since the conditional variance is a function only of the magnitudes of the past values and not their sign.

5.5 Suggested Areas for Further Research

There is need for the study on the impact real effective exchange rate volatility on Foreign Aid and government expenditure in Uganda. Also there is need for a study on the impact real effective exchange rate volatility on economic growth of Uganda under different exchange rate regimes and compare and contrast where Uganda performed best.

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APPENDICES

Appendix 1: Data sets used in the study.

quarterly	GDPPC	Labor	Exports	Imports	GOV	REER
1993Q1	165.4927	48.68368	6.733712	22.79036	3.99E+11	116.9564
1993Q2	165.1718	48.64715	6.895692	21.55621	4.21E+11	109.997
1993Q3	167.7661	48.6139	7.143513	20.56024	4.42E+11	105.8078
1993Q4	173.2757	48.58395	7.477174	19.80244	4.64E+11	98.47184
1994Q1	181.7005	48.55729	7.896677	19.28282	4.85E+11	88.63606
1994Q2	193.0406	48.53391	8.40202	19.00138	5.06E+11	82.06445
1994Q3	207.2959	48.51383	8.993203	18.95811	5.27E+11	85.89618
1994Q4	224.4664	48.49703	9.670228	19.15301	5.48E+11	86.9287
1995Q1	263.5654	48.51851	11.09806	20.04702	5.63E+11	87.44197
1995Q2	278.961	48.4943	11.68078	20.5339	5.86E+11	87.35996
1995Q3	289.6666	48.45939	12.08335	21.0746	6.12E+11	87.64012
1995Q4	295.682	48.41377	12.30578	21.6691	6.39E+11	87.6133
1996Q1	285.8116	48.31781	11.70562	23.26731	6.68E+11	86.34547
1996Q2	286.9252	48.26664	11.82473	23.58946	7.01E+11	84.17915
1996Q3	287.8269	48.22063	12.02067	23.58545	7.36E+11	88.17419
1996Q4	288.5168	48.17977	12.29344	23.25528	7.74E+11	83.74492
1997Q1	287.8871	48.14696	13.63494	21.43493	8.32E+11	82.09015
1997Q2	288.5965	48.11525	13.66461	20.91805	8.68E+11	80.71664
1997Q3	289.5373	48.08754	13.37435	20.54061	9.00E+11	79.89147
1997Q4	290.7095	48.06383	12.76416	20.30262	9.27E+11	79.85899
1998Q1	298.926	48.04774	10.04469	19.96481	9.42E+11	80.05031

1998Q2	297.8356	48.03058	9.510388	20.10142	9.64E+11	85.97384
1998Q3	294.2514	48.01597	9.371895	20.47318	9.85E+11	90.09976
1998Q4	288.1733	48.00391	9.629215	21.08009	1.01E+12	98.00522
1999Q1	267.9816	47.99689	11.93011	23.29813	9.86E+11	95.35187
1999Q2	261.5636	47.98894	12.31995	23.82496	1.02E+12	95.74403
1999Q3	257.2996	47.98255	12.44649	24.03655	1.07E+12	96.47867
1999Q4	255.1895	47.97772	12.30975	23.93291	1.13E+12	96.22022
2000Q1	264.1825	47.98289	10.86603	22.19629	1.25E+12	99.00964
2000Q2	262.8009	47.9778	10.62016	21.98927	1.33E+12	98.93804
2000Q3	259.9937	47.97091	10.52848	21.99412	1.39E+12	104.4249
2000Q4	255.7609	47.96219	10.59097	22.21082	1.46E+12	105.985
2001Q1	242.1234	47.94345	11.37612	23.24118	1.52E+12	106.464
2001Q2	238.2312	47.93439	11.51957	23.64089	1.58E+12	105.0915
2001Q3	236.1049	47.92681	11.58981	24.01175	1.63E+12	103.1078
2001Q4	235.7447	47.92069	11.58682	24.35376	1.69E+12	100.5945
2002Q1	242.7538	47.91652	11.25285	24.76949	1.75E+12	102.4888
2002Q2	243.6845	47.91317	11.20654	25.01276	1.80E+12	106.6056
2002Q3	244.14	47.91109	11.19012	25.18615	1.85E+12	112.0913
2002Q4	244.1202	47.9103	11.20359	25.28966	1.88E+12	110.1264
2003Q1	234.136	47.90959	11.14407	25.55018	1.90E+12	117.9523
2003Q2	236.9615	47.91184	11.25848	25.42315	1.94E+12	123.8037
2003Q3	243.1076	47.91585	11.44393	25.13549	1.98E+12	126.1534
2003Q4	252.5741	47.92163	11.70042	24.68718	2.02E+12	128.8699
2004Q1	277.186	47.9284	12.17859	22.97551	2.07E+1	129.456

	7	7			2	6
2004Q2	288.5641	47.93805	12.51692	22.64701	2.11E+12	124.284
2004Q3	298.5317	47.94966	12.86605	22.59896	2.16E+12	114.8981
2004Q4	307.0896	47.9633	13.22596	22.83135	2.20E+12	116.0897
2005Q1	311.8371	47.99008	13.68413	23.81221	2.25E+12	117.8667
2005Q2	318.5358	48.00336	14.03064	24.4183	2.30E+12	118.0866
2005Q3	324.7851	48.01425	14.35296	25.11763	2.35E+12	117.1096
2005Q4	330.585	48.02274	14.65108	25.91021	2.41E+12	122.4707
2006Q1	327.6818	48.01494	14.80922	27.31802	2.49E+12	123.8305
2006Q2	335.8841	48.02419	15.10527	28.08829	2.55E+12	124.9167
2006Q3	346.9384	48.0366	15.42344	28.74301	2.60E+12	126.3368
2006Q4	360.8447	48.05216	15.76373	29.28218	2.64E+12	120.7648
2007Q1	387.5132	48.07316	15.22748	29.38078	2.69E+12	120.6909
2007Q2	403.1593	48.09414	15.97148	29.81885	2.73E+12	116.755
2007Q3	417.6934	48.11736	17.09707	30.27139	2.75E+12	119.0985
2007Q4	431.1154	48.14284	18.60425	30.73837	2.76E+12	124.6872
2008Q1	431.5848	48.17284	23.72312	31.9477	2.67E+12	124.0917
2008Q2	447.5187	48.2019	24.70144	32.15245	2.70E+12	117.4481
2008Q3	467.0767	48.2323	24.7693	32.0805	2.76E+12	114.4592
2008Q4	490.2588	48.26403	23.92671	31.73186	2.86E+12	121.0856
2009Q1	536.2194	48.29778	18.82317	30.16281	3.02E+12	118.422
2009Q2	558.9878	48.33192	17.49988	29.63826	3.15E+12	129.1498
2009Q3	577.7184	48.36712	16.60633	29.2145	3.30E+12	117.4216
2009Q4	592.4113	48.40339	16.14254	28.89152	3.46E+12	113.3752
2010Q1	601.4189	48.44784	16.86693	27.94949	3.45E+12	116.2119
2010Q2	608.6954	48.4834	16.95926	28.11603	3.71E+12	125.3358
2010Q3	612.5931	48.51717	17.17796	28.67129	4.06E+12	134.2162
2010Q4	613.1121	48.54916	17.52303	29.61528	4.49E+12	138.8191
2011Q1	589.6292	48.56963	18.41769	32.87729	5.72E+12	141.3457
2011Q2	591.64	48.60196	18.84622	33.82701	6.04E+12	140.771
2011Q3	598.5213	48.6364	19.23184	34.39372	6.15E+12	146.7675
2011Q4	610.2731	48.67296	19.57454	34.57745	6.07E+12	127.3075
2012Q1	646.4391	48.71217	19.9417	33.6904	5.07E+12	121.2273
2012Q2	660.1144	48.75274	20.17163	33.38324	4.87E+12	126.9442
2012Q3	670.8428	48.79522	20.33168	32.96819	4.76E+12	125.6624
2012Q4	678.6243	48.8396	20.42187	32.44526	4.73E+12	132.0357
2013Q1	671.0816	48.88588	20.61271	31.53363	4.92E+12	131.9329
2013Q2	677.92	48.93406	20.49497	30.90725	5.01E+12	126.55
2013Q3	686.7624	48.98414	20.23916	30.28532	5.14E+12	121.7852
2013Q4	697.6087	49.03612	19.84528	29.66782	5.30E+12	120.5662
2014Q1	728.1019	49.09015	18.59289	28.51491	5.51E+12	118.3358

2014Q2	735.8988	49.14586	18.21106	28.12223	5.74E+12	121.9035
2014Q3	738.6425	49.20341	17.97934	27.94993	5.99E+12	124.9347
2014Q4	736.3329	49.2628	17.89774	27.99801	6.27E+12	126.7577
2015Q1	728.97	49.32402	18.36292	29.07584	6.99E+12	129.3192
2015Q2	716.5539	49.38709	18.42288	29.24094	7.16E+12	131.0205
2015Q3	699.0845	49.45199	18.47428	29.30266	7.21E+12	144.1486
2015Q4	676.5618	49.51872	18.51714	29.26103	7.12E+12	135.7024

Appendix 2: Determination of Real Effective Exchange Rate Volatility

1 Nominal Effective exchange rate (NEER)

$$NEER_t = \sum_{it}^{n} ER_{it} * w_{it} \ldots\ldots\ldots\ldots (1)$$

Where, ER_{it} is Uganda's bilateral exchange rate index particular country I at period t while w_{it} is the bilateral trade weight for Uganda's i^{th} trading partner at period t denotes total of countries going to be included in the study. . ER_{it} computation is shown below.

$$ER_{it} = \left[\frac{NER_C}{NER_{t=0}}\right] * 100 \ldots\ldots\ldots\ldots (2)$$

Where NER_C represents the index of Uganda shilling exchange rate per unit of trading partner currency in the base period (2009/10). $NER_{t=0}$ is current period year index of Uganda shilling exchange rate per unit of its trading partner currency.

The monthly bilateral trade weights in equation a is going to be computed as a ratio of total trade (exports and imports) for each trading partner to the ratio of total trade (exports and imports) for all Uganda's trading partners and formula is shown below

$$w_{it} = \left[\frac{\sum(x_{it}+m_{it})}{\sum(X_t+M_t)}\right] \ldots\ldots\ldots\ldots (3)$$

Where x_{it} is the total value of what Uganda exports to its i^{th} trading partner at period t and M_t is also what Uganda imported from it's i^{th} trading partner in same time t. X_t denotes Uganda's total exports to all its trading partners at time t and total imports from trading partners at t time is denoted by M_t . Where i = 1, 2---n and n denotes all Uganda's trading partners.

$$REER_t = NEER_t\left[\frac{P_{wt}}{Pdt}\right] \ldots\ldots\ldots\ldots (4)$$

As P_{dt} denotes the price level in Uganda represented by Consumer Price Index (CPI) at t time and P_{wt} denotes the weighted average price level of trading trading partners of Uganda represented by weight CPI at t time which is got by the addition of all trade weighted price levels represented by CPI of trading partners of Uganda as shown in equation below.

$$P_{wt} = \sum_{it}^{n} P_{it} * w_{it} \ldots\ldots\ldots(5)$$

Where P_{it} denotes price level of Uganda's i^{th} trading partner countries represented by CPI at time, whereas w_{it} is Uganda's i^{th} trading partner country at time t showing its trade weights and those are similar to those going to considered in computation of REER.

2 Real Effective Exchange Rate Volatility

REER volatility measure is used instead of a bilateral exchange rate with dollar because of the following advantages[6]. First of all it includes neighbors' (trade partners) externalities in the evaluation of the effects of exchange rate volatility on growth. Favorable and unfavorable exchange rate movements with different trade partners may compensate each other there by dampening the negative effects of individual bilateral exchange rates volatility on growth because it takes into account of financial diversification[7]. The measure is also much less correlated with exchange rate regimes than bilateral exchange rate volatility with dollar and therefore gives an opportunity of jointly testing the advantages of flexibility and cost of volatility arguments[8]

Because standard deviation method has two weaknesses one being the assumption of empirical distribution of RER being normal and secondly the distinction between unpredictable and predictable elements in the exchange rate process is ignored. Further the use of standard deviation methodology has been discouraged as measure of RER volatility because RER data has a tendency to be skewed in terms of distributions or volatility clusters.

[6] Bagella et al., (2006)
[7] Qian and Varangis,(1994)
[8] Bagella et al., (2006)

Appendix 4: Testing for ARCH (1, 1) effects

Before computing volatility using ARCH, the study tested for the presence of ARCH effects. The results revealed presence of ARCH (1, 1) effects when the computed Chi-square value of 46.178 exceeded the value of the test statistic with a probability of 0.0000 which is less than 5% as seen below. The study then generated a measure of volatility using the GARCH (1, 1) model.

```
. reg d.logReer
```

Source	SS	df	MS	Number of obs =	91
				F(0, 90) =	0.00
Model	0	0	.	Prob > F =	.
Residual	.170468481	90	.001894094	R-squared =	0.0000
				Adj R-squared =	0.0000
Total	.170468481	90	.001894094	Root MSE =	.04352

D.logReer	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_cons	.0016337	.0045623	0.36	0.721	-.0074301	.0106974

```
. estat archlm, lag(1)
LM test for autoregressive conditional heteroskedasticity (ARCH)
```

lags(p)	chi2	df	Prob > chi2
1	3.960	1	0.0466

H0: no ARCH effects vs. H1: ARCH(p) disturbance

Garch(1,1)

D.logReer	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
logReer						
_cons	.0062721	.0037461	1.67	0.094	-.0010701	.0136144
ARCH						
arch						
L1.	.4982331	.2857798	1.74	0.081	-.0618849	1.058351
garch						
L1.	-.1255933	.2805511	-0.45	0.654	-.6754633	.4242767
_cons	.0013421	.0005288	2.54	0.011	.0003058	.0023785

Appendix 5: VECM Residual Heteroskedasticity Test

Joint test:

Chi-sq	df	Prob.
432.0315	546	0.9999

Source: Author's Computations