THE ANALYSIS OF MONETARY FRAMEWORK OF INFLATION TARGETING, EXCHANGE RATE REGIME SWITCHING AND VOLATILITY IN SELECTED SUB-SAHARAN AFRICAN COUNTRIES

MOHAMMED UMAR

DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA

May, 2016

THE ANALYSIS OF MONETARY FRAMEWORK OF INFLATION TARGETING, EXCHANGE RATE REGIME SWITCHING AND VOLATILITY IN SELECTED SUB-SAHARAN AFRICAN COUNTRIES

By

MOHAMMED UMAR

Thesis Submitted to
School of Economics, Finance and Banking,
Universiti Utara Malaysia,
in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

Kolej Perniagaan
(College of Business)
Universiti Utara Malaysia

PERAKUAN KERJA TESIS / DISERTASI
(Certification of thesis / dissertation)

Kami, yang bertandatangan, memperakukan bahawa
(We, the undersigned, certify that)

MOHAMMED UMAR

calon untuk Ijazah **DOCTOR OF PHILOSOPHY**
(candidate for the degree of)

telah mengemukakan tesis / disertasi yang bertajuk:
(has presented his/her thesis / dissertation of the following title):

THE ANALYSIS OF MONETARY FRAMEWORK OF INFLATION TARGETING, EXCHANGE RATE REGIME SWITCHING AND VOLATILITY IN SELECTED SUB-SAHARAN AFRICAN COUNTRIES

seperti yang tercatat di muka surat tajuk dan kulit tesis / disertasi.
(as it appears on the title page and front cover of the thesis / dissertation).

Bahawa tesis/disertasi tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan, sebagaimana yang ditunjukkan oleh calon dalam ujian lisan yang diadakan pada: **24 April 2016.**
(That the said thesis/dissertation is acceptable in form and content and displays a satisfactory knowledge of the field of study as demonstrated by the candidate through an oral examination held on: ***24 April 2016****).*

Pengerusi Viva *(Chairman for Viva)*	: Assoc. Prof. Dr. Russayani Ismail	Tandatangan *(Signature)*	
Pemeriksa Luar *(External Examiner)*	: Prof. Dr. Fadzlan Sufian	Tandatangan *(Signature)*	
Pemeriksa Dalam *(Internal Examiner)*	: Assoc. Prof. Dr. Hussin Abdullah	Tandatangan *(Signature)*	

Tarikh: 24 April 2016
(Date)

Nama Pelajar (Name of Student)	:	Mohammed Umar
Tajuk Tesis / Disertasi *(Title of the Thesis / Dissertation)*	:	The Analysis of Monetary Framework of Inflation Targeting, Exchange Rate Regime Switching and Volatility in Selected Sub-Saharan African Countries
Program Pengajian *(Programme of Study)*	:	Doctor of Philosophy
Nama Penyelia/Penyelia-penyelia *(Name of Supervisor/Supervisors)*	:	Prof. Dr. Jauhari Dahalan

Tandatangan

Nama Penyelia/Penyelia-penyelia *(Name of Supervisor/Supervisors)*	:	Dr. Mukriz Izraf Azman Aziz

Tandatangan

PERMISSION TO USE

In presenting this thesis in fulfillment of the requirements for a Post Graduate degree from the Universiti Utara Malaysia (UUM), I agree that the Library of this university may make it freely available for inspection. I further agree that permission for copying this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor(s) or in their absence, by the Dean of School of Economics, Finance and Banking where I did my thesis. It is understood that any copying or publication or use of this thesis or parts of it for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the UUM in any scholarly use which may be made of any material in my thesis.

Request for permission to copy or to make other use of materials in this thesis in whole or in part should be addressed to:

Dean of School of Economics, Finance and Banking
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman

ABSTRACT

Exchange rate volatility has affected not only sub-Saharan African economies but the volume of international transactions in general. It directly affects the nations' profitability of tradable commodities, balance of payment, terms of trade and investment decisions. Despite the measures taken by the monetary authorities to ensure macroeconomic stability, exchange rate remains volatile. This study, therefore pursues the following objectives. First, it investigates the effectiveness of the inflation targeting framework (ITF) as a hedging strategy for exchange rate volatility. Second, examines whether the monetary policy of ITF has performed the role of the nominal anchor in the economies. Third, examines the influence of exchange rate regime switching on exchange rate volatility and finally, determines causality among the variables of the monetary theory of exchange rate determination. In achieving the results of the objectives, the study employed a battery of econometric procedures namely, threshold generalised autoregressive conditional heteroscedasticity (TGARCH) model, generalised method of moments (GMM) estimators, time-varying Markov-switching transition probability ARCH model and asymmetric/Toda-Yamamoto dynamic causality with leverage bootstrapping. The results of the first objective indicate that the menace of exchange rate volatility reduces when the IT policy was adopted in Ghana and South Africa. However, the ITF policy transition increases the volatility of exchange rate. Secondly, the findings on the baseline and augmented Taylor rule models reveal that ITF become a nominal anchor in the economies immediately after the adoption of the policy, although the hypothetical response of interest rate to inflation deviation and output gap is greater in South Africa compared to Ghana. Thirdly, the results of the time-varying Markov-switching models indicate that the exchange rates of the countries are characterised by decline in the downward regime except for Nigeria which shows high decline in the upward regime. Finally, the estimates of the asymmetric/Toda-Yamamoto causality reveal the existence of size distortion when the asymptotic Granger causality is used. The main policy implication of the findings is that monetary authorities can ensure exchange rate stability through accountability and transparency in contractionary or expansionary policies in aggregate demand using monetary policy instrument.

Key words: asymmetric causality, exchange rate, volatility, inflation targeting, regime switching.

ABSTRAK

Kesan daripada volatiliti kadar pertukaran bukan sahaja keatas ekonomi sub-Sahara Afrika malahan juga keatas jumlah urus niaga antarabangsanya. Ia secara langsung memberi kesan keatas perolehan keuntungan negara melalui perdagangan komoditi dipasaran antarabangsa, imbangan pembayaran, kadar syarat dagangan dan pemutusan pelaburan. Walaupun terdapat langkah-langkah yang diambil oleh pihak berkuasa kewangan bagi memastikan kestabilan makroekonomi, ianya masih tidak dapat mengurangkan volatiliti kadar pertukaran. Kajian ini bertujuan mencapai objektif yang berikut. Pertama, mengkaji keberkesanan rangkakerja mensasar inflasi (*inflation targeting framework*, ITF) sebagai strategi lindung nilai terhadap volatiliti kadar pertukaran. Kedua, mengkaji sama ada polisi kewangan ITF telah memainkan peranan sebagai tunjang nominal dalam ekonomi. Ketiga, mengkaji pengaruh kadar pertukaran sebagai pensuisan-rejim keatas volatiliti kadar pertukaran dan akhir sekali, menentukan kausalitas antara pembolehubah teori kewangan penentuan kadar pertukaran. Bagi mencapai objektif yang dinyatakan, kajian ini menggunakan model ambang autoregresif umum heteroskedastisiti bersyarat (TGARCH), kaedah penganggar umum momen (GMM), transisi kebarangkalian masa-berbeza pensuisan-Markov model ARCH dan kausalitas dinamik tidak-simetri/Toda-Yamamoto dengan *leverage bootstrapping*. Bagi capaian objektif pertama hasil empirikal menunjukkan bahawa ancaman volatiliti kadar pertukaran berkurangan apabila dasar mensasar inflasi dilaksanakan di Ghana dan Afrika Selatan. Walau bagaimanapun, peralihan kepada polisi ITF itu menambahingkatkan volatiliti kadar pertukaran. Kedua, penemuan pada model garis dasar dan model pengembangan peraturan Taylor menunjukkan bahawa ITF menjadi tunjang nominal dalam ekonomi sebaik sahaja pelaksanaan polisi tersebut, walaupun tindakbalas hipotetikal kadar faedah terhadap sisihan inflasi dan jurang keluaran adalah lebih besar di Afrika Selatan berbanding Ghana. Ketiga, keputusan empirikal bagi model masa-berbeza pensuisan-Markov bagi negara-negara dalam kajian menunjukkan kadar pertukaran dengan ciri-ciri penurunan dalam rejim ke bawah kecuali Nigeria yang menunjukkan penurunan tinggi dalam rejim ke atas. Akhir sekali, anggaran kausalitas tidak-simetri /Toda-Yamamoto memperlehatkan kewujudan saiz herotan apabila kausalitas asimptot Granger digunakan. Rumusan kajian keatas implikasi utama polisi ialah pihak berkuasa kewangan boleh memastikan kestabilan kadar pertukaran melalui kebertanggungjawaban dan ketelusan dalam perlaksanaan polisi penguncupan atau pengembangan permintaan agregat dengan menggunakan instrumen polisi monetari.

Kata kunci: kausalitas tidak-simetri, kadar tukaran, volatiliti, sasaran inflasi, pensuisan regim.

DECLARATION

Some part of this thesis has been published and/or under publication process in the following referred journals and conference proceedings. Furthermore, few other articles are under review.

PUBLICATION IN REFERRED JOURNALS:

Dahalan, J. & Umar, M. (In press). Asymmetric causality between exchange rate and interest rate differentials: A test of international capital mobility. *International Journal of Globalisation and Small Business* (Scopus indexed)

Umar, M. & Dahalan, J. (In press). Does Inflation Targeting effectively combat exchange rate volatility in Ghana and South Africa?. *International Journal of Economic Perspectives* (Scopus indexed)

Umar, M., Dahalan, J. & Aziz, M. I. A. (In press). Exchange rate stability and asymmetric causality in Nigeria: Does inflation differentials matter?. *Actual Problems of Economics* (Scopus indexed)

Umar, M., Dahalan, J. & Aziz, M. I. A. (In press). The South African monetary policy and inflation targeting as a nominal anchor: Does the monetary policy becomes more effective?. *International Journal of Monetary Economics and Finance* (Scopus indexed)

Umar, M. & Dahalan, J. (2016). An application of asymmetric Toda-Yamamoto causality on exchange rate-inflation differentials in emerging economies. *International Journal of Economics and Financial Issues, 6(2), 420-426.* (Scopus indexed)

Umar, M. & Dahalan, J. (2016). Asymmetric real exchange rate and inflation causality based on Toda-Yamamoto dynamic Granger causality test. *Actual Problems of Economics*, *5*(179), 430-440 (Scopus indexed)

Umar, M. & Dahalan, J. (2015). Evidence on real exchange rate-inflation causality: An application of Toda-Yamamoto dynamic Granger causality test. *International Business Management*, 9(5), 666-675. (Scopus indexed)

CONFERENCE PAPERS:

Dahalan, J. & Umar, M. (2016). *Asymmetric causality between exchange rate and interest rate differentials: A test of international capital mobility*. SIBR-UniKL 2016 Kuala Lumpur Conference on Interdisciplinary Business and Economics Research, 12th-13th February, The Royale Bintang, Kuala Lumpur, Malaysia.

Umar, M. & Dahalan, J. (2015). *The effectiveness of Overnight Policy Rate as a nominal anchor for Malaysian monetary policy*. The 4th ASEAN Consortium on Department of Economics Conference (ACDEC) 2015, 4th to 5th November, SAC, University Utara Malaysia.

Dahalan, J. & Umar, M. (2015). *The effectiveness of inflation targeting as hedging strategy for exchange rate volatility in emerging Southeast Asian economies.* 2^{nd} Global Conference on Business and Social Sciences, 17^{th} to 18^{th} September, ASTON Denpasar Hotel and Convention Centre, Bali, Indonesia.

Umar, M. & Dahalan, J. (2015). *On the causality between exchange rate-inflation in emerging economies: An application of asymmetric Toda-Yamamoto dynamic Granger causality test*. Singapore Economic Review Conference (SERC) 2015, 5^{th} to 7^{th} August, Mandarin Orchard Hotel, Singapore.

Umar, M. & Dahalan, J. (2015). *Does Inflation Targeting effectively combat exchange rate volatility in Ghana and South Africa?*. 3^{nd} International Conference on Economics, Finance and Management Outlooks, 27-28^{th} July, lebua Hotels and Resorts, Bangkok, Thailand.

Umar, M., Dahalan, J. & Aziz, M. I. A. (2015). *The Inflation Targeting as a nominal anchor in South African monetary policy: Does the monetary policy become more effective.* SIBR-Thammasat 2015 Conference on Interdisciplinary Business and Economics Research, 4^{th} – 6^{th} June, Emerald Hotel, Bangkok, Thailand.

Umar, M. & Dahalan, J. (2015). *Further evidence on real exchange rate-inflation causality: An application of Toda-Yamamoto dynamic Granger causality test*. 16^{th} Eurasia Business and Economics Society (EBES) Conference, 27^{th} to 29^{th} May, Bahcesehir University, Istanbul, Turkey.

Umar, M. & Dahalan, J. (2015). *Evidence on real exchange rate-inflation causality: An application of Toda-Yamamoto dynamic Granger causality test*. 2^{nd} International Conference on Business Strategy and Social Sciences, 16^{th} February, Movenpick Ibn Battuta Gate Hotel, Dubai, UAE.

Umar, M., Dahalan, J. & Aziz, M. I. A. (2014). *The relationship between inflation and exchange rate volatility in Nigeria (1970-2012): Further evidence*. 5^{th} International Conference on Economics and Social Sciences (ICESS-2014), 13^{th} to 14^{th} December, Rainbow Paradise Hotel, Penang, Malaysia.

ACKNOWLEDGEMENT

First of all, I thank almighty Allah for the guidance and blessings bestowed on me to see the successful completion of this study.

I wish to express my profound gratitude and appreciation to my supervisors, Prof. Dr. Jauhari Dahalan and Dr. Mukhriz Izraf Azman Aziz, who guided me throughout the period of my study. I particularly learned a lot from Prof. Dr. Jauhari Dahalan. He encouraged and taught me many scholarly ways of research. I specially thank them for the time they devoted in reading the earlier versions of this thesis.

I also wish to thank my thesis examination committee; the chairperson, Assoc. Prof. Dr. Russayani Ismail; the external examiner, Prof. Dr. Fadzlan Sufian and the internal examiner, Assoc. Prof. Dr. Hussin bin Abdullah for their important suggestions and comments. My sincere appreciation also goes to Assoc. Prof. Dr. Hussin bin Abdullah and Dr. Nor Azam bin Abd Razak for their invaluable comments and suggestions on the initial Ph.D. research proposal.

I acknowledge and sincerely wish to express my profound gratitude to Prof. Hatemi-J for furnishing me with his GAUSS programme codes and his essential clarifications. I wish to similarly appreciate the help of Dr. Weinbach Gretchen for providing me with her programme codes as well.

I also wish to use this opportunity to thank the staff of Department of Economics and Agribusiness at Universiti Utara Malaysia (UUM), especially Assoc. Prof. Dr. Sallahuddin Hassan, Assoc. Prof. Dr. Lim Hock Eam, Dr. Nor Azam bin Abdul Razak and Dr. Soon Jan Jan for the opportunity given to me to attend their various postgraduate classes. I sincerely acknowledge the management of UUM for given me the enabling environment.

I thankfully acknowledge the postgraduate scholarship given to me by UUM during my second semester before the commencement of my Tertiary Education Trust Fund's (TETFund) PhD fellowship award in the third semester. My gratitude and appreciation equally go to the management of Federal University Kashere (FUK), Nigeria through which the TETFund fellowship award was granted me and for the continuous flow of my monthly salary throughout the duration of the programme.

Finally, I thank my family members, friends and colleagues for their support, prayers and well wishes. This acknowledgement would be incomplete without special thanks and appreciations to my beloved wife (Hafsat), my son (Muhammad, Hafeez) and daughter (A'isha) for their support, patience and prayers.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviation	**Full Meaning**
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
AR	Autogressive
ARCH	Autoregressive Conditional Heteroscedasticity
ARMA	Autoregressive Moving Average
ASSOC	Associate
CBN	Central Bank of Nigeria
EU	European Union
FAVAR	Factor Augmented Vector Autoregressive
FDI	Foreign Direct Investment
FER	Flexible Exchange Rate
FUK	Federal University Kashere
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GAUSS	Is a programming language designed to operate on matrices
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
HP	Hodrick-Prescott
ICRG	International Country Risk Guide
IFS	International Financial Statistics
IMF	International Monetary Funds
IT	Inflation Targeting
ITF	Inflation Targeting Framework
LM	Lagrange Multiplier
LS	Lee and Strazicich
LP	Lumisdaine and Pappel Unit Root Test
MS	Markov-switching
MS-ARCH	Markov-switching ARCH
MWALD	Modified WALD Test
OECD	Organization of Economic Cooperation and Development
PPP	Purchasing Power Parity
SAP	Structural Adjustment Programme
SARB	South African Reserve Bank
SFEM	Second Tier Foreign Exchange Market
SIC	Schwarz Information Criterion
SSA	Sub-Saharan Africa
TETFund	Tertiary Education Trust Funds
TGARCH	Threshold GARCH
UUM	Universiti Utara Malaysia
USD	United States Dollars
VAR	Vector Autoregression
WDIs	World Development Indicators

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter presents the general introduction of the thesis. The motivation and background of the study are highlighted in the following section. Section 1.3 discusses the statement of the problem. The research questions are presented in section 1.4. Sections 1.5 contains the objectives of the study. The significance of the study is given in section 1.6 while sections 1.7 and 1.8 respectively present the scope of the study and the organization of the thesis.

1.2 Background of the Study

Exchange rate volatility[1] has affected not only sub-Saharan African (SSA) economies but the volume of the world international transactions in general (Eun, Resnick & Sabherwal, 2012). It directly affects the nations' profitability of tradable commodities and services, balance of payment, terms of trade, efficient allocation of resources and investment decision (Kemme & Teng, 2000 and Taiwo & Adesola, 2013). The uncertainty stated as far back as 1914, during the World War I when the gold standard was discarded. The frequent uncertainties led to the Bretton Wood agreement of fixed exchange rate in 1944. The fixed exchange rate era overvalued the United States (US) dollar in the 1970s in relation to other countries' currencies. This paved way to Smithsonian agreement of flexible exchange rate in 1973. Despite the Smithsonian

[1] Exchange rate volatility is the degree of fluctuations or uncertainty pertaining the size of changes in the value of currencies. On the other hand, it is the degree of instability or unpredictability regarding the size of changes in the value of currencies. It is also seen as the liability of one country's currency relative to another to fluctuate over time (Nnamdi & Ifionu, 2013).

agreement, governments continue having difficulties in ensuring exchange rate stability.

Most of the sub-Saharan African states practiced fixed exchange rate prior to the structural changes in January, 1986 in the case of Gambia, September, 1986 in Ghana and July, 1986 and 1995 in Nigeria and South Africa respectively. The practice of fixed exchange rate ensures relatively low cost of importing capital equipment and raw materials for industries through overvaluation of the currencies. However, flexible exchange rate was introduced as a result of persistent deficit in the balance of payment due to massive importation of consumer goods coupled with low exports that further worsened the deficit of the countries' balance of payment. Therefore, the structural reforms of the 1980s and the wake of the currency crises in the 1990s in the third world countries also lead to increase in the exchange rate volatility in developing economies like Gambia, Ghana, Nigeria and South Africa among others (Azeez, Kolapo & Ajayi, 2012 and Imimole & Enoma, 2011).

The SSA economies are being saddled with uncertainties in exchange rate over a long period of time despite the governments' effort to ensure low inflation and stable exchange rates for better economic growth (Aliyu, 2012; Central Bank of Nigeria (CBN), 2012 and Sanusi, 2010). The various policies and changes in regimes especially the frequent movement of inflationary trend and money supply have seriously affected the region's price stability and lead to various countries' currency depreciation (Aliyu, 2012 and Sanusi, 2010). The devaluation of currencies embarked upon by most of the African economies in order to ensure stable exchange rate also causes inflationary pressure due to the inelastic nature of importation behavior of developing and emerging economies (Soludo, 1993).

Furthermore, financing of the persistent budget deficit in the region through excessive increase in the money supply culminates into an upward inflationary pressure. This was further aggravated by the ample oil revenues generated during the oil boom of the 1970s, in the case of oil exporting countries like Nigeria and Ghana. Moreover, fiscal expenditure on rehabilitation and reconstruction of the post-war era especially in the high politically unstable economies such as Nigeria and South Africa, coupled with the frequent increase in wages and salaries in the economies also lead to the upward inflationary pressure (Imimole & Enoma, 2011). Inflation[2] leads to the rise in exchange rate and persistent decrease in the value of domestic currencies which result to problems in international transactions (Danmola, 2013).

In Nigeria, for instance, inflation increased from 10% in 1980 to 20.8% in 1981. The percentage later reduced to 5.7% in 1986 and rise up to 50.5% in 1989. The rate of inflation however, reduced to 7.4% in 1990 and 6.6% in 1999. In 2003, the rate jumped to 14% and later decreased to 12.2% in 2012 (CBN, 2012). On the other hand, the Nigerian currency (*naira*) exchange rate was fixed with marginal changes prior to 1986. In 1980 for instance, the *naira* exchange rate to United States dollar (USD) was 0.55. This shows the nominal strength of *naira* over USD. However, the domestic currency was exchanged at 1.75 to 1 USD in 1986. This later fluctuate around 22.06 in 1993 and 21.89 in 1998. The rate further jumped to 129.22 in 2003 before it later

[2] Inflation is a monetary term which refers to a sustained increase in the supply of money in an economy which causes persistent rise in the general level of prices.

dropped down to 118.55 in 2008. This trend continues until the official exchange rate was reported around 185.89 before the end of 2014.

Similarly, the scenario also prevailed in Gambia, Ghana and South Africa where Gambian *dalasi*, Ghanaian *cedi,* and South African *rand* were exchanged for 1.72, 0.000275 and 0.78 respectively to one USD in 1980. The exchange rate later raised to 9.54, 0.12 and 3.63, in 1995 and further increased to 22.19, 1.06 and 8.26 in 2008. The trend continues up to 2013 when Gambian *dalasi* was exchanged at 35.96, Ghanaian *cedi* at 1.95 and South African *rand* at 9.66 per USD (World Bank, 2015). The scenario of exchange rate movement is further presented on time series graphs exhibited in Figure 1.2 under appendix B-1, using the nominal exchange rates of Gambia, Ghana, Nigeria and South Africa.

Another issue is that most of the SSA states are bedeviled with political instability since independence. "Many countries suffered from civil strife and 'stop-go' economic policies that resulted into serious macroeconomic instability" (Omotor, 2008). The region experience greater political instability in the early days of independence starting from 1963 when Sylvanus Olympio of Togo was toppled and murdered by the Togolese military. This marked the forays of military into politics in the region leading to the coup *d'état* belt reputation of the continent (Olukoshi, 2001). Therefore, the stability of exchange rate in this region might be affected by the unfashionable attribute of government that tempered with the transparency and continuity of exchange rate stability as a result of the frequent transformation and changes in administration. A clear instance is the rampant military regimes and civil crises in some parts of the region. This scenario coupled with attitude of small market participants lead to apparent exchange rate instability in the region (World Bank, 2000, in Yagci, 2001). Furthermore, Petterson (2000) and Levy-Yeyati, Sturzenegger and Reggio (2010) argue that political instability and weak government policies may affect exchange rate equilibrium as a result of less predictive ability of the circulated news.

In response to various macroeconomic instabilities, the monetary authorities of SSA economies had experienced several monetary and exchange rate policy changes. At some points in time, most of the central banks in the region embarked on sterilization policies to ensure sustainable stability of exchange rate. However, the frequent monetary policies reform also aggravate the instability in the exchange rate. The sterilisation policy reforms include formal pegging of currencies, centralization of exchange rate management in central banks, restriction of Bureau de change in foreign exchange transactions, Dutch Auction system and derivative contracts to transform and deepen the foreign exchange markets in the region. Other monetary policies such as monetary targeting or interest rate targeting, exchange rate targeting among others were also introduced in most sub-Saharan African states to ensure stability of exchange rate and other macroeconomic indicators.

Furthermore, the most recent monetary policy framework of Inflation Targeting (IT) has become a standard monetary policy rule adopted by the central banks in the Organisation of Economic Corporation and Development (OECD) and few developing countries to maintain a stable inflation rate in the economies (Aizenman, Hutchison & Noy, 2011). The policy is increasingly pursued in the developing countries as a result of its advocated successes in some developed nations. Despite the adoption of the IT framework in some countries to ensure stable macroeconomic performance, their currencies have been volatile and depreciating over time. Moreover, the global financial crisis of 2009 has also affected the exchange rate stability in the countries under study (CBN, 2013).

1.3 Statement of Problem

The economic policymakers and monetary authorities in the sub-Saharan Africa are faced with macroeconomic policy challenges. Their currencies' exchange rate against other currencies is at the depreciation trend over a long period. Evidence from the World Bank in Figure 1.2 (see appendix B-1) has shown that the currencies depreciate over time. For instance, the real effective exchange rate of Gambia, Ghana, Nigeria and South Africa for the period under study depreciated by 67%, 88%, 60% and 40% respectively. Furthermore, the exchange rate of Gambian *dalasi*, Ghanaian *cedi*, Nigerian *naira* and South African *rand* against USD depreciated by 8.8%, 20%, 1.4% and 0.8% respectively from January 2012 to December 2013. In a nutshell, the average continues real exchange rate depreciation in the sub-Saharan Africa as far back as early 2000 is estimated at more than 4% (Bleaney & Greenaway, 2001). This signifies that any investor who holds his financial position in these currencies will be affected by such trend of depreciation. This situation will, therefore, hamper not only the foreign investment into the economies, but also the value of export and balance of payment position that has direct implication on economic growth and development prospect of the countries.

The instability of the exchange rate causes risk and unpredictability in investment and productivity. This negatively affects the performance of many macroeconomic indicators especially in the less financially matured economies such as Gambia, Ghana and Nigeria. Similarly, exchange rate volatility is identified as one of the factors that negatively affects tradable and non-tradable, investment and growth in sub-Saharan Africa (Bleaney & Greenaway, 2001 and Pokhariyal, Pundo & Musyoki, 2012). The exchange rate uncertainties coupled with inflation affect the value of domestic currencies in the region which significantly affect investment profitability of multinational corporations and investors (Brada, *et al.*, 2004; in Udoh & Egwaikhide, 2008). It deteriorates the region's international competitiveness which negatively affects the economic growth of the countries (Masron & Yusuf, 2006 and Pokhariyal *et al.*, 2012). The international less competitiveness of real exchange rate discourages export and growth in output, usually through their underdeveloped financial channels (Aghion, Bacchetta, Ranciere & Rogoff, 2009).

The above phenomenon causes investors in the region to embark on assets substitution and speculations thereby affecting financial sector and entire economic activities of the region (Mcgibany & Nourzad, 1995 and Subair & Salihu, 2004). It, therefore, became a major source of worry and concern by the national governments, monetary authorities, researchers and investors among others. This motivates the pursuance of some monetary policy frameworks such as inflation targeting in the recent years.

On the other hand, most of the IT economies adopted the framework as a means of reducing the menace of the macroeconomic and exchange rate volatility in their countries. However, the effect of IT on the volatility of exchange rate is a significant policy issue which has not been exhaustively addressed by the previous debate in the literature (Edwards, 2007; Grossman, Love & Orlov, 2014 and Tolulope & Ajilore, 2013). The findings on the effectiveness of IT towards maintaining stability in macroeconomic variables are mostly reported for industrialized nations and the results are found inconclusive. However, the continuous volatility in exchange rate, inflation and other macroeconomic variables even after the introduction of IT framework in these countries caused doubt on the effectiveness of such a policy in achieving the desired macroeconomic objective (Batini, Harrison & Millard, 2003; Markiewicz, 2012; Pavasuthipaisit, 2010 and Tolulope & Ajilore, 2013).

Furthermore, it has been argued that the fundamental macroeconomic variables have seized to explain the phenomenon of exchange rate instability immediately after the Bretton Wood era (Chau, Deesomsak & Wang, 2014; Evans & Lyons, 2000; Flood & Rose, 1999 and Freeman, Hays & Stix, 2000). Several studies have been conducted in the advanced and emerging markets with inconsistent findings. Some of the mix findings show that unstructured sudden changes in the exchange rate regime impact positively on the volatility of exchange rate whereas, the structured changes do not influence volatility in exchange rate (Mensi, Hammoudeh & Yoon, 2014). Therefore, the menace of the structural adjustment in exchange rate regimes and political instability and civil wars in most of the SSA countries tend to have permanent shock effect on the equilibrium level of exchange rate (Arize, Malindretos & Shwiff, 1999 and Cookey, 1997). Furthermore, it is argued that the persistent political instability and weak government policies in SSA may affect the exchange rate equilibrium due to the less predictive ability of the circulated news, which leads to capital flight due to loss of confidence by the foreign investors (Levy-Yeyati *et al.*, 2010).

Another problem related to this study is the exchange rate disconnect puzzle. This is indicated by the weak and rarely significant relationship between exchange rate and most macroeconomic fundamentals such as inflation, money supply, interest rate, and real income differentials (Obstfeld & Rogoff, 2001). Furthermore, the unpredictability of exchange rate has been an issue of concern since the seminal work of Meese and Rogoff (1983). Simply put, the direction of causality between exchange rate and macroeconomic fundamentals remains unpredictable in the literature. The inconsistent nature of the relationship among the variables has been the subject of concern in international economics and macroeconomics. The reported conflicting findings suffered from methodological problems and hamper appropriate policy formulation especially in the developing economies of sub-Saharan Africa.

1.4 Research Questions

This study entitled the analysis of monetary framework of inflation targeting, exchange rate regime switching and volatility in selected sub-Saharan African countries is designed to provide answers to these core research questions:

1. What is the effectiveness of inflation targeting as a hedging strategy for exchange rate volatility in Ghana and South Africa?
2. Does the monetary policy framework of inflation targeting performs the role of the nominal anchor in Ghana and South Africa?
3. What is the influence of exchange rate regime switching and political instability on exchange rate volatility in Gambia, Ghana, Nigeria and South Africa?
4. Does causal relationship exists among the exchange rate fundamentals in Gambia, Ghana, Nigeria and South Africa?

1.5 Research Objectives

The main aim of this study is to determine the connection between the monetary framework of inflation targeting, exchange rate regime switching and volatility in selected sub-Saharan African economies.

The specific objectives are to:

1. Investigate the effectiveness of inflation targeting as a hedging strategy for exchange rate volatility in Ghana and South Africa.

2. Determine whether the monetary policy framework of inflation targeting has performed the role of the nominal anchor in Ghana and South Africa.

3. Examine the influence of exchange rate regime switching and political instability on exchange rate volatility in Gambia, Ghana, Nigeria and South Africa.

4. Determine the causal relationship among the exchange rate fundamentals in Gambia, Ghana, Nigeria and South Africa.

1.6 Significance of the Study

Findings of this study, theoretically contribute to the literature and provide future research possibility due to inadequate empirical studies in the areas. The main contributions of the study include investigating; the effectiveness of inflation targeting as a hedging strategy for exchange rate volatility in Ghana and South Africa, whether the inflation targeting framework has performed the role of the nominal anchor in Ghana and South Africa, the influence of exchange rate regime switching on exchange rate volatility and finally, the causal relationship between exchange rate and macroeconomic fundamentals (inflation, interest rate, money supply and income differentials) for Gambia, Ghana, Nigeria and South Africa. The study generally accounts for the existence of structural breaks in the data generating process. This is included in the estimated models to see the influence of structural breaks, such as financial crisis, economic downturn and a like, in determining the relationship among the regressors and regressand. The structural breaks are identified using Lee and Strazicich (2013) endogenous minimum LM test. Specifically, the main contributions of the study are highlighted based on the specific objectives of the study.

Firstly, most of the previous empirical studies conducted on inflation targeting were limited to the determinants of applicability and readiness for adoption of the framework mostly in the developed countries with very few studies from the emerging economies. Furthermore, the previous literature did not adequately address the effect of inflation targeting on the instability of exchange rate and other macroeconomic variables (Edwards, 2007 and Markiewicz, 2012). This is precisely lacking in the sub-Saharan African region.

Therefore, one of the contributions of this study is that unlike the studies of Edward (2007) and Grossman *et al.* (2014) who employ the standard Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model to test the effect of inflation targeting using developed countries' data and panel VAR to study exchange rate volatility dynamics respectively, the present study employs the powerful time series Threshold Generalised Autoregressive Conditional Heteroscedasticity (TGARCH) model using data from developing countries. The advantages of employing the model is that it employs more flexible lags while considering both positive and negative aspect of the shock process in terms of asymmetric effect especially in relation to inflation targeting and volatility of exchange rate in the selected sub-Saharan African economies. Furthermore, the methodology does not enforce constant structure for the entire lags. This is because in asymmetric modelling, opposite contributions may arise from different lags. Moreover, the model uses absolute residuals which are found more efficient in estimating the variance compared to the squared residuals, especially in the normal distribution (Davidian & Carroll, 1987). Besides, the study found the existence of asymmetric effect in the model. This shows that exchange rate users react differently during good and bad times. The asymmetric response in the estimation indicates that positive shocks lead to higher volatility of exchange rate in the succeeding quarter compared to the same level of negative shocks.

Another contribution of the study to the literature is the use of two measures of inflation targeting; the commonly used dummy variable, which takes the value of one for the period after adoption of the framework and zero otherwise and a constructed inflation target series using the methodology of Hodrick-Prescott filter. The later is employed to check the robustness and sensitivity of the dummy variable using an alternative measure. Moreover, the present study augments the TGARCH model with macroeconomic fundamentals based on the theory of exchange rate determination to take care of the possible explanatory variables bias in the ARCH modelling process. These factors also influence the volatility of exchange rate (Chinn, 2011; Chin *et al*., 2007 and Edwards, 2007). The inclusion of the other factors also distinguishes the thesis from the previous studies that usually investigate the effect of the lagged exchange rate on the instantaneous series without controlling for other factors that can lead to exchange rate movement. Furthermore, the study incorporates structural breaks in the variance equation in order to determine the effect of structural shocks on the stability of exchange rate. The breaks dates basically coincide with the structural adjustment programmes of the 1980s. Apart from the structural breaks accounted for in the model, the study further takes account of floating exchange rate regime due to the country's prolonged flexible exchange rate era. Moreover, the study estimates the effect of IT policy transition effect in the TGARCH model.

Based on the available literature, this study is considered as one of the first attempts to investigate the effectiveness of inflation targeting as hedging strategy for exchange rate volatility in inflation targeting sub-Saharan African economies, Ghana and South Africa especially using the TGARCH modelling process while accounting for structural breaks.

Secondly, the study examines whether the inflation targeting framework has performed the role of the nominal anchor; and the process through which interest rate is determined in Ghana and South Africa. This is achieved using the Taylor rule specification. The models are estimated using the time series GMM estimators. Unlike the ordinary least squares and maximum likelihood estimators, the GMM estimators solve the overlapping data problem resulting from the variable construction and non-constant variance in the forecast error (Hansen, 1982). Moreover, the technique is found consistent and efficient while allowing for the existence of ARCH effect and serial correlation in the orthogonal construction.

Unlike the studies of Aron and Muellbauer (2007), Gupta *et al*. (2010) and Kabundi, Schaling and Some (2015) for South Africa who employ backward-looking rule and different methodology, the present study uses the forward-looking policy rule specification of the central bank reaction function using a longer sample data. The contribution here is based on the argument in the literature which emphasized that monetary authorities should be concerned about expected future economic performance thereby forward-looking specification rather than previous economic performance, measured by the backward-looking policy rule specification (Bernanke Gertler and Gilchrist, 1999; Torres, 2003). Another important contribution of the study is that the study also augmented the forward-looking policy rule specification by including other variables which can also help in determining the process through which interest rate is determined in Ghana and South Africa under the framework of inflation targeting. The augmented variables include, exchange rate and money supply as suggested in Taylor (1993), Torres (2003) and Svensson (2000) among others. The study also identifies the process followed by the Ghanaian and South African monetary authorities in determining their monetary policy instruments (interest rate) in the economies.

One other contribution of the study to the literature is the estimation of the influence of structural breaks in the interest rate determination process in the selected sub-Saharan African economies which are characterised by frequent structural changes in the data generating process. Furthermore, the study investigates the process of determining the monetary policy instruments in three different regimes, the period prior to IT adoption, the period after the adoption and the full sample period. This study, to the best of the researcher's knowledge, is one of the early studies conducted to assess whether the IT framework has served as a nominal anchor in the only two sub-Saharan African inflation targeting economies, Ghana and South Africa using the robust GMM estimators.

Thirdly, previous studies carried out on the non-linear relationship between the macroeconomic fundamentals and exchange rate such as Taylor and Peel (2000); Taylor, Peel and Sarno (2001) and Kilian and Taylor (2003) did not consider the transitional effect of the macroeconomic fundamentals on the exchange rate stability (Diebold, Lee and Weinbach, 1994 and Yuan, 2011). The present study follows Diebold *et al*. (1994) and Yuan to investigate the influence of regime switching on exchange rate volatility through Markov-switching transition probabilities. The use of the time-varying transition probabilities ARCH model accounts for large shock absorption in both parameters and variance movement due to instability in government policies, financial crisis and the time-invariant effect in the conditional variance. Furthermore, it takes care of the shocks in the international monetary policies, changes in global trade relationship, financial market crisis and sudden financial shocks which affect the dynamism of exchange rate (Yuan, 2011). The time-varying Markov-switching transition probabilities differs from Cai (1994) and Hamilton and Susmel (1994) in that it allows for the existence of state dependent ARCH effect in both coefficients and intercept on conditional variance. The model allows for transitional probabilities over time.

Additionally, the present study differs from the previous studies in the area in that it introduces the variable of political instability on the exchange rate determination model and uses the time-varying transition probabilities ARCH model to test the influence of regime changes in the selected sub-Saharan African countries. Although the impact of regime changes on exchange rate has rarely been studied with mixed conclusions (Bodart & Reding, 1999; Mensi *et al.*, 2014 and Syllignakis & Kouretas, 2011), the use of time-varying transition probabilities Markov-Switching ARCH model has not been widely employed especially in the developing countries of sub-Saharan Africa. More so, previous literature primarily concentrates on the effect of political instability on stock return and asset price volatility with inconclusive findings (Beaulieu, Cosset & Essadam, 2006; Boutchkova, Doshi, Durnev & Molchanov, 2012; Chan & Wei, 1996 and Chau, *et al.*, 2014). However, only few studies focus on political risk and exchange rate vulnerability.

Furthermore, unlike the work of Yuan (2011) who study the exchange rate and macroeconomics determinant using data from Australia, Canada, Japan and United Kingdom, this study employs data from the developing countries (Gambia, Ghana, Nigeria and South Africa), a region characterised by prolonged autocracy and numerous civil wars which immensely contribute to different kinds of instabilities in the region (Boafo-Arthur, 2008). Moreover, the model distinguishes between the influence of exchange rate in high/depreciation and low/appreciation transition probability states on the volatility of exchange rate.

Finally, the study presents a comparative causality analysis among the variables of the theory of exchange rate determination using three methods; asymptotic Granger, dynamic Toda-Yamamoto with leverage bootstrapping and asymmetric causality for Gambia, Ghana, Nigeria and South Africa. Most of the previous studies employ asymptotic Granger causality in establishing the causal relationship among variables, the present study uses asymmetric causality in order to determine causality in both good and bad times in addition to the modified Toda-Yamamoto dynamic Granger causality with leverage bootstrapping. The methods are robust in solving the problems of non-standard asymptotic distribution, size distortion and nuisance parameter estimates especially in the presence of Autoregressive Conditional Heteroscedasticity (ARCH) effect and small sample size (Guru-Gharana, 2012 and Hatemi-J & Irandoust, 2006).

Another contribution associated with this study is that most of the previous causal analyses are conducted on bivariate models without controlling for possible explanatory variables which might lead to control variables bias. This study estimates multivariate model. The advantages of estimating such models are highlighted in Stock and Watson (2001). Furthermore, the study generates critical values based on the underlying empirical data using a GAUSS program procedure developed by Hacker and Hatemi-J (2006) and Hatemi-J (2012) for the leverage bootstrap distribution and asymmetric causality. This reduces the menace of size distortion especially in a small sample size like the one employed in this study. In determining the maximum order of integration for the purpose of lag argumentation in Toda-Yamamoto causality process, this study depart from the previous studies by employing an endogenous break detective mechanism (LM test) with one structural break in addition to the traditional ADF test.

Based on the available literature, this study is one of the first studies that investigates the causation among the variables of the theory of exchange rate determination using the modified Toda-Yamamoto causality with leverage bootstrapping and asymmetric causality using developing countries' data in the selected sub-Saharan African economies.

The findings of this study would also guide policymakers in formulating more sound and effective monetary policies based on the policy implications of the study. Firstly, using data from selected sub-Saharan African countries, this study will practically help policymakers to uncover the impact of transparency, accountability and announcement of interest rate by the central bank aimed at reducing the menace of macroeconomic instability and exchange rate volatility. The study will stimulate other economies the fact that the policy is found effective in reducing the volatility of exchange rate especially for the countries pursuing alternative strategies to consider moving towards the inflation targeting framework instead of pursuing the alternative strategies aimed at ensuring exchange rate stability. The study will also assist the monetary authorities in determining the process through which they can set their monetary instrument (interest rate) in the economies.

Secondly, the study will help policymakers in their decision towards changes in exchange rate regimes especially in the developing countries of Africa with rampant political instability and structural adjustment programmes. Finally, knowing the causal relationship among the variables of interest will also help the policymakers to prevent decision making based on uncertainty, enhances forecasting process and properly understand the linkage between the variables and how to manipulate the related variables for better economic stability.

The study will also help multinational corporations, investors/arbitragers, exchange rate users and other market participants in their investment portfolio appraisals in inflation and non-inflation targeting countries, as well as regime changing and politically unstable countries of sub-Saharan Africa. The study will also help the stakeholders to realize the opportunities and challenges involved in exchange rate volatility in the developing and emerging economies such as Gambia, Ghana, Nigeria and South Africa.

1.7 Scope of the Study

The study is carried out on four sub-Saharan African countries namely Gambia, Ghana, Nigeria and South Africa using quarterly time series data from 1980:1 to 2014:4. The choice of these four countries is informed by the peculiar nature of the countries as highlighted in the background of the study and the availability of data on the identified variables of interest. The justification for using 1980 is also based on availability of data as some variables in most African countries especially the real effective exchange rate do not have data prior to 1980.

Furthermore, the selected countries are classified into two; inflation targeting economies, Ghana and South Africa to assess the effectiveness of the policy in reducing volatility of exchange rate and whether it serves as a nominal anchor in the economies or not and other two non-inflation targeting economies, Gambia and Nigeria due to their high prevalence of historic and clustering volatility.

The data are collected on nominal and real exchange rate, inflation, interest rate, money supply and income from the International Financial Statistics (IFS) of the

International Monetary Fund (IMF) and World Bank Development Indicators (WDIs). The data on political risk are obtained from the International Country Risk Guide (ICRG) whereas, inflation deviation, inflation target and output gap are constructed using Hodrick-Prescott filtering (Hodrick & Prescott, 1997).

1.8 Organization of Thesis

This thesis is categorized into five chapters. Chapter one provides the general background and motivation of the study. The chapter offered a brief introduction to give a general overview of the chapter's contents. Chapter two reviews literature on theoretical and empirical studies. The theoretical aspect involves review on the concepts and classifications of inflation targeting and exchange rate regime switching as well as a review on related theories. The empirical review is carried out on the effect of inflation targeting on exchange rate volatility, central bank intervention and exchange rate volatility, macroeconomic effect of inflation targeting, relationship between regime changes, political instability and volatility of exchange rate. The section further presents review on the causal relationship between exchange rate and other variables of the monetary theory of exchange rate determination.

Chapter three deals with the theoretical framework underpinning the study. It also discusses the research methodology employed in the study. The sources of data and the estimation procedures are also explained in the chapter. It also presents operational justification of variables. Chapter four presents results and discussions of research findings. Chapter five follows the normal convention to present the summary of findings based on the objectives of the study, policy implication, recommendations for future research work and limitations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter is divided into five sections. Section 2.2 presents literature review on conceptual/theoretical and empirical studies. The former deals with review on the concept and classification of inflation targeting, concept and division of exchange rate regime switching and review of theories of exchange rate, optimum currency area and Taylor rule while the later involves empirical review on the relationship between inflation targeting and exchange rate volatility, macroeconomic effect of inflation targeting, political instability and volatility of exchange rate and review on causal relationship between the variables of monetary theory of exchange rate determination. Section 2.3 discusses the gaps in the literature and the chapter summary is presented in section 2.4.

2.2 Literature Review

This section deals with review of previous theoretical and empirical studies. The section is divided into two. Section 2.2.1 presents review on conceptual/theoretical studies. The section is categorised into five sub-sections. The second section, section 2.2.2 deals with the empirical literature review. The section is further divided into six sub-sections.

2.2.1 Conceptual/Theoretical Review

This section presents the theoretical review. The section is categorised into five sub-sections. Sub-sections 2.2.1.1 and 2.2.1.2 discuss review on the concept and classification of inflation targeting respectively. Sub-section 2.2.1.3 presents concept of exchange rate regime switching. Sub-section 2.2.1.4 gives review on the divisions of exchange rate regime switching and the review of theories of exchange rate, optimum currency area and Taylor rule are presented in sub-section 2.2.1.5.

2.2.1.1 Concept of Inflation Targeting

From the prominent work of Taylor (1993) inflation targeting emerged the widely embraced monetary policy framework (Bassey & Essien, 2014). However, the concept lacks a universal definition. According to Svensson (1999) and Orlowski (2000) Inflation targeting is a framework of monetary policy conducted on the pre-announced target of inflation, transparent and tactical to support the pre-announced target to predict the deviations of the target inflation and its forecast based on policy response. Inflation targeting involves public announcement of the numerical target of medium-term inflation; institutional commitment towards price stability; information-inclusive strategy with increase accountability and transparency (Bernanke, Laubach, Mishkin and Posen, 1999 and Mishkin, 1999).

In other words, Sherwin (2000) defines inflation targeting as a constrained discretion. While Miao (2009) describes inflation targeting as a monetary policy framework with well-defined targeted inflation point supported with strong institutional arrangement to achieve a certain degree of transparency and accountability. The concept has also been described as a nominal anchor policy framework where the central bank accounts for inflation deviation from its target (Aliyu & Englama, 2009). Furthermore, Bassey and Essien (2014) define inflation targeting as framework of monetary policy committed to ensure price stability through setting an inflation target over a given time horizon publically communicated to improve the credibility, accountability and transparency of monetary authorities.

The policy is highly transparent and rapidly understood by the public compared to other monetary policies. It reduces the likelihood of the central bank to enter the trap of time inconsistency (Mishkin, 2007). The policy allows for flexibility in inflation deviation from its target in response to shocks in the level of supply. Therefore, inflation targeting is a framework of monetary policy committed to target and forecast inflation within a certain range over a determined time horizon to ensure successful achievement of the aggregate macroeconomic objectives. The framework is aim at ensuring credibility, transparency, accountability and serving as a nominal anchor monetary policy.

2.2.1.2 Classification of Inflation Targeting Framework

The new monetary policy framework of inflation targeting exhibits a gradual transition and admission process. Different classification of inflation targeting has been unanimously identified in the literature. According to Bassey and Essien (2014) and Aliyu and Englama (2009) inflation targeting framework is mainly classified into full-fledged, eclectic and lite inflation targeting. The full-fledged framework exists where inflation targeting is readily adopted as a sole nominal anchor through which the economy seeks to achieve its objective of price stability. It tends to be fully transparent, highly accountable and committed towards the actualization of inflation targeting. The eclectic inflation targeting is a kind of inflation targeting that is less transparent and pursued in a predictable financial environment along with other policies by the central bank. While the inflation targeting lite is the least version adopted due to absence of sound macroeconomic environment. Under the inflation targeting lite, the monetary authorities could not maintain the announced inflation target (Aliyu & Englama, 2009; Bassey & Essien, 2014 and Roger, 2009).

Furthermore, Ojo (2013); Rogers and Stone (2005) also categorised inflation targeting into full-fledged, eclectic and inflation targeting lite. In the complete taxonomy of monetary policy framework proposed by Stone and Bhundia (2004) inflation targeting framework is grouped into full-fledged regime, inflation targeting lite and implicit price stability ascribed by Carare and Stone (2006).

For the purpose of this study, the full-fledged inflation targeting will constitute the basic concern of the analysis. However, the central bank's inability to adopt full-fledged inflation targeting to ensure stable and low rate of announced inflation indicates the institutional weakness and vulnerability to policy shocks (Ojo, 2013).

2.2.1.3 Concept of Exchange Rate Regime Switching

The concept of exchange rate regime is fundamentally classified and defined based on the nominal exchange rate changes and uncertainty in the nominal exchange rate as well as the international reserve fluctuation (Levy-Yeyati & Sturzenegger, 2003). The fixed regime relates to the foreign reserve changes that aim at minimizing the nominal exchange rate fluctuations. The flexible regime relates to foreign reserve stability with substantial nominal exchange rate instability (Levy-Yeyati & Sturzenegger, 2003). Other regimes are found in between these two extreme regimes that entail movement from or changing from one exchange rate policy to another (Mussa *et al.*, 2000). According to Rose (2011) exchange rate regime switching is a movement in the government set of exchange rate policies from one established exchange rate management style to another.

The regime changes started since the collapse of the gold standard in 1944 to the Bretton Wood agreement of fixed exchange rate which lapsed in 1973. This gave rise to a new style of exchange rate management by many central banks around the world (Klein & Shambaugh, 2010). Although countries adopt different regimes depending on their peculiar characteristics and other factors that determine the regime switching from one policy to another, the Mundell trilemma shows that the monetary policy regime determines the choice of exchange rate regime in the free capital mobility situation. The desire of the government to pursue an independent monetary policy facilitates switching and maintaining flexible exchange rate in the economy. The government's ability to manipulate the short-term monetary instrument such as interest rate to ensure price stability entails adoption of the fixed exchange rate (Sørensen & Whitta-Jacobsen, 2010).

2.2.1.4 Classification of Exchange Rate Regimes

Exchange rate regime has been classified in the literature into several classes depending on the nature of flexibility of the system. In the initial stage, exchange rate regime has been classified into fixed and flexible exchange rates with the exception of pegged regime which has been distinguished from the flexible exchange rate (Edwards, 1996 and Collins, 1996). The widely noticed regimes include: floating, fixed, managed floating, crawling pegs, crawling bands, fixed peg and pegged within bands (Edwards & Savastano, 1999 and Frankel, 1999). In the managed floating regime, the exchange rate is determined and maintained by the government in order to ensure global competitiveness. In addition, the crawling band regime is subdivided into narrow and broad bands. The former, periodically regulates the exchange rate at a fixed rate within a given band to maintain competitiveness in the market while, the later relates to floating system where the rate is maintained within broad bands pre-announced to keep it to a competitive level.

The classification is further extended to include a new regime, the light managed floating regime to make a better comparison between the prevailing regimes. The new regime moderates the persistent movements in the foreign exchange through light intervention by the government (Yagci, 2001). In the light managed floating regime, the exchange rate is primarily determined by the forces of demand and supply. Rose (2007) further classified exchange rate regime into fixed, intermediate and floating. In a nutshell, the exchange rate regimes are broadly classified into floating regime which comprises; independent float and lightly managed float; intermediate regime involving managed float and crawling broadband; soft peg regime which entails crawling narrow band, crawling peg, pegged within bands and fixed peg and finally hard peg regime such as currency board and currency union dollarization (Levy-Yeyati *et al.*, 2010; Mussa *et al.*, 2000 and Yagci, 2001).

2.2.1.5 Theories and Models of Exchange Rate

This section discusses some theories and models of exchange rate determination, optimum currency area and Taylor rule. Below are some of the theories that are widely discussed in the literature and seminal works on exchange rate.

2.2.1.5.1 Purchasing Power Parity (PPP) Theory

The basic concept of exchange rate started from the Purchasing Power Parity (PPP from now henceforth) which evolved in the 16th century (Eun *et al*., 2012). The PPP theory is largely attributed to the work of David Hume and David Ricardo in the early 1800s in the writings of bullionist controversy. The theory is however more associated with the Swedish economists, Gustav Cassel who first used the term PPP to explain differential price level and its influence to relative exchange rates during and after world war I. Cassel (1916) tested the theory empirically and make it an operational theory. He mainly focuses on the relationship between domestic price level and foreign commodity prices via the exchange rate (Caginalp, 1982).

In its absolute term, the PPP theory as postulated by Cassel is that the demand and the value of a currency depend on the quantity of commodities the unit of the currency can purchase in the issuing country. Considering two countries the value of currency of one country in terms of the other country is regarded as the short run equilibrium exchange rate. Therefore, the absolute PPP equals the ratio of the purchasing powers as in Equation 2.1:

$$PER = \frac{P_{FX}}{P_{DM}} \tag{2.1}$$

where PER is the predicted exchange rate, P_{FX} is the purchasing power of foreign currency, P_{DM} is the purchasing power of the domestic currency. The theory postulates that if the value of foreign currency rises, the local arbitragers would massively import commodities from abroad and exchange their domestic currency for foreign currency. This would raise the price of foreign currency in domestic monetary terms. This will continue until when the arbitragers stop importing the foreign commodities. Cassel (1916) admitted that the absolute purchasing power parity is an extreme case which rarely exists in the real world situation due to the heterogeneity of commodities among other factors.

However, the relative PPP takes heterogeneity into consideration. Relative PPP states that percentage change in exchange rate equals to the percentage change in domestic price level after deducting the percentage change in the foreign price level as presented in Equation 2.2:

$$\%\,\Delta\,EXR \;=\; \%\Delta P_{DM} - \%\,\Delta P_{FX} \tag{2.2}$$

where *EXR* is the exchange rate. The symbol Δ is the difference operator. P_{DM} and P_{FX} represent domestic and foreign prices respectively. In a nut shell, exchange rate is the same as the domestic inflation rate minus the foreign inflation rate. This is known as the concept of inflation differentials. It is therefore, deduced that relative prices determines exchange rate only in the short run because of its random nature. In the long run however, the exchange rate movement is largely determined by the inflation differentials. The relative PPP considers the similarities in the price index over a period for each country.

$$CEXRP \;= \frac{DMPI \,/\, DMPI_b}{FXPI \,/\, FXPI_b} * CX_b \tag{2.3}$$

where *CEXRP* is the predicted current exchange rate, *DMPI* is domestic price index, $DMPI_b$ represents domestic price index at base year, *FXPI* means foreign price index, $FXPI_b$ stand for foreign price index at base year and CX_b denotes current exchange rate at based period. If a country's currency depreciates by less than the inflationary rate, the country's real exchange rate will be higher than unity which weakens the country's competitiveness. When domestic inflation exceed inflation abroad the real effective exchange rate rises which decreases the country's competitiveness (Madura, 2003).

Purchasing Power Parity exists well for countries with high inflation rate. This simply means that the PPP is more closely exhibited in high inflation countries than in low-inflation countries because exchange rate is highly correlated with inflation differentials unlike in the low or medium inflation economies where exchange rate movement is dominated by the relative price effect which leads to difference from PPP.

According to the ex-ante PPP, the expected change in the exchange rate is influenced by differential of the interest rate. This is depicted in Equation 2.4.

$$\Delta S_t^e + K = i_t - i_t^* \tag{2.4}$$

The expected change in exchange rate ΔS_t^e is dependent on the relative expected price, inflation rate. This is derived using the "Fisher open relationship". The nominal interest rate is decomposed in the expected inflation and the real interest rate components. Therefore, changes in the exchange rate is shown to depend on the expected interest rate differential. However, in the short run, the actual exchange rate, *S* may diverge from the long run equilibrium because of the influence of other factors (Officer, 1976).

2.2.1.5.2 Monetary Theory of Exchange Rate

The monetary model is anchored on the fact that equilibrium exchange rate depends on the stock of equilibrium conditions in each country's money market and based on the fact that interest rates are equalized on global basis (Stockman, 1980). This implies that any change in supply of money has a proportionate effect on inflation and hence on the exchange rate.

$$s_t = m_t - m_t^* - \alpha_1 (y - y^*)_t + \alpha_2 (i - i^*)_t \tag{2.5}$$

where s represents spot exchange rate. m, y and i denote money supply, income and interest rate respectively. The variables with asterisk are their respective foreign counterparts. Therefore, any percentage increase in money supply leads to a corresponding increase in exchange rate (depreciation in currency value). The monetary model sees exchange rate as the relative prices of currencies which depend on the relative demand and supply of stock of money. In this regards, two strands are discerned: the flexible prices where PPP holds continuously (Bilson, 1981 and Frenkel, 1976) and sticky price versions in which PPP only holds in the long run (Dornbusch, 1976 and Frankel 1979).

The monetary model provides two main implications; higher relative income induces a stronger currency and a higher relative interest rate results to weaker currency. These postulations are found opposite of the Mundell-Fleming model where it is hypothesised that higher income leads to higher import and weaker currency, while in monetary model a higher income causes a higher money demand relative to supply. So also in the case of interest rate, the higher interest rate causes a capital inflow in Mundell–Fleming model while it causes low money demand in monetary model (Frankel, 1979 and Mundel, 1964).

2.2.1.5.3 Balassa-Samuelson and Productivity based Model

The basic motivation in empirical exercise dealing with exchange rate productivity nexus rely upon tradable and non-tradable difference, pinpointed by Balassa (1964) and Samuelson (1964). When non-tradable are incorporated in the model, real exchange rate is described by Equations 2.6.

$$q_t = q_t^T + \alpha \left(P_t^N - P_t^T \right) \tag{2.6}$$

where q_t represents quantity of products at time *t* and q_t^T is the tradable quantity of commodities at a given time. The symbol α denotes a coefficient of the price of non-tradable and tradable, P_t^N and P_t^T respectively. Even if all the commodities are tradable, yet they are not perfect substitutes. Thus, real exchange rate is defined as the traded goods prices (Lucas, 1982). Any increase in domestic product only reduces the relative prices slightly and the rate of exchange appreciates and vice versa. The more inelastic the demand for a home product, the higher the drop in prices (relative price effect). Assuming perfect capital mobility, free factor mobility and internal relative price of tradable and non-tradable goods, the real exchange rate will be a function of inter country relative productivity differentials. Therefore, if PPP holds for tradable goods then, the real exchange rate depend solely on the productivity differentials.

2.2.1.5.4 Portfolio Balance Model

This is another structural fundamental-based exchange rate model. The model is proposed by Hooper and Morton (1982). It is specified as a quasi-reduced model as presented in Equation 2.7 below:

$$s_t = \alpha_0 + \alpha_1(m_t - m_t^*) + \alpha_2(y_t - y_t^*) + \alpha_3(i_t^s - i_t^{s*}) + \alpha_4(\pi_t - \pi_t^*) + \alpha_5(\overline{TB} - \overline{TB}^*) \qquad (2.7)$$

where i^s and $\overline{TB}$ represent short-term interest rate and cumulative home trade balance respectively. The similar notations with asterisks represent the corresponding foreign counterpart of the series. In the portfolio balance model, it is assumed that the fundamental variables affect the exchange rate with the same magnitude irrespective of domestic and foreign variables. This is in line with Meese and Rogoff (1983) specification. They further assume that the exchange rate is influenced by the future market expectation of the fundamental variables due to the embodiment of expectation in interest and inflation rate differentials (Meese and Rogoff, 1988). The model considers the heterogeneous behaviour of domestic and foreign trade transactions between countries in exchange rate determination (Hooper & Morton, 1982).

2.2.1.5.5 Theory of Optimum Currency Areas

The Optimum Currency Areas (OCA) theory states that in a common currency phenomenon, the currency of the domestic and the foreign countries' exchange rate is at equilibrium full employment and assumes that monetary authorities exit to control inflation in the economy (Mundell, 1961). Any change in demand from one country to another leads to instability in the exchange rate equilibrium between the countries. Shift in demand from the domestic economy to the foreign economy will cause deflation/unemployment and inflationary pressure in the domestic and foreign economies respectively. If a foreign country pursues restrictive contractionary policies to curtail inflation, the domestic economy reduces the level of its real income since the country cannot lower its prices. The theory further advocates that to eliminate the unemployment panacea in the domestic country, monetary authorities raise the level of the money supply which lower interest rate.

The theory points to the tendency of fixed exchange rate due to the policies of restraining prices by the surplus countries whereas, in the world with two or more currency areas, it is defined as floating exchange rate regime in which the interaction of the market forces correct the external imbalances and deflation in the domestic country and adjusts the inflationary pressure in the foreign economy back to equilibrium. Mundell (1961) further argues that the OCA theory effectively operates and gains practical applicability in areas characterised by political instability.

It has been argued that a country's decision towards exchange rate regime depends on the country's degree of openness, size, financial shock absorption capacity as well as its trade relationship with other territories. The theory postulates that a large amount of exchange rate volatility is influenced by the different regimes of exchange rate. This is in line with the Keynesian proposal on exchange rate policy and capital mobility (Ferrari-Filho & Paulo, 2008).

The theory advocates that government should determine a regime that better its insulating effect. Impliedly, the OCA theory advocates the adoption of floating exchange rate regime by countries confronted with exchange rate uncertainties to achieve flexibility of prices in the presence of nominal rigidity. The theory sees openness, smallness and trading with pegging countries as factors that encourage fixed regime to ensure stability of exchange rate (Levy-Yeyati, 2011). However, Mundell--Fleming framework advocates the choice of floating regime in the case of real shock. According to Tornell and Velasco (2000) the flexible exchange rate is associated with more disciplined compared to the fixed regime. However, Frankel (1999) argues that there exist no single perfect or better regime that prove to be more appropriate at all times for all countries.

2.2.1.5.6 Taylor Rule Model

This is a monetary policy rule which stipulates that for each one-percent increase in inflation, the central bank should raise the nominal interest rate by more than one percentage point (Taylor, 1993). This aspect of the rule is often called the Taylor principle. According to Taylor's original version of the rule, the nominal interest rate should respond to divergence of actual inflation rates from target inflation rates and of actual Gross Domestic Product (GDP) from potential GDP (Taylor, 1993). This hypothesis is depicted in Equation 2.8 below:

$$i_t = \pi_t + r_t^* + \alpha_\pi(\pi_t - \pi_t^*) + \alpha_y(y_t - \bar{y}_t) \qquad (2.8)$$

In Equation (2.8), i_t is the target short-term nominal interest rate, π_t is the rate of inflation at time *t*, π_t^* is the desired rate of inflation, r_t^* is the assumed equilibrium real interest rate, y_t is the logarithm of real GDP, and $\bar{y}_t$ is the logarithm of potential output, as determined by a linear trend. Both α_π and α_y are hypothesised to be positive, as a rough rule of thumb, and proposed to be $\alpha_\pi = \alpha_y = 0.5$ (Taylor, 1993). This implies that in order to reduce inflationary pressure, the rule advocates a relatively high interest rate (a tight monetary policy) when inflation is above its target or when output is above its full-employment level. Similarly, the rule emphasises a relatively low interest rate in the opposite situation, to stimulate output. When monetary policy goals conflict, as in the case of stagflation, that is, when inflation is above its target while output is below full employment, Taylor rule specifies the relative weights given to reduced inflation versus increased output and ensure stability in macroeconomics variables (Clarida, Gali & Gertler, 1999).

2.2.2 Empirical Literature Review

This section discusses the empirical literature review. The section is divided into six sub-sections: Sub-section 2.2.2.1 offers empirical review on the relationship between inflation targeting and exchange rate volatility. Sub-section 2.2.2.2 presents review on central bank intervention and exchange rate volatility. The macroeconomic effect of inflation targeting is reviewed in sub-section 2.2.2.3. Sub-section 2.2.2.4 discusses review on exchange rate regime switching and exchange rate volatility. The subsequent sub-section, 2.2.2.5 deals with the review on political instability and volatility of exchange rate and review on causal relationship between the variables of monetary theory of exchange rate determination is conducted in sub-section 2.2.2.6.

2.2.2.1 Inflation Targeting and Exchange Rate Volatility

It has been widely argued that countries adopt inflation targeting primarily to react to inflation and monetary policies to ensure stability in inflation and other macroeconomic indicators. However, most previous literature consider the general concept of central bank intervention as well as the impact of inflation targeting on the reduction of inflation and other macroeconomic variables with few studies focusing on inflation targeting and volatility of exchange rate. Moreover, the few available studies are also found to be inconsistent and inconclusive. Some studies indicate strong evidence that inflation targeting reduces the menace of exchange rate volatility in the targeting countries. This is found in the studies of Allsop, Kara and Nelson (2006); Edwards (2007); Josifidis, Allegret and Pucar (2011); Khodeir (2012); Rose (2007) and Yamada (2013).

Allsop *et al.* (2006) examine the impact of inflation targeting on exchange rate volatility in the United Kingdom. The study discovers that with inflation targeting the relationship between domestic inflation and exchange rate volatility has been weak. Edwards (2007) explore the significance of inflation targeting on inflation and exchange rate variability in 7 advanced countries. The result shows that the economies that adopt inflation targeting experience a great decrease in the level of inflation and exchange rate variability. Josifidis *et al.* (2011) analyse the divergence in managing exchange rate volatility in some selected inflation targeting transition economies. The result shows that using interest rate management known as inflation targeting leads to a substantial reduction in the volatility of nominal exchange rate in the long run. Rose (2007) determines the experience of inflation targeting countries on exchange rate volatility. The result shows that countries with inflation targeting regime experience lower volatility of exchange rate compare to non-targeting countries. The result is found consistent irrespective of whether using real or nominal exchange rate. Khodeir (2012) study the applicability of inflation targeting in Egypt. The result shows that applying flexible inflation targeting will yield a strong, stable relationship between inflation and exchange rate changes in Egypt.

However, other studies highlighted insignificant relationship between inflation targeting and exchange rate volatility. The conflicting findings are reported in Petreski (2012) who finds a mixed result for the effectiveness of exchange rate management under inflation targeting. The review shows that inflation targeting does and does not impact significantly in reducing the level of exchange rate volatility. In addition to the work of Petreski, a number of scholars contrarily argued that inflation targeting has increased the volatility of exchange rate in their study areas. The contrary notion is found in the researches of Batini *et al*. (2003); Berganza and Broto (2012); Dennis (2003); Gregorio, Tokman and Valdés (2005); Kollman (2002) and Pavasuthipaisit (2010).

Berganza and Broto (2012) empirically analyse inflation targeting on exchange rate volatility. Their findings show that inflation targeting leads to higher volatility in exchange rate than the alternative regimes. However, they reveal that forex intervention practiced by some inflation targeters relatively reduces inflation and exchange rate volatility compare to non-inflation targeting economies. It is also argued that inflation targeting in 36 different countries is found to be less appropriate than inflation-forecast-based rule in lowering the average variability of inflation and exchange rate instability due to its inability to react to deviations of anticipated inflation from target (Batini *et al.*, 2003).

According to Dennis (2003) and Kollman (2002), price level targeting is more significant in the reduction of economic dynamism of exchange rate than inflation targeting in Australia, Japan, Germany, and the United Kingdom. The results further show that inflation targeting leads to more volatile interest rate. Hence, optimized policy rule leads to significant volatilities in both nominal and real exchange rates. Moreover, Gregorio *et al.* (2005) examine whether the interaction of the macroeconomic framework of inflation targeting decreases volatilities in the exchange rate. The result portrays that exchange rate volatility increases despite the inclusion of inflation targeting in the model. The volatility is more pronounced in the short run than long run condition.

Other studies associate the menace of exchange rate instability to the lack of independence in the monetary policy formulation. Such studies include Pavasuthipaisit (2010) who examines the optimality of central bank in response to movement in exchange rate under the regime of inflation targeting in the United States. The study reveals that the state of the economy is what determine exchange rate and inflation not inflation targeting. Accordingly, if the central bank can properly monitor the state of the economy, there will be no gain targeting inflation or exchange rate to ensure stability in the economic operations of the country (Pavasuthipaisit, 2010).

However, most of the previous analysis were carried out under fixed or pegged exchange rate regimes that have fewer bases for effectiveness as it cannot coexist under the principle of *trilemma*. Inflation targeting should be best examined under a floating exchange rate regime due to the principle of “impossible trinity” (Edwards, 2007; Carare & Stone, 2006 and Mishkin & Savastano, 2001). Another issue is that most of the findings were concluded based on the average reported coefficients in the case of studies conducted on a number of countries with heterogeneous characteristics. Therefore, countries having distinct characteristics such as the developing countries of the sub-Saharan African states are better studied individually especially as it relates to specific monetary policy implementation. Nevertheless, the possible alternative hypothesis emanating from the inconsistent literature review is formulated below:

H_1: Inflation targeting effectively serves as hedging strategy for exchange rate volatility in Ghana and South Africa

2.2.2.2 Central Bank Intervention and Exchange Rate Volatility

The macroeconomic impact of central bank intervention on the volatility of exchange rate and other macroeconomic variables has been an inconclusive debate. Numerous studies on the intervention of central bank on the volatility of exchange rate using different volatility measurement indicate that exchange rate volatility tend to increase as a result of central bank intervention. For example: Beine, Laurent and Lecourt (2003); Beine, Lecourt and Palm (2009); Bonser-Neal and Tanner, (1996); Das and Shimatani (2013) and Dominguez (2006) found similar result.

Bonser-Neal and Tanner, (1996) measure the impact of central bank intervention on ex-ante exchange rate volatility in Germany. The result indicates a positive relationship between central bank intervention and exchange rate variability. Meaning that the ex-ante exchange rate volatility increases as central bank intervene. Beine, Laurent *et al.* (2003) and Beine, Lecourt *et al.* (2009) investigate the impact of central bank intervention on the exchange rate uncertainty. The results show that in the short run, central bank intervention in the studied economies leads to increase in the volatility of exchange rate. The findings reveal the inability of the central banks to ensure economic stability in the U.S, Germany, and Japan. It is also found that the use of the traditional GARCH model underestimates the effect of exchange rate volatility.

However, the use of rolling regression does not indicate any effect of the intervention in the Denmark/USD market irrespective of the economic situation. Das and Shimatan (2013) and Dominguez (2006) recently examine the Bank of Japan intervention on the exchange rate volatility and return. The findings indicate that the intervention of the bank does not influence exchange rate return and perform badly in stabilizing the exchange rate which leads to increase in the exchange rate volatility. Dominguez (2006) argue that the volatility increases especially in a coordinated intervention.

Conversely, Behera, Narasimhan and Murty (2008) examine the interaction between reserve bank intervention and exchange rate volatility in India. It is discovered that exchange rate volatility is minimized in India as a result of reserve bank intervention. In other words central bank intervention leads to a reduction in the fluctuations of Indian exchange rate. Whereas using instrumental variable estimation, Galati, Melick and Micu (2005) investigate the impact of the intervention on the market expectations and volatility of exchange rate in U.S and Japan. The study accounts for the simultaneity bias in the estimation and reveals that central bank intervention had no systematic significant effect on exchange rate volatility. The result shows that the central bank intervention in the U.S and Japan leads to neither increase nor decrease in the volatility of exchange rate. This might be as a result of accounting for simultaneity bias in the estimation process.

2.2.2.3 Macroeconomic Effect of Inflation Targeting

The literature on the macroeconomic performance of inflation targeting largely focus on the developed countries (Aizenman *et al.*, 2011). The results from the advanced countries also differ in most cases and therefore, inconclusive in the literature. Some studies argue that inflation targeting improves the aggregate economic performance of the targeting countries. These studies include: Abdul Karim and Abdul Karim (2014); Aizenman and Hutchison (2011); Daboussi (2014); Goncalves and Salles (2008); Lin and Ye (2009); Lin and Ye (2012); Mendonça, Jose and Souza (2012); Mishkin (1999) and Yamada (2013).

Abdul Karim and Abdul Karim (2014) assess the monetary policy implementation during interest rate regime era. The study shows that the policy works better during interest rate era. Abdul Karim, Said, Jusoh and Thahir (2009) and Antoni (2010) also estimated the backward-looking monetary policy rule for Malaysia. The finding shows that interest rate significantly affect the output gap in the economy. Aizenman & Hutchison (2011) empirically investigate the effect of inflation targeting in 16 emerging markets using Taylor's rule regression model. They conclude that the emerging markets adopt a dual inflation targeting where the central banks set interest rate to respond to inflation and exchange rate simultaneously even though the response to exchange rate is stronger in countries that did not adopt inflation targeting. The result further shows that real exchange rate is not a robust predictor of future inflation in emerging markets. Goncalves and Salles (2008) explore the significance of inflation targeting on inflation and growth variability in 36 developing countries where the result shows that the economies that adopt inflation targeting experience a great decrease in the level of inflation and growth variability.

The methodology of propensity score matching in over 50 developing economies reveal strong evidence that inflation targeting reduces the rate of inflation than in the regime of exchange rate targeting. The result claims to be independent of stagnation or lower economic growth (Lin & Ye, 2009; 2012 and Mendonca *et al.*, 2012). However, the level of the inflation targeting performance depends significantly on the operational structure of the countries (Lin & Ye, 2009). Yamada (2013) extended the study of the effect of inflation targeting on macroeconomic stability to over 120 countries using same propensity score matching estimator. The findings conclude that inflation targeting regime leads to decrease in the rate of inflation. It further shows that inflation targeting ensures a decrease in the level of macroeconomic instability in the studied economies.

In a review of global experience by Mishkin (1999) on four kinds of monetary policy regimes, the paper reveals that inflation targeting economies perform wonderfully in reducing its rate of inflation, and inflation expectations compare to the non-targeting countries. In an investigation of the impact of inflation targeting on interest rate, growth and inflation by Daboussi (2014) the finding shows that adoption of inflation targeting reduces the volatility of inflation and improves economic performance, even though the adoption of the policy leads to economic growth vulnerability.

In South Africa for instance, similar findings are reported by Aron and Muellbauer (2007); Gupta, Kabundi and Modise (2010); Kabundi and Ngwenya (2011) and Kabundi, Shaling and Some (2015). According to a review conducted by Aron and Muellbauer (2007) the South African monetary policy became more efficient after the adoption of IT framework. Although the manifestation of low inflation rate has been highlighted even prior to the adoption of the IT framework (Aron and Elbadawi, 1999). Furthermore, Gupta *et al.* (2010) and Kabundi and Ngwenya (2011) assess whether South African Reserve Bank (SARB) has become more effective with IT framework. The study uses Factor-Augmented VAR (FAVAR) model and the result shows that the SARB became more effective after the adoption of the policy.

However, most of the effects were insignificant. This might be attributed to shorter samples used in the analysis. Kabundi *et al.* (2015) study the relationship between inflation and inflation expectations of various analysts in South Africa during the era of IT framework. The result shows various expectations of the agents in the economy. Overall, the SARB has anchored the analysts' expectation even though the implicit focal point of IT has not been judiciously employed by the price setters.

Nonetheless, some findings show that there is no economic and policy difference between inflation targeting and non-targeting countries. Furthermore, some other studies discover the irrelevance of inflation targeting on the performance of macroeconomic aggregates. This is found in the studies of Ball and Sheridan (2004);

Brito and Bystedt (2010); Corbo, Landerretche and Schmidt-Hebbel (2002); Mishkin (2007); Røisland and Torvik (2004); Saborowski, (2010) among others.

According to Saborowski, (2010) inflation targeting leads to disinflation which maintains high distortions in the inflationary level thereby severe economic volatility in the United States. It is also stated that the influence of inflation targeting on output stability is relatively less significant in small open economies due to its response to interest rate that destabilize the traded sector in the presence of real shock compare to exchange rate targeting (Røisland & Torvik, 2004; Daboussi, 2014). Corbo *et al.*, (2002) assess the consequence and rationale for adopting inflation targeting. The findings show that inflation targeting countries do not exhibit a unique approach towards inflation aversion. Although the effect tend to differ when the inflation targeting is regressed on output growth, the result does not vary with that of non-targeting economies.

Ball and Sheridan (2004) examine whether inflation targeting improves economic performance in twenty targeting countries. The result indicates that there is no evidence of improvement in the economic performance as a result of inflation targeting in the economy. The result reveals that the interest rate policy pursued in the targeting countries does not differ from that of the non-targeting countries. However, the finding predicts that inflation targeting might lead to improvement in the economic performance in the future. Mishkin (2007) and Brito and Bystedt (2010) also show that there is no clear difference between the inflation targeters and non- inflation targeters. The results further indicates that the level of output volatility reduces concurrently in both targeting and non-targeting countries. The result also holds when the study controlled for fixed effect in the estimation process (Brito & Bystedt, 2010). Despite the unresolved inconsistencies in the literature, the study hypothesised the following alternative hypothesis.

H_2: Monetary framework of inflation targeting performs the role of the nominal anchor in Ghana and South Africa.

2.2.2.4 Exchange Rate Regime Switching and Exchange Rate Volatility

The failure of the major fundamental variables derived in the traditional theories of exchange rate determination to explain the disequilibrium nature of exchange rate especially after the Bretton Wood agreement of fixed exchange rate leads to the urge to study the influence of other factors such as regime changes, structural breaks, and political instability among others (Boutchkova *et al*., 2012; Chau *et al*., 2014; Freeman *et al*., 2000 and Flood & Rose, 1999). According to Syllignakis & Kouretas (2011) right from the pivotal work of Messe and Rogoff (1983) on the empirical exchange rate model of the seventies, many scholars attempt to suggest alternative specification that can better explain the equilibrium level of exchange rate. These include the influence of changes in the exchange rate management, country risk perceptions, and structural breaks among others (Boutchkova *et al.*, 2012; Chau *et al.*, 2014; Freeman *et al.*, 2000 and Flood & Rose, 1999). However, several studies have been conducted on regime changes in the advanced and emerging markets with inconsistent findings with only few studies in developing economies.

The study of Bodart and Reding (1999) assess how the volatility of exchange rate and market return are affected by regime changes. The result shows that the change in exchange rate regime leads to a wider variability. This occurs when flexible exchange rate was adopted in Belgium and France whereas, the regime change in Germany leads to a decrease in the volatility of exchange rate. Recently, Mensi *et al.* (2014) investigate the influence of structured and unstructured announcement of regime change on the exchange rate stability in Saudi Arabia. The finding shows that unstructured sudden change in the exchange rate impact positively on the volatility of exchange rate whereas, the structured changes do not influence volatility in exchange rate. The former aspect of the argument is supported by other scholars who found a positive link between exchange rate regime changes and volatility of exchange rate. This is found in the studies of Fiess and Shankar (2009); Ichiue and Koyama (2011); Kočenda (2005); Kočenda and Valachy (2006); Lee and Chen (2006); Moore and Wang (2007); Rapach and Strauss (2008); Walid, Chaker, Masood and Fry (2011) and Wang and Moore (2009).

According to Fiess and Shankar (2009) change in the floating exchange rate regime correlates with high macroeconomic volatility which facilitates central bank intervention to stabilize exchange rate and stock market volatility. Ichiue and Koyama (2011) examine how the volatility of exchange rate relates to the shortcomings of the uncovered interest rate parity. The finding shows that the return in Japanese exchange rate is highly influenced by changes in exchange rate regimes. Kočenda (2005) and Kočenda and Valachy (2006) reveal that change from fixed to flexible exchange rate regime leads to a surprising increase in the volatility of exchange rate in the four visegrad countries except for Slovakia. The study uncovers that the fixed regime tend to have lower volatility than the floating regime. The study discovers that the magnitude of the volatility depends on the regime adopted and the country in question.

Lee and Chen (2006) examine the superiority of Markov-Switching model in exchange rate. The result indicates that the implied exchange rate equilibrium is regime dependent in Taiwan. The finding shows that the process of the exchange rate changes is implied by the prominent flexible exchange rate regime.

In examining the influence of exchange rate regime changes on the volatility of the stock return, Moore and Wang (2007) and Wang and Moore (2009) indicate that change in exchange rate policies constitutes part of factors that influence stock return and exchange rate volatility. The results further show that accounting for regime changes will reduce the overestimated volatility persistence. Furthermore, Walid *et al.* (2011) investigate the dynamic linkage between stock price volatility and exchange rate changes for four emerging countries. The result points out that volatility of stock prices is highly influenced by changes in the exchange rate regime from calm to turbulent and vice versa. The result further shows that, except for Singapore, the turbulent regime is obtained to be more influential in ensuring volatility compare to the calm regime. Moreover, Sufian and Habibullah (2012) find that exchange rate regime switching exerts a negative effect on the technical efficiency of the Malaysian banking sector even though the coefficient is not statistically significant.

On the contrary, even though regime changes are usually considered as bad news in most exchange rate models, nevertheless, Beine and Laurent (2001); Engel (1994) and Syllignakis and Kouretas (2011) discover that exchange rate regime changes do not influence the volatility of exchange rate. According to Engel (1994), the volatility of exchange rate is independent of exchange rate regime switching in 18 developed countries. This might be affected by the short exchange rate swings since volatility can be better forecasted when a long period is utilized in the predictions. In another vein, Beine and Laurent (2001) examine the interaction between the exchange rate volatility and structural regime switching. The finding indicates that structural change in exchange rate regime reduces the level of volatility, in the long run. Furthermore, Syllignakis and Kouretas (2011) reveal that switching from flexible to fixed exchange rate leads to adjustment to equilibrium through the monetary fundamentals, whereas, shift from fixed to floating regime influence deviation to revert back to equilibrium in the exchange rate itself.

However, these studies are carried out in advanced countries using the traditional Markov-Switching models without taking into consideration the time-varying transitions element of the exchange rate movement. Furthermore, the impact of regime changes on exchange rate has widely been studied but the use of time-varying transition probabilities Markov-Switching GARCH model has not been widely employed especially in the developing countries of sub-Saharan Africa.

2.2.2.5 Political Instability and Exchange Rate Volatility

According to Levy-Yeyati *et al.* (2010) political instability is another factor that influence exchange rate disequilibrium. Weak and inconsistent government confronted with internal conflict usually adopt peg exchange rate to ensure stability. It has also been argued that weak government policies and political uncertainty may lead to exchange rate instability due to the inability of the investors and policymakers to predict what will occur in the market (Petterson, 2000: 740). The uncertainty makes it cumbersome to fix the exact exchange rate/asset price which alter the exchange rate due to sudden intervention by the monetary authorities. This weakens the currency value and make it more volatile (Bussière & Mulder, 1999). It has also been hypothesized that multinational cooperation and foreign investors usually withdraw their investments from politically unstable nations to strong, stable economies. Political uncertainty leads to capital flight as a result of loss of confidence by the foreign investors (Bussière & Mulder, 1999).

According to Edwards (1996); Eichengreen, Rose and Wyplosz (1995) and Klein and Marion (1997) political instability influence exchange rate regime switching in politically unstable economy thereby more volatility in the exchange rate. However, the influence of political instability is more emphasised in countries with weak fundamentals, and low level of reserves compared to nations with strong economic characteristics (Bussière & Mulder, 1999). Similarly, other scholars also support the argument that political instability is positively linked with the volatility of exchange rate. These include the findings of Bachman (1992); Bernhard and Leblang (1998; 2002); Blomberg and Hess (1997); Chau *et al.* (2014); Cosset and Rianderie (1985); Frieden, Ghezzi and Stein (2000); Hays, Freeman and Nesseth (2003) and Leblang and Bernhard (2006).

From the early work of Cosset and Rianderie (1985) who examine the influence of the business environment on the foreign exchange. The result reveals that political risk factor causes variations in the equilibrium exchange rate due to distortion in the investment climates of the country. The reaction is found more vulnerable to bad political news compared to the good one. Frieden *et al.* (2000) explore the effect of politics on exchange rate in the Latin America. The result shows that both nominal and real exchange rate volatility are influenced by the unstable political events in the Latin

America. Hays *et al.* (2003) examine the consequence of democratization in four Asian countries. The finding indicates that countries with weak institutional framework are vulnerable to the degree of political uncertainty especially in their financial market. The result further shows that the menace is more pronounced in Indonesia compared to other countries in the sample. Furthermore, the presidential election in Philippines leads to more volatility in exchange rate than prior to the election.

Moreover, Blomberg and Hess (1997) examine how political variable can predict exchange rate movement. They conclude that the exchange rate movement in the U.S, U.K and Germany are influenced by political risk and that inclusion of the political variable improves the in-and-out-of-sample forecasting ability compared to random walk model. Bachman (1992) indicates that political news affect the risk premium forward exchange rate. He predicts that forward bias changes likely happens under large exchange rate fluctuations due to the election event. Bernhard and Leblang (2002) and Leblang and Berhard (2006) investigate the effect of parliamentary politics on the volatility of exchange rate. The results show that even though the mean average of the exchange rate is not affected by the political instability, the volatility of exchange rate is influenced by political events. However, the volatility reduces when country participates in European Monetary System. Chau *et al.*, (2014) study the effect of political instability in the stock market volatility. The finding indicates that financial volatility increases with political uncertainty.

Despite the existence of several studies on the effect of political instability on stock return and asset prices, yet only few studies focused on the effect of political instability on exchange rate volatility especially in the developing countries which are highly characterised by political risk and high level of uncertainty.

Arising from the previous sub-section where exchange rate regime switching and exchange rate volatility is discussed as well as the empirical review on the effect of political instability on exchange rate, the third alternative hypothesis of the study is formulated underneath.

H_3: Exchange rate regime switching and political instability influence exchange rate volatility in Gambia, Ghana, Nigeria and South Africa.

2.2.2.6 Causality among Exchange Rate Fundamentals

The rarely significant relationship reported by early studies indicate weak relationship between exchange rate and most fundamentals such as inflation rate, money supply, interest rate, and real income, a situation termed as exchange rate disconnect puzzle (Obstfeld & Rogoff, 2001). Furthermore, the unpredictability of exchange rate has been an issue of concern since the seminal work of Meese and Rogoff (1983). Several studies investigate the relationship between exchange rate and some fundamentals especially, after the decline of the Bretton Wood agreement coupled with increased volatility over the years. However, policymakers and researchers are still concerned about more robust findings on the direction of relationship between the variable of exchange rate models (Danjuma, Shuaibu & Said, 2013; Ezirim, Amuzie and Amenyonu, 2012). The following subsections present the inconsistent causal relationships that exist among the variables of the monetary theory of exchange rate determination:

2.2.2.6.1 Money Supply and Exchange Rate

The nature of the causality between money supply and exchange rate is required in the manipulation of monetary policies and liquidity preference. In an open economy, the nature of the causality between money supply and exchange rate is hypothesised by Mundell-Fleming model to depend on the exchange rate regime (Zamanian, Pahlavani & Ranjbarnouri, 2013). The causality between money supply and exchange rate remains unpredictable in the literature. Numerous scholars like Akinbobola, 2012; Maitra and Mukhopadhyay, 2011; Olatunji, Sunday and Omolara, 2012; Srinivasan, Kalaivani and Devakumar (2014) and Zamanian, *et al* (2013) found a bi-directional causal relationship among money supply and exchange rate.

Akinbobola (2012) analyses money supply, inflation and exchange rate dynamism in Nigeria. The study reveals two ways causation among money supply and exchange rate. In a study of Mundell-Fleming model by Maitra and Mukhopadhyay (2011) and Zamanian *et al.* (2013), the findings indicate that under fixed exchange rate regime, a feedback causation exist among money supply and exchange rate whereas, under the floating exchange rate regime only unidirectional causality is obtained from money supply to exchange rate which conform with the Mundell-Fleming model hypothesis.

Furthermore, Olatunji *et al.* (2012) examine dynamism in the causality among money and other variables. The study shows that any shock in the broad and narrow money causes the exchange rate to rise upward in the first two years before it is restored to equilibrium. The result also finds that exchange rate causes money growth in the narrow money. Srinivasan *et al.* (2014) recently explore the causality of the macroeconomic variables. The result states that in the short run situation there prevails a bi-directional causality when the financial crisis was accounted for in India.

Other studies contrarily argue that the nature of the causality is only running from the money supply to exchange rate without any feedback response from the exchange rate direction. This is supported by the findings of Alvarez, Atkeson and Kehoe (2002) and Ko (2010). Alvarez *et al.* (2002) analyse the impact of the money supply on exchange rate and interest rate. The result finds that money supply highly caused and influenced the level of exchange rate in the studied areas. Similar finding is reported by Ko (2010) when re-evaluation of causality in the exchange rate fundamentals was carried out using a bootstrap Granger causality in six advanced countries. The result shows that, in a full sample bivariate model, money supply does not cause exchange rate except in the case of Japan. While causality from the money supply to exchange rate exist only in the case of France whereas, in the last part of the sample it only holds in Canada. On the contrary, Engel and West (2005) discover that money supply is Granger caused by exchange rate, but money supply does not cause exchange rate in the G6 countries, Canada, France, Germany, Italy, Japan, and the United Kingdom.

However, neither causality is also reported in some studies that focuses on the money supply and exchange rate relationship. The studies of Deme and Fayissa (1995); Hasan and Javed (2009); Worswick (1981) expose such argument in the literature. Deme and Fayissa (1995) investigate inflationary effect of growth rate of GDP, money supply, exchange rate and imported prices. The result does not show any relationship between the money supply and exchange rate in the three selected North African countries of Egypt, Morocco, and Tunisia. Hasan and Javed (2009) study the dynamic causality between equity prices and monetary variables in Pakistan. The result finds neither causation between money supply and exchange rate. Therefore, the variables are found independent of one another in Pakistan. In the early work of Worswick (1981), the study reveals the absence of causality between money supply and exchange rate in Switzerland.

2.2.2.6.2 Inflation and Exchange Rate

In the literature, empirical findings on the causal relationship between exchange rate and inflation have been inconsistent using a similar methodology (Granger causality), similar data generating process as well as the similar and different sample sizes. Some studies found bi-directional causality between inflation and exchange rate. These include the studies of Arabi (2012); Arize and Malindretos (1997) and Madesha, Chidoko and Zivanomoyo (2013).

Arabi (2012) and Madesha *et al.* (2013) estimate exchange rate volatility in the presence of ARCH effect. The results reveal a simultaneous long run feedback possibility between exchange rate fluctuations and its determinants such as inflation. In other words, inflation and exchange rate volatility Granger cause each other. However, the presence of ARCH effect makes Granger test inefficient (Hacker & Hatemi-J, 2006). Arize and Malindretes (1997) study exchange rate volatility as a factor that causes variability in inflation in 41 countries. The result confirms the existence of bidirectional or simultaneity between exchange rate variability and inflation under the flexible exchange rate era.

On the contrary, Achsani, Jayanthy, Fauzi and Abdullah (2010); Imimola and Enoma (2011) and Omotor (2008), establish a unidirectional relationship from exchange rate to inflation. Achsani *et al.* (2010) examine the effect of inflation on exchange rates in Asean+3, the E.U, and the North America. They discover one-way causality in Asia with a strong correlation between inflation and exchange rate in most of the Asian countries except Malaysia. They further find that the sensitivity of inflation to fluctuations in the exchange rate is higher in Asia than E.U and North America. Likewise, Imimola and Enoma (2011) and Omotor (2008) explore the effect of exchange rate depreciation on inflation in Nigeria. They find inflation to be largely determined by exchange rate depreciation, money supply, and output.

However, some studies indicate that there exist no causality between inflation and exchange rate (Cairns, Ho & McCaulay, 2007; Chen & Wu 1997; Emmanuel, 2013; Jahan-Parvar & Mohammadi, 2011; Kamas, 1995; Nnamdi & Ifionu, 2013 and Shaari, Hussain & Abdullah, 2012). Emmanuel (2013) examines the effect of foreign exchange reserve on exchange rate and inflation in Nigeria. The study reveals a significant causal relationship between foreign exchange reserves and exchange rate without any causation running from neither inflation nor exchange rate. Nnamdi and Ifionu (2013) examine volatility in the exchange rate. The findings of their study indicate that exchange rate volatility is significantly influenced by the uncertainty in the lagged exchange rate, independent of inflation and other variables. Chen and Wu (1997) analyse the sources of real exchange rate fluctuations in four Pacific basin countries. Their study shows that a real shock (technology, resource endowment, preferences) impact positively on real exchange rate fluctuations, unlike other studies where it is assumed to be caused and influenced by inflation. Shaari *et al*. (2012) use

Malaysian data to examine the impact of exchange rate volatility and oil prices on inflation. The result reveals that there exist no causal relation between consumer price index and exchange rate volatility and vice versa.

2.2.2.6.3 Interest Rate and Exchange Rate

Despite the presence of literature on the causality between interest and exchange rates, yet the findings are inconclusive (Ko, 2010). It has also been argued that the relationship between interest and exchange rates has not been clear for the past thirty years (Hnatkovska, Lahir & Vegh, 2013). The nature of this relationship is cherished especially in the measurement of nation's capital mobility. Some studies report bidirectional causality between interest and exchange rates. Such studies include Awe (2012); Dash (2004); Hacker, Karlsson and Mausson (2014); Kayhan, Bayat and Ugur (2013); Paramatic and Gupta (2013) and Srinivasan *et al.* (2014).

Awe (2012) conducts a pairwise causality test on seven macroeconomic variables. The result confirms the existence of two ways causation between interest rate and exchange rate in Nigeria. Dash (2004) and Paramati and Gupta (2013) explore the causality between interest and exchange rates relationships. The findings show the existence of feedback causality among interest rate and exchange rate in the two sample period. Hacker *et al.* (2014) reveal a feedback causation between interest rate differentials and exchange rate in the long run without any causality in the short run. Kayhan *et al.* (2013) examine the dynamics in the real exchange and interest rates. The test shows a two-way causation between interest rate and exchange rate in Turkey using non-linear Granger causality approach whereas, using frequency domain methodology the relationship tend to disappear. Furthermore, unidirectional causation exists in China under both the techniques while, the relationship exist only in the non-linear approach in India. Moreover, a bidirectional relation is found in Brazil and India under the frequency domain approach.

Another strand of the debate in the literature is the argument on the unidirectional causality among interest and exchange rates. The vast majority of the literature report a causal relationship running from interest rate to exchange rate. This is evident in the studies of Adrangi and Allender (1995); Choi and Park (2008); Hatemi-J and Irandoust (2000); Kisaka, Kithitu and Kamuti (2014); Ko (2010); Olatunji, *et al.* (2012) and Pi-anguita (1998).

Adrangi and Allender (1995) examine causality in the United States' interest rate and exchange rate. The result shows a unidirectional causality running from interest rate differential to exchange rate without any feedback. A similar finding is obtained by Kisaka *et al.* (2014) and Pi-Anguita (2014) in Kenya and France respectively. The direction of the causality changes in France immediately after capital control lifting. Choi and Park (2008) investigate exchange rate stability and monetary policy appropriateness in four Asian countries. The result shows that except for Malaysia there exist no causal relationship in the other countries. However, using full sample data, the result shows unidirectional causality in all the countries except for Malaysia. Hatemi-J and Irandoust (2000) re-examine the hypothesis of international capital mobility in Sweden. The finding reveals a unidirectional causation running from interest rate to exchange rate without reverse effect on the interest rate. Ko (2010) finds unidirectional causation under full sample period running from the interest rate to exchange rate in France and Japan. Similar result prevails in the United Kingdom, France, and Japan in the early sample period.

Interest rate like other macroeconomic fundamentals also shows absence of causation from any direction with exchange rate in some studies. This is reported in Alimi and Ofenyelu (2013); Ashfan and Batul (2014); Gupta, Chevalier and Sayekt (2000); Hamrita and Trifi (2011) and Mok (1993). According to Ashfan and Batul (2014) the test for Granger causality between interest rate and exchange rate using autoregressive distributed lags model yield no causal relationship from any of the variables. Alimi and Ofenyelu (2013) revisited the Fisher hypothesis using Toda-Yamamoto methodology. The result could not reject the null that there exist no causality among interest rate and exchange rate and vice versa. Gupta *et al.* (2000) and Mok (1993) explore the nature of causality among interest rate, exchange rate, and stock prices. The findings unanimously indicate that interest rate does not cause exchange rate and the other way round. In a panel of twelve countries, Hamrita and Trifi (2011) also discover the absence of causality between the interest rate and exchange rate.

2.2.2.6.4 Income and Exchange Rate

In the small open developing economies of sub-Saharan Africa where there exist an exchange of importation of manufactured and capital goods as well as exportation of raw materials and consumer commodities, the causal linkage of the region's real income and exchange rate has been the order of interest for a long period. However, the direction of the causality is yet to be established in the literature. Nevertheless, a number of studies find a bidirectional causality among the variables. This is contained in the studies of Awe (2012); Kamal Uddin, Rahman and Quaosar (2014); Nawaz (2012); Srinivasan and Kalaivani (2013) among others.

Awe (2012) and Kamal Uddin *et al.* (2014) study economic growth and exchange rate relationship in Nigeria and Bangladesh respectively. The results indicate that real income and exchange rate influence each other in Nigeria and Bangladesh, meaning that there is bidirectional causation between income and exchange rate. Nawaz (2012) examines the causal relationship between output and exchange rate in Pakistan. The result also shows that the movement in exchange rate causes movement in the real gross domestic product in the country. Furthermore, Srinivasan and Kalaivani (2013) discover a bidirectional relationship between output and exchange rate in the long run during the Indian economic turmoil. However, the study finds a unidirectional causality from output to exchange rate.

On the contrary, some other studies argue the existence of causation among the variables to be unidirectional running from exchange rate to income without any feedback from the income direction. The example of such studies include Berument and Pasaogullari (2003); Mahmoudinia, Soderjani and Pourshahabi (2011); Moya and Watundu (2009); Ngerebo-a and Ibe (2014); Saad (2012) and Tang (2013).

Berument and Pasaogullari (2003) investigate the causal relationship between output and exchange rate. The result shows that the movement in the exchange rate causes movement in output, but there is no evidence that output also causes exchange rate in Turkey. Mahmoudinia *et al.* (2011) investigate the long-run causality among economic growth and tourism receipt. The result indicates that there exist unidirectional causality from exchange rate to economic growth without causation from the economic growth to exchange rate. In similar studies, Ngerebo-a and Ibe (2013) and Saad (2012) indicate a one way causation from exchange rate to real income without any feedback from the real income to exchange rate in Nigeria and Lebanon respectively. Tang (2013) examines temporal causality among tourism, real income and real exchange rate in Malaysia. The result reveals that exchange rate causes real income, but real income does not cause exchange rate in Malaysia. Similar result is found in Moya and Watundu (2009) in Uganda.

Nonetheless, Ko (2010); Olatunji *et al.* (2012); Srinivasan and Kalaivani (2013) report another version of the unidirectional causality running from income to exchange rate. Ko (2010) re-evaluates the causality of exchange rate and macroeconomic fundamentals. The result depicts only a one-way causal linkage running from income to exchange rate in the later part of the sample without causality in the full sample and early sample period. Srinivasan and Kalaivani (2013) examines the dynamics of macroeconomic fundamentals in India. The short run analysis reveals only unidirectional causality from real income to exchange rate.

Despite the conflicting nature of the causal relationship among income and exchange rate in the literature, few other studies find no causality among the variables. These include Erjavec and Cota (2003) and Khan, Satter and Rehman (2013). They examine the causal linkage between macroeconomic factors in Croatia and Pakistan respectively. The result indicates that irrespective of the time horizon and despite the existence of long-run relationship among the variables, the causal nature of income-exchange rate is neutral and or independent of one another at least in their study areas.

However, Ko (2010) reexamines the test of Granger causality on the exchange rate fundamentals and discover that the test spuriously reject the null hypothesis that establish a weak relationship. Thus, the previous studies suffer from invalid inferences as a result of testing Granger causality based on asymptotic distribution theory. This leads to non-standard asymptotic distribution, nuisance parameter estimates and rank deficiency which leads to size distortion under null hypothesis (Guru Gharana, 2012; Toda & Philips, 1993). In another development, Sims, Stock, and Watson, (1990) argue against the application of asymptotic distribution theory on a VAR model to test for causality among level and integrated variables even if the variables are cointegrated.

Although it will be difficult to have a single hypothesis for the entire exchange rate fundamental variables, however a more general hypothesis is formulated below to guide the research.

H_4: There exist asymmetric causal relationship between the variables of the monetary theory of exchange rate determination in Gambia, Ghana, Nigeria and South Africa.

2.3 Gaps in the Literature

Based on the review of literature discussed in the previous sections, the following gaps are found in the literature. These include; first, most of the findings on the effect of inflation targeting on exchange rate volatility were based on unconditional comparisons of indices across economies. Furthermore, the effect of inflation targeting on the volatility of exchange rate is a significant policy concern which has not been appropriately addressed by the previous debate in the literature (Edward, 2007; Grossman *et al*., 2014 and Tolulope & Ajilore, 2013). The findings on the effectiveness of inflation targeting in maintaining stability of macroeconomic variables are inconclusive. For example, some studies find significant impacts while some argued contrarily. Example of such studies that find a significant relationship include: Aizenman and Hutchison (2010); Carare and Stone (2006); Edwards (2007); Goncalves and Salles (2008); Josifidis *et al*. (2011); Lin and Ye (2009; 2012); Mendonca *et al*. (2012); Yamada (2013). Whereas, similar cross-country studies yielded contrary findings such as the studies of Batini *et al*. (2003); Berganza & Broto, (2012) and Kollman, (2002).

Second, the literature on the macroeconomic performance of inflation targeting greatly concentrate in the developed countries (Aizenman & Hutchison, 2011). The findings from the developed countries also differ in most cases, which leads to, inconsistency in the literature. Aizenman and Hutchison (2011); Lin and Ye (2012); Mendonca *et al*. (2012) and Yamade (2013) discover that the policy reduces the level of macroeconomic instability. While some other studies argue that the policy does not help in stabilizing the economic activities in their study area. These include Ball and Sheridan (2004); Brito and Bystedt (2010); Corbo *et al*. (2002); Mishkin (2007); Roisland and Torvik (2004); Saborowski, (2010) among others.

However, the continuous volatility in exchange rate and other macroeconomic fundamentals after the introduction of inflation targeting in some of the targeting economies caused doubt on the effectiveness of such a policy in achieving the desired macroeconomic objective (Batini *et al*., 2003; Markiewicz, 2012; Tolulope & Ajilore, 2013). Moreover, Grossman *et al*. (2014) and Markiewicz, (2012) suggest adding a direct policy variable to examine the influence of such a variable on the volatility of exchange rate.

Another issue is that most of the findings were concluded based on the average reported coefficients in the case of studies conducted on a number of countries with heterogeneous characteristics. Therefore, countries having distinct characteristics such as the developing countries of the sub-Saharan African states are better studied individually especially as it relates to specific monetary policy implementation.

Third, the uncertainty and high level of inconsistency from the findings on the fundamental variables derived based on the basic theories of exchange rate to explain the equilibrium nature of exchange rate especially after the beginning of the flexible exchange rate leads to the need for more regorous studies to determine the influence of other factors that affect the stability of exchange rate. This include variables such as regime switching, political instability and structural breaks among others (Boutchkova et al., 2012 and Chau *et al*., 2014). Although the impact of regime changes on exchange rate has rarely been studied, the results provide mix conclusions (Mensi *et al*., 2014 and Syllignakis and Kouretas, 2011) especially for the developing countries like sub-Saharan African economies where such kind of studies are scantly despite the high prevelence of structural changes and government instabilities.

Nevertheless, the previous studies basically use static modelling without accounting for large shocks absorption and time-varying transition probabilities modelling. The later has not been widely employed especially in the developing countries like sub-

Saharan Africa (Yuan, 2011). More so, previous literature primarily concentrate on the effect of political instability on stock return and asset price volatility with inconclusive findings (Beaulieu *et al*., 2006; Boutchkova *et al*., 2012; and Chau *et al*., 2014). However, only few studies focus on political risk and exchange rate vulnerability. Glynn, Perera and Verma (2007) also argue that it is important to know if exchange rate volatility is associated with the regime shift, political instability, civil war and/or economic crisis rather than other macroeconomic factors.

Last, the phenomenon of exchange rate disconnect puzzle (Obstfeld & Rogoff, 2000) coupled with the rarely significant relationship reported by early studies points to the weak relationship between exchange rate and most fundamentals such as money supply, inflation, real income and interest rate. Furthermore, the unpredictability of exchange rate has been an issue of concern since the seminal work of Meese and Rogoff (1983). Several studies investigate the relationship between exchange rate and some fundamentals especially, after the beginning of the floating exchange rate regime coupled with increased volatility over the years.

Moreover, Danjuma *et al*. (2013) and Ezirim *et al*. (2012) noted the insufficiency of comprehensive studies on exchange rate volatility and macroeconomic fundamentals in developing countries like sub-Saharan African countries. Furthermore, the reasons for the inconclusive findings of the previous studies are yet to be established. Besides, the existing literature in developing countries concentrates on the general concept of exchange rate determination (Cookey, 1997 and Ezirim *et al*., 2012)

Previous studies determine causality based on the asymptotic Granger causality which has been criticised for size distortion and nuisance parameter estimates especially in the presence of small sample size, non-normality of residuals and Autoregressive Conditional Heteroscedasticity (ARCH) effect (Hacker & Hatemi-J, 2006). Furthermore, Sims *et al*. (1990) argue against the application of asymptotic distribution theory on Vector Autoregressive (VAR) model. It also brings about the problem of size distortion especially under small sample size.

In summary, the identified gaps in the literature include investigating the effectiveness of inflation targeting as a hedging strategy for exchange rate volatility in inflation targeting sub-Saharan African economies, the success of monetary policy rule of inflation targeting as a nominal anchor in the targeting economies, the influence of exchange rate regime switching and political instability on exchange rate volatility in sub-Saharan Africa due to the prevailing structural changes in the region and lastly, examining causality among the variables of monetary theory of exchange rate determination in Sub-Saharan African countries using alternative methodologies.

2.4 Chapter Summary

The chapter reviews studies on both theoretical and empirical related literature as well as causality among the exchange rate fundamentals. The review reveals mixed results on the relationship among the variables. Furthermore, the reasons for inconsistencies in the literature are not yet established. The chapter ends with summarising the gaps in the literature

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter focuses on the theoretical framework and methodology employed to answer the objectives of the study. The second section presents the theoretical framework. The chapter discusses the measurement of exchange rate volatility in section 3.3. Stationarity analysis is presented in section 3.4. Section 3.5 comprises model specification and estimation procedure discussed under five sub-headings: threshold generalized autoregressive conditional heteroscedasticity model, generalised method of moments estimators, time-varying Markov switching ARCH model, Toda-Yamamoto causality model and Hacker-Hatemi-J leverage bootstrapping approach. Section 3.6 contains the sources of data used in the study, while section 3.7 deals with operational justification of variables. The chapter summary is offered in section 3.8.

3.2 Theoretical Framework

This section established the basic connection between dependent and the independent variables in order to develop and justify testable hypotheses without regards to empirical evidence or illustrations. It also identifies and conceptualized variables relevant to the analysis. The theoretical frameworks are presented in the following sub-sections.

3.2.1 Monetary Theory of Exchange Rate Determination

This section presents the underpinning theory employed in the study. It has been explained and argued that right from the early work of Cassel on purchasing power parity in 1916, the absolute purchasing power parity and the law of one price are considered as extreme cases that hardly exist in real world situation. The relative version of PPP takes heterogeneity of commodities into account and considers exchange rate as net domestic inflation or what is known as inflation differentials. The PPP model is best given in Equation (3.1).

$$\ell n s_t = \ell n p_t - \ell n p_t^* \tag{3.1}$$

where $\ell n s_t$ is the natural logarithm of domestic exchange rate in nominal term, $\ell n p_t^*$ is the natural logarithm of foreign prices and $\ell n p_t$ is the natural logarithm of domestic price level. Imposing PPP on the money demand function and money supply will yield model 3.2 below:

$$s_t = (m_t - m_t^*) - \beta(y_t - y_t^*) + \varphi(i_t - i_t^*) \tag{3.2}$$

here m_t, y_t and i_t represent domestic money supply, income and interest rate respectively whereas, m_t^* y_t^* and i_t^* denote foreign money supply, income and interest rate respectively. The model in its simplest form assumes that the value of the currency becomes stronger with high relative income whereas, currency became weaker with the relative high-interest rate. This opposes the Mundell-Flaming model where higher income leads to weaker domestic currency due to massive importation and increase interest rate attract capital inflow into the economy.

The underpinning economic theory, in this study, is the monetary theory/model of exchange rate determination. The theory sees exchange rate as a relative prices of currencies which depends on the relative demand and supply of the money stock. The theory analysed how exchange rate stability is affected due to changes in domestic and foreign demand for and supply of money based on the assumptions that, high capital mobility exist, there is a perfect substitution of foreign and domestic commodities and PPP as well as interest rate parity continuously hold over time (CBN, 2010). The theory is categorised into two strands; the flexible price where PPP holds continuously (Bilson, 1981 and Frenkel, 1976) and sticky price version in which PPP holds only, in the long run (Dornbusch, 1976 and Frankel, 1979).

Theoretically, the model implies that any change in the money supply has a proportionate effect on exchange rate stability. It is assumed that any increase in domestic money supply leads to a corresponding increase in exchange rate and inflation which increases exchange rate instability in the domestic economy. The flexible version of the monetary theory of exchange rate determination is presented in Equation 3.3 below:

$$s_t = +\varpi_0 + \varphi_1(m_t - m_t^*) - \varphi_2(y_t - y_t^*) + \varphi_3(i_t - i_t^*) + \varphi_4(\pi_t - \pi_t^*) \qquad (3.3)$$

The additional parameters include ϖ that represents a constant long-run exchange rate value, π and π^* which denote domestic and foreign inflation rates respectively. The monetary model provides that a higher relative income induces a stronger currency and causes higher money demand relative to supply. For this reason, it is hypothesised that higher income tend to reduce volatility of domestic exchange rate. This is in line with Balassa and Samuelson productivity-based model where they postulate that real exchange rate is a function of inter-country relative productivity differentials. It is measured by the country's gross domestic product which indicates that any increase in income reduces the relative prices slightly and the rate of exchange appreciates which reduces exchange rate disequilibrium and vice versa (Balassa, 1964 and Samuelson, 1964). It is also argued that increase in productivity causes improvement in the balance of trade for both tradable and non-tradable good sectors which leads to appreciation in exchange rate (Ahmad *et al*., 2010 and Masron & Yusof, 2006).

The theory further postulates that an increase in the level of money supply increases domestic inflation rate thereby increase in exchange rate. This leads to low demand for local currency which raises the exchange rate vulnerability. The theory explains that contractionary money supply raises interest rate which facilitates foreign demand for the domestic currency (surplus foreign reserve). The high external reserve leads to exchange rate appreciation of the local currency which reduces exchange rate instability in the domestic economy. It further predicts that high domestic interest rate attracts new capital inform of savings and investment from abroad which leads to increase in aggregate demand for domestic currency. This causes appreciation of exchange rate relative to its steady state level. This is similarly reported in the Mundell-Fleming model of exchange rate. However, Dornbusch (1976) argues that the increase in the interest rate leads to a decrease in the demand for real balances which rises exchange rate levels thereby exchange rate depreciation and vulnerability.

According to Chinn (2012), the new strand of macroeconomics involved introducing the monetary policy rule otherwise known as the central bank reaction function into the derivations of the model of exchange rate. Engle and West (2005; 2006) and Chinn (2008) employ the framework of Taylor rule into the exchange rate model to assess the impact of the rule in determining the rate of changes in the exchange rate equilibrium relationship. The modified model based on this postulation is presented in Equation 3.4 below:

$$s_t = +\varpi_0 + \varphi_1(m_t - m_t^*) - \varphi_2(y_t - y_t^*) + \varphi_3(i_t - i_t^*) + \varphi_4(\pi_t - \pi_t^*) + \varphi_5(IT) \qquad (3.4)$$

where *IT* denotes the included variable representing central bank reaction function into the original model. The coefficient of the IT is expected to be negatively related to the volatility of exchange rate. This implies that implementation of inflation targeting should restore inflation and output to their target levels. This ensures stability of exchange rate and strengthen the value of the domestic currencies.

A number of studies discuss the determinants of equilibrium exchange rates in support of numerous theoretical frameworks of exchange rate determination. Studies such as Arabi (2012); Cookey (1997) and MacDonald (1988) consider variables such as net inflation, interest rate, external reserve, Gross Domestic Product (GDP), money supply, and current account balances as factors that determine exchange rate volatility. In addition, Engel and West (2005; 2006); Chinn (2012) and Edwards (2007) advocate the inclusion of Taylor rule reaction function in the monetary model of exchange rate determination. Chinn and Moore (2011) state that real factors also influence the nominal exchange rate in addition to the monetary variables.

In a nutshell, exchange rate volatility is determined to be a function of the net inflation, interest rate, income, money supply and inflation targeting. In other words, exchange rate volatility is expected to be positively related to inflation and money supply and negatively related to income (gross domestic product) and inflation targeting, while interest rate may be positive or negative depending on whether the sticky or flexible version of the underpinning theory (Dornbusch, 1976 and Frenkel, 1976). The prior expectation of the parameters in Equation 3.4 above are hypothesized as: $\varphi_1 > 0$, $\varphi_2 < 0$, $\varphi_3 < 0$, $\varphi_4 > 0$ and $\varphi_5 < 0$ for the net money stock, income, interest rate, inflation and inflation targeting respectively.

Similarly, the link between foreign exchange regime switching and exchange rate variability is explained by the theory of Optimum Currency Areas (OCA) proposed by Mundell (1961). The theory points to the tendency of static exchange rate regime due to the policies of restraining prices by the surplus countries whereas, in the world with two or more currency areas it is defined as flexible exchange rate regime in which the interaction of the market forces correct the external imbalances and deflation in the domestic country. This adjusts the inflationary pressure in the foreign economy back to equilibrium. Mundell (1961) further argues that the OCA theory effectively operates and gains practical applicability in areas characterised by political instability.

The theory postulates that a large amount of exchange rate volatility is influenced by the different regimes of exchange rate. This is in line with the Keynesian proposal on exchange rate policy and capital mobility (Ferrari-Filho & Paulo, 2008). However, Frankel (1999) argues that there exist no single perfect or better regime that prove to be more appropriate at all times for all countries. Cukierman, Edward and Tabellini (1989) advocate that the volatility of exchange rate is also influenced by the regime changes motivated by the inability of government to make hard choices due to political instability that prevails in an economy.

3.2.2 Taylor Rule from the Quantity Theory of Money

The Taylor rule proposed by Taylor (1993) as a framework for monetary policy is employed in order to achieve the second objective of the study. The objective aimed at determining whether the monetary policy framework of Inflation Targeting has performed the role of the nominal anchor in the inflation targeting economies of the sub-Saharan African countries. Taylor rule is a monetary policy rule originated from the quantity theory of money which specifies how nominal interest rate should be adopted by the central bank in response to changes in inflation deviation, output gap, and other macroeconomic variables.

The rule hypothesised that inflationary pressure increases in the economy as a result of excess aggregate demand. This leads to an upward rise in the level of inflation and output gap. Thus, the monetary authorities will raise the rate of interest in response to the increase in the gaps of output and inflation rate. However, including the deviation of the actual output from its potential quantity in the framework tends to normalize the high interest rate in response to the high inflationary rate thereby reducing it adverse effect on the economic activities (Torres, 2003). The Taylor rule in its traditional form is presented in Equation 3.5 below:

$$i_t = \alpha + \beta(\pi_t - \pi_t^*) + \gamma(y_t - y_t^*) \tag{3.5}$$

where i_t is the nominal rate of interest at time t, the symbol alpha, α represents the long run equilibrium nominal interest rate, β and γ are the coefficient of the inflation deviation and the output gap respectively. The parameters measure the magnitude of deviation of inflation from its target and the actual output from its potential output, respectively. In the traditional model, the values of β and γ were set to be 0.5 in each case (Taylor, 1993). The notation π_t is the rate of inflation over time and π_t^* represent the target inflation for the period. The symbol y_t and y_t^* denote actual output and the potential output over time respectively.

The prominent Taylor rule was reviewed and formalised by a number of authors on how to approximate the rule through central banks process of optimization in a standard New Keynesian macroeconomic framework. The central banks try to minimize the quadratic loss function that exist in the inflation and output gaps. The formalisation was found in the work of Clarida, *et al.* (1999); Svensson (1996) and Woodford (2001). They modify the Taylor (1993) policy rule and presented its forward looking version as in Equation 3.6 below:

$$i_t = \alpha + \beta(\mathrm{E}_t[\pi_{t+n} - \pi_t^*]) + \gamma(\mathrm{E}_t[y_{t+k} - y_{t+k}^*]) \tag{3.6}$$

where E_t is the instantaneous expectation operator which modifies the policy rule presented in Equation 3.5 to denote that the interest rate as a policy variable is modelled to react to the expected inflation and output gaps instead of the rate of changes in the past and present observed series of inflation and output/income. The symbol α in Equation (3.6) denotes the equilibrium nominal interest rate, in the long run. The modified rule also suggests that when the expected inflation is above the target, the real interest rate should be raised by increasing the nominal rate in order to restore inflation to the target rate. This is possible through the contraction in the aggregate demand. Furthermore, the modified rule also suggests that as output rised above its potential quantity, then the same response is expected from the monetary authorities in order to curtail the effect of future inflationary pressure in the economy. However, the specification works well in developed open economies where there is a reasonable macroeconomic stability (Clarida *et al.*, 2000).

It has been argued in the literature that in a developing small open economy such as Ghana and South Africa where the monetary authorities are confronted with other macroeconomic instability such as exchange rate volatility and external financial market shocks, other variables like exchange rate and foreign interest rate can reflect the uncertainty in the expected inflation and deviation of the actual output from the potential quantity (Ball, 1999; Gali & Monacelli, 2005; Svensson, 2000 and Torres, 2003). The policy rule was modified to capture such kind of additional variables as presented in Equation 3.7 below:

$$i_t = \alpha + \beta(\mathrm{E}_t[\pi_{t+n} - \pi_t^*]) + \gamma(\mathrm{E}_t[y_{t+k} - y_{t+k}^*]) + \varphi(\mathrm{E}_t[Z_{t+m}]) \qquad (3.7)$$

here the symbol φ is the coefficient of other included variables in the model and Z_{t+m} is hypothesised by Torres (2003) to represent any variable apart from inflation and output gaps that can influence the determination of the rate of interest. These include exchange rate, foreign interest rate, money supply, openness, and country risk perception, among others (Clarida *et al.* 1999 and Torres, 2003). Taylor (1993) also suggests similar variables such as money supply and exchange rate.

Although the inclusion of exchange rate is controversial in the literature, Engel and West (2005) and Chinn (2012) argue that exchange rate represents the market's expectation of the policy rule. However, the effect of exchange rate on inflation and output in a small open economy will be captured by the policy rule parameter whereas variables such as openness is expected to affect the parameters of the model, not that of the overall policy rule. However, the central banks have given up in the control of the money supply due to the challenge of demand for money instability in most economies. Nevertheless, under the framework of inflation targeting the central banks do implicitly control the high-powered supply of money to ensure its role of the nominal anchor (Felipe, 2009). When exchange rate and money supply rise in a given economy the monetary authorities should also raise the nominal interest rate to stimulate an increase in the real interest rate to restore the exchange rate and money supply to the equilibrium.

Therefore, according to Torres (2003), inflation targeting would be consistent with the process through which monetary authorities determine the rate of interest, thereby a nominal anchor in the economy if the coefficients of inflation deviation, output gap, exchange rate, money supply are positive and greater than unity for inflation deviation and zero for the other variables respectively. Impliedly the rule hypothesised that, $\beta > 1$, $\gamma > 0$, $\varphi_1 > 0$ and $\varphi_2 > 0$ for the coefficients of inflation deviation, the output gap, exchange rate and money supply respectively.

3.3 Measurement of Exchange Rate Volatility

The term exchange rate volatility still lacks a standard unit of measurement. As such some studies use variance, standard deviations at level or difference, moving averages, nominal and real exchange rate, Autoregressive and Generalized Autoregressive Conditional Heteroscedasticity (ARCH) and (GARCH) models among others which also differ among studies (Bahmani-Oskooee & Hegerty, 2007). Although the measure of variance is the most common construct in the measurement of volatility of exchange rate, other measures are also employed.

Early researchers such as Akhtar and Hilton (1984) first used standard deviation to measure the volatility of the nominal exchange rate using daily data in three month's interval. It was later criticized for not capturing the actual volatility. Kenen and Rodrik (1986) suggest the use of monthly changes measured by moving standard deviations. The method was considered a more stationary method which was quite prominent with desirable property before the beginning of co-integration analysis in economics. On the other hand, the squared residuals of the autoregressive integrated moving average are also employed to measure volatility (Assery & Peel, 1991).

However, Engle and Granger (1987) develop an Autoregressive Conditional Heteroscedasticity (ARCH) model as another method of estimating volatility. The method measures volatility in the errors of time series modeling. The method is reviewed by Bahmani-Oskoosee and Hegety (2007) as the most popular method of measuring exchange rate volatility in the literature. The technique considers the instantaneous variance of the error term as a function of the lag(s) error term. This is widely applied as a result of it stationarity despite formulating the instantaneous variance as a function of the previous error term(s) in the ARCH process and including the moving average component in a more generalized form referred to as GARCH process (Pattichis, 2003). On the contrary, Clark, Sadikov, Tamirisa, Zeng, and Wei (2004) measure the volatility of exchange rate, as the "standard deviation of the first difference of the logarithms of exchange rate series".

Following Arize and Malindretos (1998); Emenike (2010); Kroner and Lastrapes (1993); Ndako (2012) and Pattichis (2003) this study employs the widely adopted family of ARCH models due to its property of stationarity in measuring the volatility of exchange rate.

3.4 Stationarity Analysis

The problem of unit root or non-stationarity of most time series macroeconomic variables has been the subject of concern immediately after the pivotal work of Nelson and Plosser (1982). Unit root implies non-stationarity in the mean and variance of the series; that is, non-zero long run mean and time-dependent variance of a variable which suffers from a permanent random shock effects and inferences. This was traditionally tested using Augmented Dickey-Fuller developed by Dickey and Fuller (1979) as a prerequisite for determining long-run cointegration based on the assumption that present shocks are only temporal and do not have long-run effect on the series (Glynn *et al.*, 2007).

However, Perron (1989) indicates the deficiency of Augmented Dickey-Fuller (ADF) in taking into consideration an existing break which leads to bias and less power in rejecting the null hypothesis when a structural break exists. Perron developed a test that takes care of an exogenous or known break period under the null hypothesis in order to solve the problem associated with ADF test. Moreover, Perron (1989) builds his argument on fixed break date selected autonomously from the data using a dummy variable to denote the exogenous break period. The test was developed based on the fact that the only shocks that have persistent consequence are 1929 and 1973 shocks effect (Perron, 1989).

Nevertheless, some scholars proposed more advanced tests that endogenously determine a breakpoint from a given data-generating process. Such tests include Banerjee, Lumsdaine and Stock (1992); Lumsdaine and Pappel (1997); Papell and Prodan (2004); Perron (1997) and Zivot and Andrews (1992). Banerjee *et al.*, employ sub-samples to determine the break date which affects the power of the rejection or otherwise of the hypothesis. While, Zivot and Andrews use the full sample and choose the most negative *t*-statistic from the unit root test as the breakpoint date. Furthermore, Lumsdaine and Papell (1997) capture two endogenously determined structural breaks under the alternative hypothesis and allow for both the level and trend breaks. Papell and Prodan (2004) further came up with a restricted test based on structural change that openly emphasized two fundamental changes.

However, the tests were censured for size distortion and type one error considering the existence of a break under the alternative hypothesis alone. It leads to conclusion that the series are trend stationary while associated with unit root due to structural break(s) which leads to misleading conclusion as a result of spurious rejection of the null hypothesis (Lee & Strazicich, 2001; 2003). As an alternative Lee and Strazicich (2003, 2013) developed a minimum two and one breaks Lagrange Multiplier (LM) unit root test in which the rejection of the null hypothesis entails stationarity in trend of the series.

3.4.1 Unit Root Test without Structural Breaks

The properties of the time series data is first investigated using the conventional ADF test developed by Dickey and Fuller (1979, 1981). A variable is said to contain a unit root if it fails to be stationary at level. Unit root test helps in determining the order of transformation (integration) denoted as (d) before stationarity is achieved in a given set of data. The test also aids in knowing whether permanent or temporal shocks affect variables in the long run. The test also serves as a precursor for examining the interrelationship among series (Petterson, 2000).

3.4.1.1 Augmented Dickey-Fuller Unit Root Test

The ADF test is conducted on three different equations depending on the behaviour of the data. To differentiate between the three equations, the deterministic elements of Equations (3.8 to 3.10) are considered. Equation 3.8 tests unit root with intercept. Equation 3.9 incorporates time trend in addition to the intercept. Equation 3.10 represents a pure random walk equation without intercept and trend. The three equations are presented below:

$$\Delta Y_t = \mu + \alpha y_{t-1} + \sum_{i=1}^{k} \beta \Delta Y_{t-i} + \varepsilon_t \quad (3.8)$$

$$\Delta Y_t = \mu + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k} \beta \Delta Y_{t-i} + \varepsilon_t \quad (3.9)$$

$$\Delta Y_t = \alpha y_{t-1} + \sum_{i=1}^{k} \beta \Delta Y_{t-i} + \varepsilon_t \quad (3.10)$$

where Δ represents the first difference operator, Y_t is the series under consideration, μ is the intercept term, t is the time trend, y_{t-1} is the lag variable being tested, k denotes lag length, ΔY_{t-i} means first difference lagged series usually taken to eliminate the problem of serial correlation (Dickey & Fuller, 1979) and ε is the white noise process with $\varepsilon_t \sim iid(0, \sigma^2)$. The term k in this test is determined by Schwert (1987) to get the optimal lag length and ensure white noise process of the residuals.

The null hypothesis of the ADF test states that the series is associated with a unit root, that is, $\alpha = 0$ while the alternative is that the series is stationary ($\alpha < 0$). Accordingly, if the *t*-statistic is less than the test critical values at the appropriate significance level, then the hypothesis $\alpha = 0$ is rejected, and the series is considered to be stationary, that is $\alpha < 0$. Therefore, rejection of the null hypothesis of the time series indicates stationarity of the series. If the series are free from unit root at level then, the order of the integration is denoted as $I(0)$ or d = 0, whereas, if the series has a unit root but integrated of order one process, represented as $I(1)$ then, the series became stationary after first difference transformation (Glynn *et al.*, 2007). However, the ADF test is proved to be deficient and results to bias and less power to reject the null hypothesis if structural breaks exist (Perron, 1989; Perron 1997 and Zivot & Andrews, 1992).

3.4.2 Unit Root Test with Structural Break

The area of unit root test witnessed advanced techniques of estimation developed by authors such as Lee and Strazicich (2003, 2013) who developed a minimum two and one breaks Lagrange Multiplier (LM) unit root test in which the rejection of the null hypothesis entails stationarity in the trend of the series. This tests serve as an alternative to the failure of the previous unit root tests. Therefore, to remedy the likely shortcomings of the traditional unit root test such as ADF and PP tests, this study employs the robust Lee and Strazicich (LS) (2013) with one break minimum LM test.

3.4.2.1 Justification for using Unit Root Test with Structural Break(s)

The justifications for employing the LS (2013) minimum LM with one structural break test is that the test takes care of the weak assumption of the absence of break in null hypothesis associated with endogenously break determined tests such as Lumsdaine and Pappel (LP) (1997), Perron (1997) and Zivot and Andrews (1992) as well as other similar tests. This assumption leads to major rejection of the unit root when structural break(s) exist (Lee & Strazicich, 2001 and Nunes, Newbold & Kuan, 1997). Furthermore, rejection of the null hypothesis in the previous endogenous tests does not indicate trend stationarity, rather a unit root rejection with break. Whereas, in the LM test rejection of the null hypothesis signifies stationarity in trend.

Unlike the LP test which is variant to the breakpoint nuisance which led to the assumption of no breakpoint under the null hypothesis, LS test is break point nuisance invariant under both the null and alternative hypotheses showing neither size (d) nor location (λ) distortion. Furthermore, LM test is not a break location dependent. Therefore, the tests can consider up to two different breaks under the unit root null without relying on nuisance parameters. This is the important distinctive feature that makes LM test free from spurious rejection. The test is unaffected by size and incorrect estimation irrespective of whether structural breaks are presence or not (Adebola & Dahalan, 2012 and Lee & Strazicich, 2013).

The LM test solves the problem of divergence emanating from the increase in the magnitude of the break due to the independence of the test on break location. Although the asymptotic distribution of the null hypothesis of the LM intercept and trend model rely on break location (λ) like LP test, the LM minimum *t*-statistics for the model does not deviate when break is present under the unit root null hypothesis no matter the magnitude of the break. In other words, the test does not over reject or deviate as in the LP test. The LS test is appropriate in this study due to the prevailing structural changes in the developing countries of sub-Saharan Africa.

3.4.2.2 LS Unit Root Minimum LM Test with Two Structural Breaks

Unlike the endogenous break determined test of Perron (1989, 1997), the Lee and Strazicich (2003, 2013) minimum break(s) LM test follows the data generating process shown below.

$$y_t = \delta Z_t + X_t, \quad X_t = \beta X_{t-1} + \varepsilon_t \tag{3.11}$$

where Z_t is a vector that contains exogenous variables. The null hypothesis is given as $\beta = 1$, ε_t is a white noise process that is $\varepsilon_t \sim iid(0, \sigma^2)$ which can be relaxed to ensure the absence of serial correlation. The test considers two different structural changes.

Model A of the two breaks LM test permits dual changes in the intercept defined as $Z_t = [1, t, D_{1t}, D_{2t}]$, in which $D_{jt} = 1$ for time $t \geq T_{Bj} + 1, j = 1, 2$ and zero otherwise. The second model (model C) takes account of two shifts in intercept and trend. This is defined as $Z_t = [1, t, D_{1t}, D_{2t}, DT_{1t}^*, DT_{2t}]$, $DT_{jt}^* = t - T_{Bj}$ for $t \geq T_{Bj} + 1, j = 1,2$ and zero otherwise. For a break in the trend model $Z_t = [1, t, DT_{1t}^*, DT_{2t}^*]$, $DT_{jt}^* = t$ for $t \geq T_B + 1$ and zero otherwise[3]. T_{Bj} indicates the break period. Recall that the break period in this test is embedded in both null and alternative hypotheses as $\beta = 1$ and $\beta < 1$ respectively. Equations 3.12 and 3.13 below will be obtained based on β 's values.

Null hypothesis

$$y_t = \mu_0 + d_1 B_{1t} + d_2 B_{2t} + y_{t-1} + v_{1t} \tag{3.12}$$

Alternative hypothesis

$$y_t = \mu_1 + \gamma t + d_1 D_{1t} + d_2 D_{2t} + v_{2t} \tag{3.13}$$

where v_{1t} and v_{2t} are white noise errors, $B_{jt} = 1$ for $t = T_{Bj} + 1, j = 1,2$ and zero otherwise. To ensure time-invariance to the break size, a dummy variable B_{jt} is included in Equation 3.12. Similar models should be repeated with additional D_{jt} and DT_{jt} terms to Equations 3.12 and 3.13 respectively to account for the model that allows for two shifts in both intercept and trend.

The following Lagrange Multiplier (LM) regression equation will be estimated to derive the two breaks unit root *t*-statistics.

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + \mu_t \tag{3.14}$$

where $\tilde{\delta}$ is the coefficient of Δy_t on ΔZ_t; $\tilde{S}_t = y_t - \tilde{\psi}_x - Z_t \tilde{\delta},\ t = 2, \ldots\ldots., T$; ψ_x is $y_t - Z_t \tilde{\delta}$. The null hypothesis is defined as $\phi = 0$ and the LM *t*-statistics is given as $\tilde{\rho} = T \times \tilde{\phi}$

[3] Following Lee and Strazicich (2003; 2013) the trend model is (model B) is not considered based on the argument that most of the macroeconomic time series can be adequately described by model A or C.

and $\tilde{\tau} =$ *t*-statistics for testing the unit root null of LM test $\phi = 0$. The minimum LM two breaks unit root uses grid search to endogenously determine the break point T_{Bj} as written below:

$$LM_p = \inf_{\lambda} \tilde{\rho}(\lambda) \tag{3.15}$$

$$LM_\tau = \inf_{\lambda} \tilde{\tau}(\lambda) \tag{3.16}$$

The break periods are indicated by the minimum *t*-statistics.

3.4.2.3 LS Minimum LM Unit Root Test with One Structural Break

To avoid the adverse effect of the loss of power to reject the null hypothesis under the two breaks LM test due to small sample size of the data under study[4], the study utilizes the one break LM test by Lee and Strazicich (2013). The advantage of the one break minimum LM test is that it is free from spurious rejection and size distortion in the presence of unit root with a structural break. The only difference between the two breaks LM test of Lee and Strazicich (2003) and one beak LM test of Lee and Strazicich (2013) is that the one break test permits only one-period break in the intercept and intercept and trend. The test is derived by a similar data generating process as shown below:

$$y_t = \delta' Z_t + X_t, \qquad X_t = \beta X_{t-1} + \varepsilon_t \tag{3.17}$$

where $\beta = 1$ if $Z_t = [1, t]'$, and model A known as crash/intercept model can be explained as $Z_t = [1, t, D_t]'$ in which $D_t = 1$ for $t \geq T_B + 1$ and zero if contrary. T_B is a structural change period. The second model, model B[5] is denoted as trend model where $DT_t^* = t$ for $t \geq T_B + 1$ and zero if reverse is the case and the third model, model c

[4] Although the critical values of the two breaks LM test are also simulated using a sample of T=100.
[5] See footnotes on page 81

considers movement in level and trend represented as $Z_t = [1, t, D_t, DT_t]'$ for $DT_t = t - T_B$ for $t \geq T_B + 1$ and zero otherwise. Just like the two breaks Lagrange multiplier unit root test, the *t*-statistics of the one break LM are derived from Equation 3.18 below:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + \mu_t \quad (3.18)$$

Equation 3.18 follows similar interpretation with two breaks LM test except that in this case only one break is allowed in each of the models. It follows that, $\tilde{\delta}$ is the coefficient of Δy_t on ΔZ_t in Equation 3.18. The notation ΔZ_t is described by $[1, B_t]$ in the intercept model and $[1, B_t, D_t]$ in intercept and trend model. B_t is the change in D_t and $D_t = \Delta DT_t$. Any shift in level and trend is captured by B_t under the alternative hypothesis, so also any drift shift and a period change is captured by D_t under the null hypothesis.

The null hypothesis in one break LM unit root test is also defined as $\phi = 0$ and the LM *t*-statistics is represented by $\tilde{\tau}$ = *t*-statistics for testing the unit root null hypothesis $\phi = 0$. General to specific procedure of selecting the maximum number of lag(s) of k will be used in order to eliminate the problem of serial correlation by incorporating the augmented terms $\Delta S_{t-j}, j = 1,...,k$. Just as in Equations 3.15 and 3.16, the breakpoint is indicated by the minimum *t*-statistics value shown as $\inf \tilde{\tau}(\tilde{\lambda}) = \inf_{\lambda} \tilde{\tau}(\lambda)$ in which $\lambda = T_B / T$ and $\lambda \in [0,1]$.

3.5 Model Specification

This section presents the five different models employed in this study to address the specific research objectives. The models are presented in the following sub-sections.

3.5.1 Monetary Model of Exchange Rate Determination

Following Chin *et al*. (2007); MacDonald and Taylor (1994) and Miyakoshi (2000) the reduced form of the monetary model of exchange rate determination is specified to achieve the first objective of the study. The economic model is presented in Equation 3.19 below:

$$s_t = \varphi_0 + \varphi_1(\pi_t - \pi_t^*) + \varphi_2(m_t - m_t^*) + \varphi_3(y_t - y_t^*) + \varphi_4(i_t - i_t^*) + \varphi_5 it_t \qquad (3.19)$$

where s_t is the spot exchange rate in its nominal form. π_t, m_t, y_t and i_t represent domestic inflation, money supply, income and interest rate respectively. π_t^*, m_t^*, y_t^* and i_t^* denote foreign inflation, money supply, income and interest rate respectively and it represents the extension to include inflation targeting in the model. This is similarly advocated in Edwards (1996); Engle and West (2005; 2006) and Chinn (2008) who equally employ the framework of Taylor rule into the exchange rate model to assess the impact of the rule in determining the rate of changes in the exchange rate equilibrium relationship. This is equally emphasised in Chinn (2012) who advocates a new strand of macroeconomics by introducing the monetary policy rule otherwise known as the central bank reaction function into the model of exchange rate determination. The empirical counterpart of the economic model specified in Equation 3.19 above is presented in Equation 3.20 below:

$$EXR_t = \alpha_0 + \varphi_1(\pi_t - \pi_t^*) + \varphi_2(m_t - m_t^*) + \varphi_3(y_t - y_t^*) + \varphi_4(r_t - r_t^*) + \varphi_5 it_t + \varepsilon_t \qquad (3.20)$$

where *EXR* represents the domestic nominal exchange rate, α is the long run constant term, π_t is the inflation rate in the domestic country, m_t is the money supply in the domestic country, y_t is the real domestic income, r_t represent interest rate in the domestic country, it_t denotes the dummy of inflation targeting or inflation target constructed by HP filtering, whereas, the variables with asterisks represent the foreign variables in the model and ε_t is the white noise process. The prior expectation of the coefficients in model specified in Equation 3. 20 above are hypothesised as: $\varphi_1 > 0$, $\varphi_2 > 0$, $\varphi_3 < 0$, $\varphi_4 < 0$ and $\varphi_5 < 0$ for the net inflation, money stock, income, interest rate and inflation targeting respectively.

From the model of monetary theory of exchange rate determination presented in Equation 3.20, the present study employs the powerful TGARCH model to investigate the effectiveness of inflation targeting as a hedging strategy for exchange rate volatility in Ghana and South Africa. The TGARCH model is given as:

$$\varepsilon_t = \sigma_t z_t \qquad (3.21)$$

$$\sigma_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i^+ \varepsilon_{t-1}^+ - \alpha_i^- \varepsilon_{t-1}^- + \sum_{j-1}^{p} \beta_j \sigma_{t-j} \qquad (3.22)$$

where z_t is identically independently distributed iid, $\mathrm{E}z_t = 0$ $Vz_t = 1$, z_t is independent of ε_{t-1} for all t. The symbol ε_t represents the real-valued discrete type process, $\varepsilon_{t-i} = (\varepsilon_{t-1}, \varepsilon_{t-2}, ..., \varepsilon_{t-n})$. The σ_t denotes the information set through t. ε_t^+ is the maximum and ε_t^- is the minimum for the positive and negative components of the ε_t . $(\varepsilon_t^+)_i = 1, q$, $(\varepsilon_t^-)_i = 1, q$ and $(\beta_j)_j = 1, p$. By construction the model considers a positive conditional variance σ^2 for lesser mathematical complication as follows:

$$\alpha_0 > 0, \quad \alpha_i^+ \geq 0, \quad \alpha_i^- \geq 0, \quad \beta_i \geq 0, \text{ for all } i.$$

In a more general form. $\varepsilon_i^+ = \varepsilon_i^- = \alpha_i$ for all i . The conditional standard deviation is given as:

$$\sigma_t = \alpha_0 + \sum_{i=i}^{q} \alpha_i \,|\, \varepsilon_{t-1} \,|+ \sum_{j=i}^{p} \beta_j \sigma_{t-j} \qquad (3.23)$$

Therefore, the volatility depends on the size of the unusual movement or changes. This model allows the sign of the previous innovations to affect the present volatility reaction and that the standard deviation σ_t is affected by the sign and magnitude of the ε_{t-k} shocks.

3.5.1.1 Justification for using ARCH Family Models

Unlike most of the time series models that impose the assumption of constant variance, the ARCH models allow changes in the conditional variance. This proves the importance of ARCH models in which the past forecast errors predict the present forecast variance which may change with time. In monetary and financial economics, financial assets such as exchange rate are assumed to depend on their anticipated means and variances. Therefore, changes in demand for such assets depend on the expected variance and changes in the means of return in the series. Thus, using a standard time series model where the variance is restricted to be constant over time and the use of exogenous variables alone to determine the changes in variance will lead to spurious result and invalid inference (Engle, 1982).

Furthermore, the existence of ARCH effect denotes model misspecification such as a variable omission and presence of structural break. Therefore, estimating ARCH family models depict approximation of near reality compared to the standard time series models. The family of the models in its simplest Autoregressive (AR) form, depicted as the first order model is given as:

$$y_t = \beta y_{t-1} + \varepsilon_t \tag{3.24}$$

where y_t is a random variable with conditional mean βy_{t-1} and zero (0) for unconditional mean, ε_t is a white noise process with $V(\varepsilon) = \sigma^2$. The symbol σ^2 is a conditional variance of y_t whereas, $\sigma^2 / 1-\beta^2$ is the unconditional variance. Allowing additional news from the previous period to impact on the forecast variance leads to a better forecast interval (Engle, 1982). The heteroscedastic standard approach introduces exogenous variables x_t to predict the variance in the equation having zero (0) mean. The equation can be represented as:

$$y_t = \varepsilon_t x_{t-1} \tag{3.25}$$

where $y_t = \sigma^2 x_{t-1}^2$. Therefore, the exogenous variables became the function of the forecast interval. This requires specific cause of change in the variance instead of assuming the evolvement of conditional mean and variance over time. Granger and Andersen (1978) in Engle (1982) developed a simple model where the previous series realization is a function of the conditional variance.

$$y_t = \varepsilon_t h_t^{1/2} \text{ or } y_t / \psi_{t-1} \sim N(0, h_t) \tag{3.26}$$

$$y_t = \alpha_0 + \alpha_1 y_{t-1}^2 \tag{3.27}$$

where $V(\varepsilon_t) = 1$ and the $h_t = h(y_{t-1}, y_{t-2}, ..., y_{t-p}, \alpha)$ with p referring to the order of the process (ARCH) and α is a parameter to be estimated.

The extension of the ARCH process to accommodate flexible lag length and longer memory is what is referred to as the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) (Bollerslev, 1986). This allows for modeling the conditional variance as Autoregressive Moving Average (ARMA) process (Dahalan, 2004). The model is criticized for its dependence on the size of the previous period error terms which does not relate to the direction of the relationship. Besides, the model fails to account for the leverage effect as well as distributional asymmetry (Yoon & Lee, 2008).

However, a more general model was formulated by Nelson (1991) to take care of the asymmetric effect in volatility modeling that does not necessitate the constraint of non-negativity as the GARCH models do. The proposed model introduced exponents in the GARCH model. The model better explains the magnitude of every shock effect and measure leverage effect on the logarithm of the conditional variance (Enders, 2004; Nelson, 1991). Despite these advantages of the Exponential GARCH model (EGARCH), the model suffers from the inability to forecast conditional volatility. However, the threshold generalized conditional heteroscedasticity model was proposed to take care of the shortcomings of the previous variance modeling (Zakoian, 1994).

Although both TGARCH and EGARCH models are similar in measuring asymmetries in volatility, nevertheless, the two models differ in that the TGARCH model considers volatility to depend on the non-normalized innovation. More so, absolute residuals are found to be more efficient in estimating the variance compared to the squared residuals, especially in the normal distribution (Davidian & Carroll, 1987). Secondly, the TGARCH model does not enforce constant structure for the entire lags due to the fact that in asymmetric modeling, opposite contributions may arise from different lags such as when $\alpha_1^+ - \alpha_1^- > 0$ the other side may be $\alpha_2^+ - \alpha_2^- < 0$, whereas, EGARCH applies constant structure across all lags. Finally, the TGARCH model linearly conserves the properties of the traditional GARCH models which enable two steps least squares as oppose to EGARCH model which entails ARMA modelling for the natural logarithm of the conditional variance (Zakoian, 1994).

3.5.1.2 Threshold GARCH Model

According to the Longmore and Robinson (2004) the TGARCH model takes care of the inabilities in the EGARCH process. The model assumes that positive shocks lead to less volatility than the negative shocks. The model enables forecasting of the conditional variance, takes account of asymmetric effect, employs more flexible lag lengths and considers both negative and positive aspects of the stochastic process while keeping the tractability of GARCH model. In addition, the TGARCH model is not constrained by positivity condition (Zakoian, 1994).

3.5.1.3 Estimation Procedure of TGARCH Model

The following TGARCH model (Equation 3.28) is estimated for the purpose of the current study in order to answer the first objective of the research.

$$\sigma_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i^+ \varepsilon_{t-i}^+ - \alpha_i^- \varepsilon_{t-i}^- + \sum_{j-1}^{p} \beta_j \sigma_{t-j} + \sum_{k=1}^{m} \lambda_k X_k + \gamma_1 Dit_t + \gamma_2 Dit_{t-1} + \gamma_3 DFER_t + \gamma_4 BDT_t \quad (3.28)$$

where σ_t and σ_{t-j} represent exchange rate volatility at time *t* and time *t-j* respectively. X_k denotes other explanatory variables specified by the monetary theory of exchange rate determination which are considered as other factors that determine the equilibrium or otherwise of the exchange rate. The variables are already explained under model specification in Equation 3.19. These variables assist in explaining the volatility of the exchange rate measured as a standard deviation σ_t in the model; ε is the mean equation residuals. In this model unlike the traditional GARCH models, the residuals (ε_t) can be either negative or positive with ε_t^+ being the maximum $(\varepsilon_t, 0)$ or ε_t^- a minimum $(\varepsilon_t, 0)$. In other words, $\varepsilon_t = 0$ is the threshold value and that positive shocks are associated with different effect compared to negative innovations effect. Negative value of ε_t^- indicates a more severe shock effect than the ε_t^+ innovation. The threshold effect is noticed in a given set of data if the value of either α_i^+ or α_t^- is statistically non-zero.

To examine the effectiveness of inflation targeting in reducing exchange rate volatility, a dummy variable Dit_t and the inflation target calculated by Hodrick-Prescot filtering (IT_t) is included in the equation. It is hypothesised that unexpected information officially published on government policies and economic variables such as inflation will be sudden and surprising which can temper with market prior expectations, hence, may affect asset prices such as exchange rate (Petterson, 2000).

The dummy variable Dit_t is assigned zero for the sample period prior to the implementation of inflation targeting and one for the period after the announcement. If the coefficient of inflation targeting is found to be statistically significant and different from zero, then the inflation targeting has an effect on exchange rate volatility. Assuming the coefficient γ_1 in Equation 3.28 is estimated to be less than zero $(\gamma_1 < 0)$, then the conclusion is that inflation targeting decreases the average of the volatility of exchange rate and vice versa. Dit_{t-1} respresents lag of IT variable to denotes policy transition effect. $DFER_t$ stands for exchange rate regime and DBT_t is the structural break dummy. The employment of a dummy variable to account for shock or policy effect have been used in a number of research works such as in Aggarwal *et al.* (1999); Hamilton and Susmel (1994); Lamoureux and Lastrapes (1990) among others.

3.5.1.4 Diagnostic test for TGARCH model

Before the model of TGARCH or any model in the family of volatility modeling is considered fit and appropriate for interpretation, it is essential to test the appropriateness of estimating the family of ARCH models (Engle, 1982). Therefore, the following diagnostics checks will be performed to ensure the validity of the model.

3.5.1.4.1 Test for Modified ARCH Effect

According to Peguin-Feissolle (1999) the normal LM test leads to power distortion and ambiguous ARCH identification compared to the augmented LM test. Positive and negative residuals are distinguished in the regression to account for asymmetric ARCH effect. The auxiliary regression presented in Equation 3.29 is estimated after obtaining the estimated $\hat{\varepsilon}_t$ from the OLS regression.

$$\hat{\varepsilon}_t = \varphi_0 + \varphi_1^+ \hat{\varepsilon}_{t-1}^+ + \ldots + \varphi_q^+ \hat{\varepsilon}_{t-q}^+ + \varphi_1^- \hat{\varepsilon}_{t-1}^- + \ldots + \varphi_q^- \hat{\varepsilon}_{t-q}^- \quad (3.29)$$

The asymptotic distribution of $\chi^2(2q)$ for no symmetric ARCH effect is calculated as *T* times R^2 from the *t*-statistics of the null hypothesis that $\varphi_i^+ = \varphi_i^- = 0$ for $i = 1, \ldots, q$. Rejection of the null hypothesis of the Modified ARCH effect test indicates the existence of asymmetric ARCH effect.

3.5.1.4.2 Test for the Asymmetric Effect

To ensure the appropriateness of the TGARCH model, a specific test for the asymmetric effect is conducted. According to Engle and Ng (1993), to determine whether the influence of negative shock effect on conditional volatility varies from the positive effect, Equation 3.30 is estimated.

$$s_t^2 = \alpha_0 + \alpha_1 d_{t-1} + \varepsilon_{1t} \quad (3.30)$$

where s_t^2 is the squared estimated residuals, d_{t-1} is a dummy variable assuming zero if ε_{t-i}^{+} holds, that is $\varepsilon_{t-i} \geq 0$ and one if ε_{t-i}^{-} holds, that is $\varepsilon_{t-i} < 0$ exist. This shows that d_{t-1} can be used to predict the squared estimated residuals s_t^2. If the coefficient of d_{t-1} is different from zero, then there exist an asymmetric effect. In a more general form Equation, 3.31 is estimated to account for the asymmetric effect in the model.

$$s_t^2 = \alpha_0 + \alpha_1 d_{t-1} + \alpha_2 d_{t-1} s_{t-1} + \alpha_3 (1 - d_{t-1}) s_{t-1} + \varepsilon_{1t} \tag{3.31}$$

A non-zero value of the coefficients of $d_{t-1}s_{t-1}$ and $(1-d_{t-1})s_{t-1}$ determine whether the shock effect rely on its magnitude or not. A more informative method is to follow Glosten, Jagannathan and Runkle (GJR) ARCH and formulate a regression which emphasised the asymmetric aspect variation of the alternative hypothesis as shown in Equation 3.32 (Petterson, 2000).

$$\hat{\varepsilon}_t = \alpha_0 + \alpha_1^{+} \hat{\varepsilon}_{t-1}^{+} + \ldots + \alpha_q^{+} \hat{\varepsilon}_{t-q}^{+} + \rho_1^{-} \hat{\varepsilon}_{t-1}^{-} + \ldots + \rho_q^{-} \hat{\varepsilon}_{t-q}^{-} + \eta_t \tag{3.32}$$

The $\rho_i, i = 1, 2, \ldots, q$ coefficient equal zero under the null hypothesis which states that there is no asymmetric effect in the ARCH model. Thus, asymmetric effect is said to exist in the model if the hypothesis is rejected. This allows for the estimation of asymmetric models like TGARCH.

3.5.1.4.3 Test for Normality

The estimation of GARCH models using maximum likelihood assuming that the residuals of the error term are conditionally normally distributed is found to be invalid with financial data. Violation of the normality assumption leads to invalid inferences, suboptimal estimation and inaccurate findings (Jargue & Bera, 1987). However, a number of literature indicates that the diagnostics check of normality and autocorrelation in ARCH models are not expected to be much powerful but usually assist in detecting model misspecification (Bera & Higgins, 1993). Using the maximum likelihood method of estimation, Equation 3.33 is estimated based on Equation 3.28.

$$\log L_T(Y;\theta) = -\sum_{t=q+1}^{T} \log \sigma_t - \frac{1}{2}\sum_{t=q+1}^{T} (\varepsilon_t^2 / \sigma_t^2) \tag{3.33}$$

where Y is a random series, $\theta = (\alpha', \beta')$, represents conditional mean and conditional variance, T denotes time observation. In threshold GARCH model, the θ can only be differentiated with respect to α and β rather than λ (in Equation 3.28) due to the existence of the threshold. The equation is normally distributed as:

$$\sqrt{T}(\hat{\theta}_T - \theta_T) \xrightarrow{d} N(0, j^{-1}) \tag{3.34}$$

with

$$J = \mathrm{E}_0\left[\frac{d^+ \log \ell(Y;\theta_0)}{\partial\theta} . \frac{d^+ \log \ell(Y;\theta_0)}{\partial\theta'}\right] \tag{3.35}$$

$$= \left[\frac{d}{\partial\theta}\mathrm{E}_0\left[\frac{d^+ \log \ell(Y;\theta_0)}{\partial\theta}\right]\right]_{\theta=\theta_0}$$

where $\dfrac{d^+}{\partial\theta}$ is the right derivation and $\ell(Y;\theta)$ is the density function of Y_t conditional on Y_{t-1}. The null of normality states that the residuals are normally distributed, rejection of which indicates the non-normality in the distribution of the residuals in the model.

3.5.1.4.4 Test for Functional Formulation

The model is also tested for functional form specification to avoid inconsistency in the maximum likelihood parameter estimates in the conditional mean. This usually happens if asymmetric effect is found or ARCH-M models are estimated (Bera & Higgins, 1993). This is tested using Equation 3.36 below:

$$\varepsilon_t^* = \varepsilon_t / h_t^{1/2} \mid \psi_{t-1} \sim N(0,1) \tag{3.36}$$

If the model is specified correctly, then the $\hat{\varepsilon}_t^*$ should be characterized as a white noise process.

3.5.1.4.5 Test for Heteroscedasticity

Given the linear TGARCH model specified in this study in Equation 3.28. A linear model presented below is considered in testing for heteroscedasticity effect. Following Glejser (1969) and Breusch and Pagan (1979), the following model is specified.

$$y_t = \beta X_t + \varepsilon_t, \ \ \varepsilon_t \sim N(0, \sigma^2) \tag{3.37}$$

where y_t is the endogenous variable at time t, X_t is a vector of the predetermined series, β is a vector of parameters coefficient and ε_t is a white noise process. From the Equation 3.37, the error term shall be written as:

$$\varepsilon_t = \sigma\left[\alpha_0 + \alpha_1 f(z) + \alpha_2 [f(z)]^2 + ... + \alpha_g [f(z)]^g\right] = \sigma P_g(z) \tag{3.38}$$

where σ is a random series with $(0, \sigma^2)$, whereas, $P_g(z)$ represents an g order of a polynomial function of a variable z. In practice, z will be part of the series in X_t that is x_j. The function $f(x)$ can be $x_j^{1/2}$ or log x_j. Equation 3.38 can be reduced as follows:

$$\sigma_\varepsilon = \sigma\left[P_g(z)\right]^g \tag{3.39}$$

Suppose that there exist a normality among ε_t and $\hat{\varepsilon}_t$. Then, $\mathrm{E}(\in) = \mathrm{E}(|\hat{\varepsilon}|) - \mathrm{E}(|\varepsilon|) = (\sigma_{\hat{\varepsilon}} - \sigma_\varepsilon)(2/\pi)^{1/2} < 0$. The null hypothesis of homoscedasticity or constant variance will be tested on the condition that the following hypothesis are assumed:

Null hypothesis: $\alpha_0 \neq 0, \alpha_1 = \alpha_2 = ... = \alpha_i = ... = \alpha_g = 0$

Alternative hypothesis $\alpha_i \neq 0 (i \neq 0); \alpha_1 = \alpha_2 = ... = \alpha_g = 0$

Rejection of the null hypothesis indicates the prevalence of the problem of heteroscedasticity.

3.5.1.4.6 Test for Serial Correlation

The model is subjected to the test of serial correlation in order to check that the residuals are not serially correlated. The existence of serial correlation will lead to wrong specification of the conditional mean of the model (Mackinnon, 1992). The following models are considered.

$$y_t = Y_t' \lambda + x_t' \beta + \mu_t \tag{3.40}$$

$$\mu_t = \mu_t' \alpha + \varepsilon_t \tag{3.41}$$

where $Y_t = (y_{t-1}, ..., y_{t-m})$, $\lambda_t = (\lambda_1, ..., \lambda_m)$ and $\alpha = (\alpha_1, ..., \alpha_p)$. To test the first-order serial correlation using the standard LM approach, the residuals μ_t are regressed on the μ_t' and x_t' and the TR^2 statistics which follow the asymptotic χ^2 distribution are calculated. The hypothesis of no serial correlation is given as:

$$\alpha = 0 \;\; \alpha_1 = \alpha_2 = ... = \alpha_n = 0$$

The rejection of the null hypothesis indicates that the residuals in the model are serially correlated.

3.5.2 Taylor Policy Rule Model

The second objective of the study uses the Taylor rule model to determine whether the monetary framework of inflation targeting has performed the role of the nominal anchor in Ghana and South Africa. Followig Clarida *et al*. (1999, 2000); Taylor (1993) and Torres (2003), the traditional Taylor rule model is presented in Equation 3.42 below:

$$i_t = \alpha + \beta(\pi_t - \pi_t^*) + \gamma(y_t - y_t^*) \quad (3.42)$$

where i_t is the nominal rate of interest at time *t*, α represents an equilibrium nominal interest rate in the long run, β, γ are the coefficient of the inflation deviation and the output gap respectively. π_t is the rate of inflation over time and π_t^* represents the target inflation for the period. The symbols y_t and y_t^* denote actual output and the potential output over time respectively. The model was modified to capture such kind of additional variables as presented in Equation 3.43 below:

$$i_t = \alpha + \beta(\pi_t - \pi_t^*) + \gamma(y_t - y_t^*) + \varphi Z_t \quad (3.43)$$

here the symbol φ is the coefficient of other variables included in the model and Z_t is hypothesized by Taylor (1993) and Torres (2003) to represents exchange rate and money supply. The models presented in Equations 3.42 and 3.43 are estimated using the Generalized Method of Moments (GMM) estimators described below.

3.5.2.1 Generalized Method of Moments Estimators

The study estimates Equations 3.42 and 3.43 using the commonly employed Generalized Method of Moments (GMM) proposed by Hansen (1982) and Hansen and Singleton (1982). The first-order condition discrete-time model can be specified below:

$$E_t h(x_{t+n}, b_0) = 0 \quad (3.44)$$

where E_t represents expectation operator over time, x_{t+n} is the k - dimension vector of observed variables at time $t+n$ for forward-looking rule and $t-n$ for the backward-looking rule. The observed variables in this study include the interest rate, inflation deviation, real output gap, real exchange rate, and real money supply. b_0 denotes the unknown l dimension vector of parameters that is estimated using the procedure of the generalized instrumental variables with orthogonality condition and criteria function that guarantee consistency, asymptotically normal distribution and consistent asymptotic covariance matrix estimators of b_0. The function f of the Equation (3.45) is defined as:

$$f(x_{t+n}, z_t, b) = h(x_{t+n}, b) \otimes z_t \quad (3.45)$$

here f becomes R^r, while $r = m*q$. The notation $\otimes$ is the Kronecker product operator, Z_t represents q dimension vector of the instrument and the instrument vector is constructed using the lagged series of x_{t+n} which include the lags of interest rate, inflation deviation, output gap, real exchange rate and real money supply. The instrument variables are not expected to be stationary but rather needed for the convergence of the moment matrix (Amemiya, 1975; Gallant, 1977 and Hansen & Singleton, 1982). The only requirement is that the instrument variables need to be determined a priori at time *t* and not necessarily exogenous (Hansen, 1982 and Hansen & Singleton, 1982). The lags of x_{t+1} employed in z_t ranged from 1 to the maximum of 4 lags. The resulting implication of (3.44) and (3.45) is given in Equation 3.46 below:

$$\text{E}[f(x_{t+n}, z_t, b)] = 0 \quad (3.46)$$

Equation 3.46 shows the set of orthogonality conditions that enable the construction of b_0 estimators provided that the population orthogonality conditions at least equals to the b parameters in the model. The sample information such that $\{(x_{1+n}, z_1), (x_{2+n}, z_2), ..., (x_{T+n}, z_T)\}$ as well as the vector of the unknown parameter b_0 are employed to develop the objective function.

The choice of the weighting matrix W_T influences the estimators' asymptotic covariance matrix. Assuming that the Z_t vector is chosen and *h* can be differentiated, then the full rank matrix is represented in Equation 3.47 below:

$$W_0 = \mathrm{E}[\partial h / \partial b (x_{t+n}, b_0) \otimes z_t] \tag{3.47}$$

The W_0 limiting constant matrix converges closely to the W_T weighting matrix given in Equation 3.48 below:

$$S_0 = \sum_{j=-n+1}^{n-1} \mathrm{E}[f(x_{t+n}, z_t, b_0) f(x_{t+n-j}, z_{t-j}, b_0)'] \tag{3.48}$$

where S_0 is the full rank condition, n is the auto covariance's number of the population emanating from the u_t moving average of the disturbance term, $W_0^* = S_0^{-1}$ in the model. This is estimated using b_T of b_0 consistent estimators. The characteristics of the estimation procedure are that adjustments in the conditioning data set influence the conditional variance of the series (Hansen & Singleton, 1982). In this situation, the lagged interest rate influences the conditional variance of the instantaneous interest rate.

3.5.2.2 Justification for using GMM Estimators

The use of the GMM estimators is justified due to the anticipated overlapping data problem resulting from the variables construction and non-constant variance in the forecast error. This leads to moving average process which prevents the consistency of the usual variance covariance matrix. Thus, will not be efficient in testing hypotheses. The GMM approach replaces unobserved disturbances with observed values and real parameter vector in the orthogonality condition using expected cross multiplication which usually converge to the true parameter vector in terms of the asymptotic distribution. The model also exhibits superiority among the estimators that operate within the orthogonality conditions because it does not suffer the obvious problem of errors in variables (Hansen, 1982; Kan and Zhang, 1999 and Shabri, Kameel & Azmi, 2008). Furthermore, the estimates using the GMM technique are robust irrespective of normality in the distribution of errors or otherwise.

Moreover, the approach allows for both conditional heteroscedasticity and serial correlation in orthogonality construction. It further permits the dynamism in considering the distance measure which influences the estimator’s asymptotic distribution. The model circumvents the explicit stochastic equilibrium emphasised in the theoretical requirement (Hansen & Singleton, 1982).

3.5.2.3 Estimation Procedure of Taylor Rule Model

For the purpose of this study, the inflation targeting monetary policy rule for Ghana and South Africa are considered under both the baseline and augmented forward-looking policy rules described in the following sub-sections.

3.5.2.3.1 IT and Monetary Policy: The Baseline Case

Following the work of Clarida *et al.* (1999) and Torres (2003) the baseline monetary policy rule is estimated to determine the process followed by Ghana and South Africa to set interest rate in the economies. The Taylor rule in its simple form sets nominal interest rate as monetary policy instrument. The rule is assumed to react to deviations in inflation and output gaps in the economies. According to Orphanides (2004), the policy rule is a function of inflation and real economic activities outlook as presented in Equation 3.49 below:

$$i_t = \alpha + \beta(\pi_t - \pi_t^*) + \gamma(y_t - y_t^*) + \eta_t \tag{3.49}$$

here α represents the equality of inflation to its target policy rate in a steady state when deviation of output from its potential quantity equals to zero. The error term η_t is considered as other factors that can affect the interest rate for the period apart from the inflation and output gaps. All other symbols are as earlier defined under Equation 3.46. In a simple forward-looking baseline case, the monetary policy rule is described in Equation 3.50 below:

$$i_t^* = (k + \alpha\pi_{t+n}^*) + \beta(\mathrm{E}_t[\pi_{t+n} - \pi_{t+n}^*]) + \gamma(\mathrm{E}_t[y_{t+k} - y_{t+k}^*]) \tag{3.50}$$

where the i_t^* is the target interest rate. In Equation 3.50 the long-run nominal interest rate is represented by $k + \alpha\pi_{t+n}^*$ and that both the target inflation π_{t+n}^* and the nominal interest rate are assumed to vary over time whereas the actual interest rate assumed a gradual adjustment process in converging to the target interest rate. Moreover, the actual interest rate is the combination of the lagged interest rate, the weighted average of the interest rate target and the white noise interest rate shock depicted in Equation 3.51 below:

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + v_t \tag{3.51}$$

An estimable baseline, forward-looking monetary policy rule can be described in Equation 3.52 below:

$$i_t = (1-\rho)(k + \alpha\pi^*_{t+n}) + (1-\rho)\beta(\mathrm{E}_t[\pi_{t+n} - \pi^*_{t+n}]) + (1-\rho)\gamma(\mathrm{E}_t[y_{t+k} - y^*_{t+k}]) + \rho i_{t-1} + v_t \qquad (3.52)$$

where the parameter ρ indicates the magnitude of interest rate smoothening and in turn assumed a minimum value of between zero (0) and a maximum of one (1). Equation 3.52 is estimated using GMM technique following Clarida *et al.* (1999, 2000), Torres (2003) and Ophanides (2004) to overcome the problem that usually arise from the variable construction. The study tests the hypothesis of whether the monetary policy in Ghana and South Africa has fulfilled the requirement to serve as a nominal anchor and whether it represents the process through which the central bank determines interest rate from the baseline monetary policy rules. To ascertain this assertion, the monetary policy rule in its baseline case (Equation 3.52) is estimated to see if β and γ are significantly greater than 1 and 0 respectively.

3.5.2.3.2 IT and Monetary Policy: The Augmented Rule

The augmented forward-looking rule takes into account another important set of information in addition to the lagged inflation and output to predict the future situation of the economy (Clarida *et al.*, 2000). This version of the rule also uses interest rate as the policy reaction function in its simplest specification. The rule is a function of the expected inflation and output gaps each period coupled with their target levels. This is presented in a linear form in Equation 3.44, following the work of Clarida *et al.* (2000).

$$r^*_t = r^* + \beta(\mathrm{E}[\pi_{t,k} / \eta_t] - \pi^*) + \gamma\mathrm{E}[x_{t,q} / \eta_t] \qquad (3.53)$$

where r^*_t represents the target interest rate, *t* denotes the time period, r^* is the target interest rate when the target levels of inflation and output are achieved. β and γ are the coefficients of inflation and output gap respectively. The symbols E and η_t indicate the expectation operator and a set of information when interest rate is determined. $\pi_{t,k}$ stands for the price level annual percentage change between *t* and $t+k$. π^* represents the inflation target. $x_{t,q}$ is the deviation of output from its potential quantity expressed in percentage. It measures the average output gap in terms of *t* and $t+q$.

The rule presented in Equation 3.53 is vast recognized in both theoretical and empirical literature especially by the central banks that suffer from inflation and output deviation in a quadratic loss function. Furthermore, the rule depicts the behaviour of most central banks in the world (Clarida *et al.,* 2000). However, the rule as presented in Equation 3.53 is found to be inflexible in describing the actual interest rate changes in many economies. This is attributed to the unrealistic assumption of the immediate reversion of the actual interest rate to its target without considering the smoothening process of the monetary authorities. The assumption of the efficiency of the central banks to have absolute control over the rate of interest through the instrument of monetary policy and finally, the way monetary authorities consider all changes in the policy rule function as it occurs based on the underlying economic situation. Based on the noticeable difficulty in the reversion process of the interest rate, Clarida *et al.* (2000) specify a more realistic policy rule to depict the actual relationship using the actual interest rate r_t taking into consideration the exogenous shock and smoothening process in the model as presented in Equation 3.54 below:

$$r^* = \rho(L)r_{t-1} + (1-\rho)r_t^* \qquad (3.54)$$

where $\rho \equiv \rho(1) * V_t$ stands for the exogenous zero mean interest rate shock, r_t^* is the interest rate target already specified in Equation 3.53. ρ denotes the magnitude of changes in interest rate smoothening, at anytime the monetary authorities change interest rate to adjust a fraction of a given gap between the past values and the current target level. In a general form, Equation 3.55 is presented as a combination of both Equations 3.53 and 3.54.

$$r_t = (1-\rho)[rr* - (\beta-1)\pi* + \beta\pi_{t,k} + \gamma x_{t,q}] + \rho(L)r_{t-1} + \varepsilon_t \qquad (3.55)$$

$$\varepsilon_t \equiv -(1-\rho)\{\beta(\pi_{t,k} - \mathrm{E}[\pi_{t,k} / \eta_t] + \gamma(x_{t,q} - \mathrm{E}[x_{t,q} / \eta_t])\}$$

The information set in any variable is orthogonally related to the forecast error in a linear combination way.

In Equation 3.56 below, we let Z_t to represent a set of instrument variables exogenously determined when the monetary authority sets the interest rate. Therefore, the orthogonality condition is further presented in Equation 3.56 below:

$$\mathrm{E}\{[r_t - (1-\rho)(rr* - (\beta-1)\pi* + \beta\pi_{t,k} + \gamma x_{t,q}) + \rho(L)r_{t-1}]z_t\} = 0 \qquad (3.56)$$

Thus, the estimable forward-looking augmented monetary policy model is further given in Equation 3.57 below:

$$\begin{aligned} i_t = {} & (1-\rho)(k + \alpha\pi^*_{t+n}) + (1-\rho)\beta(\mathrm{E}_t[\pi_{t+n} - \pi^*_{t+n}]) + (1-\rho)\gamma(\mathrm{E}_t[y_{t+k} - y^*_{t+k}]) \\ & + (1-\rho)\phi(\mathrm{E}_t[z_{t+m}]) + \rho i_{t-1} + v_t \end{aligned} \qquad (3.57)$$

here the additional symbol z_{t+m} represents other variables such as the real money supply and real exchange rate that can also help in determining the process through which interest rate is determined in a given economy like Ghana and South Africa. This is considered in order to find out the function of other macroeconomic variables in determining the process through which interest rate is determined by the monetary authorities in the economies.

Equations 3.56 and 3.57 give the opportunity to estimate $(\alpha, \beta, \gamma, \rho)$ parameters using the Hansen (1982) GMM estimators while accounting for serial correlation in $\{\varepsilon_t\}$ using an optimal weighting matrix until the vector of instruments, z_t become greater than the number of the estimated parameters. This assessment is also done considering expected inflation as the most important measure compared to the lagged inflation. The rule also follows the same process in determining the process of setting interest rate and the way in which monetary policy becomes a nominal anchor in the economies.

Equation 3.57 is estimated to see if β and γ are significantly greater than 1 and 0 respectively. Additional parameter restriction is imposed to estimate inflation target π^* in order to characterised the monetary policy correctly in the model. Furthermore, the equilibrium real interest rate rr^* is derived as the average of the observed sample.

3.5.2.4 Diagnostic Test

The GMM estimation is subjected to the test of validity of the employed instruments and model specification as well. The moment condition of over-identification is assessed using an objective function via modified Sargan statistics (*J*-statistics). Hence, the model is evaluated using the *J*-statistics with the null hypothesis that the over-identifying restriction is fulfilled. None rejection of the null hypothesis at any conventional level of significance, indicates that the GMM estimators are asymptotically normally distributed and consistent (Hansen & Singleton, 1982).

3.5.3 Monetary Model of Exchange Rate Determination

The objective three of the study is estimated using the reduced form of the monetary model of exchange rate determination following Chin *et al*. (2007), Miyakoshi (2000) and Yuan (2011). The model is presented in Equation 3.58 below:

$$s_t = \beta_0 + \beta_1(\pi_t - \pi_t^*) + \beta_2(m_t - m_t^*) + \beta_3(y_t - y_t^*) + \beta_4(i_t - i_t^*) + \beta_5 PI_t \tag{3.58}$$

where s_t is the spot exchange rate in its nominal form, π_t, m_t, y_t and i_t represent domestic inflation, money supply, income and interest rate respectively whereas, π_t^*, m_t^*, y_t^* and i_t^* denote foreign inflation, money supply, income and interest rate respectively and PI represents the extension to include political instability in the model. The link between foreign exchange regime switching and exchange rate variability is explained by the OCA theory. Mundell (1961) argues that the OCA theory effectively operates and gains practical applicability in areas characterised by political instability. The theory postulates that a large amount of exchange rate volatility is influenced by the different regimes of exchange rate. This is in line with the Keynesian proposal on exchange rate policy and capital mobility (Ferrari-Filho & Paulo, 2008). The empirical counterpart of the economic model specified in Equation 3.58 above is presented in Equation 3.59 below:

$$s_t = \beta_0 + \beta_1(\pi_t - \pi_t^*) + \beta_2(m_t - m_t^*) + \beta_3(y_t - y_t^*) + \beta_4(r_t - r_t^*) + \beta_5 PI_t + \varepsilon_t \tag{3.59}$$

where s_t represents the domestic nominal exchange rate, β_0 is the long run constant term, π_t is the inflation rate in the domestic country, m_t is the money supply in the domestic country, y_t is the real domestic income, r_t represent interest rate in the domestic country, PI_t denotes political instability, whereas, the variables with asterisks represent the foreign variables in the model and ε_t is the error term. To determine the influence of regime switching while accounting for political instability, the study employs time varying transition probabilities Markov Switching ARCH model.

3.5.3.1 Time-varying Markov-Switching ARCH model

According to Edwards and Susmel (2000; 2001), the most appropriate model to estimate volatility of series such as interest rate and alike in emerging markets is the regime-switching model due to the failure of the standard GARCH model as a result of large shock occurrence in those economies. It has also been deduced that the existence of the regime shift or structural change largely distorts the estimated results of the standard ARCH/GARCH models and hence leads to spurious conclusions (Lamoreux & Lastrapes, 1990).

3.5.3.2 Justification for using Time-varying MS-ARCH Model

The justification for using time-varying Markov-Switching models over the other models is that the time-varying Markov Switching ARCH model is characterised by shifts or breaks in the parameters of the Autoregressive (AR) regressions, consider an observed characteristics of the given series and draw a probabilistic inference on regime changes. Furthermore, the model inherently captures turning point as a structural phenomenon in the data generating process with at most a turning point in a given interval (Hamilton, 1989). The model is also able to correctly track the behaviour of the economy and characterised by an appealing economic interpretation (Yuan, 2011). Moreover, the Markov-Switching model developed by Hamilton succeeded in modeling changes in regimes but performed less efficiently when variance movement is taking into account (Pagan & Schwert, 1990).

Therefore, following Yuan (2011) by combining the traditional Markov-Switching and ARCH model addresses the problem of capturing regime changes in the variance movement. It has been well established that the Markov-Switching ARCH model permits the possibility of unexpected changes in the parameters value and leads to a fewer persistent parameters in the ARCH process. The model also captures the conditional variance time variant effect. Furthermore, the model considers the possible instability in parameters of the exchange rate models as a result of changes in government policies and financial crisis among others (Yuan, 2011).

However, to avoid the path dependence problem on the conditional variance and for easy computation while maintaining the effectiveness of the ARCH modelling process, regime-switching phenomenon is examined using regime-switching ARCH model. In Yuan (2011) model, the state-dependence ARCH effect is considered on the conditional variance of both intercept and coefficient. Unlike in Cai (1994) where the regime switching is considered only in the intercept, the model also enjoys the dynamics of exchange rate transitional evolution in which changes are observed in the transitional probabilities over time.

3.5.3.3 Estimation Procedure of Time Varying MS-ARCH Model

Following Yuan (2011) to investigate the influence of changes in regime on the volatility of exchange rate in Gambia, Ghana, Nigeria and South Africa, the following equation (Equation 3.60) is estimated.

$$y_t = x_t\beta + \varepsilon_t \tag{3.60}$$

$$(\varepsilon_t \mid \varepsilon_{t-1}, \varepsilon_{t-2}, ...) \sim N(0, h) \tag{3.61}$$

where y_t represents the exchange rate, x_t is a vector of exogenous variables which include the differences between domestic and foreign inflation rate, interest rate, income, money supply and political instability; ε_t here is referred to as a random error term. To allow for regime switching in parameters in order to capture the existing instability of exchange rate as a result of changes in exchange rate regimes, the following Equations (3.62 – 3.64) are specified.

$$y_t = \mu_{s_t} + \mu_t \tag{3.62}$$

$$\mu_t = \delta_t \varepsilon_t, \ \ \varepsilon_t \sim N(0,1) \tag{3.63}$$

$$\sigma_t^2 = \alpha_{s_t} + \sum_{j=1}^{q} \beta_{j,s_t} \mu_{t-j}^2 + \xi . d_{t-1} . \mu_{t-1} \tag{3.64}$$

where the symbol S_t is categorised into 2 (1, 2) which denotes a latent variable in the model to account for changes in regime in the exchange rate data generating process, $d_{t-1} = 0$ if $x_{t-1} > 0$ and $d_{t-1} = 0$ if $x_{t-1} < 0$ and the underlying μ_t is to be multiplied by s_t if the process is characterised by $s_t = 1$ regime and $s_t = 2$ when the process is in regime two. When asymmetric effect exists in the model $(\xi \neq 0)$ whereas, $\xi = 0$ if there is no asymmetric effect in the model. The assumption is that the latent variable s_t follows the transitional probabilities time-varying first order Markov process such that:

$$P(S_t = j \mid S_{t-1} = i) = P_t^{ij}(Z_{t-1}) \tag{3.65}$$

where P_t^{ij} is a $k \times 1$ function of Z_{t-1} which comprises of an intercept, the lag exchange rate y_{t-1} and d_{t-1} the deviation of exchange rate from its equilibrium, that is, the difference between domestic and foreign inflation, interest rate, income, money supply and the domestic political instability and $\Sigma_j p_t^{ij} = 1 \forall i, j \in \{1, 2\}$ the observed information. The transition probabilities matrix Z_{t-1} is further assumed to evolve as:

$$P_t = \begin{pmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{pmatrix}$$

In which

$$P_{11} = \frac{\exp(a \times z'_{t-1})}{1 + \exp(a \times z'_{t-1})}, \quad P_{12} = \frac{1}{1 + \exp(a \times z'_{t-1})}$$

$$P_{21} = \frac{1}{1 + \exp(b \times z'_{t-1})}, \quad P_{22} = \frac{\exp(b \times z'_{t-1})}{1 + \exp(b \times z'_{t-1})}$$

here $z_t = (1, y_t, d_t)'$ where 1 represents constant term, y_t denotes exchange rate and $d_t = e_t - f_t$ where e_t and f_t are the exchange rate fundamental value determined by the macroeconomic variables in the model. From Equations 3.62 through 3.65 the sample likelihood function is given as shown below:

$$L(\theta; Y_T) = \prod_{t=1}^{T} f(y_t \mid Z_{t-1}; \theta) \qquad (3.66)$$

The symbol θ represents the model parameters vector denoted as $(\mu', \alpha', \beta', a', b, \rho)'$, where Y_t is assumed to be $(y_{t,}; ..., y_{t-1}, y_1)'$ and $Z_{t-1} = (z'_{t-1}, z'_{t-2}, ..., z'_0)'$ representing vector of observed series through time t and $S_t = (s_t, s_{t-1}, ..., s_1)'$ represents a historical regime variable realization through date t. The symbol μ is the exchange rate mean changes given as $(\mu_1, \mu_2)'$, $\alpha = (\alpha_1, \alpha_2)'$ is the ARCH model intercept parameters, $\beta = (\beta_1, \beta_2)'$ denotes the coefficients of the ARCH model. The parameters of the transition probabilities are represented by a and b and the parameter ρ or

$\rho = \rho(S_0 = 1;, b)$ represent unconditional probability in regime one from the onset. Therefore,

$$f(y_t \mid Z_{t-1};\theta) = \sum_i^2 \sum_j^2 f(y_t, s_t = j, s_{t-1} = | Z_{t-1};\tau)$$

$$= \sum_i^2 \sum_j^2 f(y_t, s_t = j, s_{t-1} = i \mid Z_{t-1};\theta).\rho(s_t = j, s_{t-1} = i \mid Z_{t-1};\theta) \tag{3.67}$$

Using the unconditional probability earlier specified, the weighted probability is obtained through Bayes' rule as presented in Equation 3.68 below:

$$P(s_t = j, s_{t-1} = i \mid Z_{t-1};\theta) = P_t^{ij} P(s_{t-1} = i \mid Z_{t-1};\theta) \tag{3.68}$$

Then, $$P(s_t = j \mid Z_t : \theta) = \frac{\Sigma_i f(y_t \mid s_t = j, s_{t-1} = i, Z_{t-1}, \theta).p(s_t = j, s_{t-1} = i \mid Z_{t-1};\theta)}{f(y_t \mid z_{t-1};\theta)} \tag{3.69}$$

The y_t conditional density on both s_t and s_{t-1} is given as:

$$f(y_t \mid s_t = j, s_{t-1} = i, Z_{t-1};\theta) = \frac{1}{\sqrt{2\pi\sigma_t}} \exp\left(\frac{-(y_t - \mu_j)^2}{2\sigma_t^2}\right) \tag{3.70}$$

where

$$\sigma_t^2 = \alpha_1 + \beta_1(y_{t-1} - \mu_1)^2 \text{ for } s_t = 1, \quad s_{t-1} = 1$$

$$\sigma_t^2 = \alpha_2 + \beta_2(y_{t-1} - \mu_1)^2 \text{ for } s_t = 2, \quad s_{t-1} = 1$$

$$\sigma_t^2 = \alpha_1 + \beta_1(y_{t-1} - \mu_2)^2 \text{ for } s_t = 1, \quad s_{t-1} = 2$$

$$\sigma_t^2 = \alpha_2 + \beta_2(y_{t-1} - \mu_2)^2 \text{ for } s_t = 2, \quad s_{t-1} = 2$$

Due to the difficulty in summing the k values of $(s_1, s_2, ..., s_T)$ to unity. The Hamilton (1990) expectation-maximization algorithm is used to arrive at the maximum likelihood estimates. The parameters of the maximum likelihood estimate given

$P(s_t = j, s_{t-1} = i | Y_t, Z_{t-1}; \theta)$ $t = 2,3,...,T$ smooth regime probabilities based on the whole sample. The first order condition of the parameters, μ, α, and β is estimated by differentiating the likelihood function.

$$\mu_k = \sum_{t=2}^{T} \left\{ \hat{\xi}_{t/T}^{ij} . \sum_{i}^{2} \sum_{i}^{2} \left(\frac{\partial H_t^{ij}}{\partial \mu_k} + \frac{\partial H_L^{ij}}{\partial \mu_k} \right) \right\} = 0$$

$$\alpha_k = \sum_{t=2}^{T} \left\{ \hat{\xi}_{t/T}^{ij} . \sum_{i}^{2} \sum_{i}^{2} \left(\frac{\partial H_t^{ij}}{\partial \alpha_k} + \frac{\partial L_t^{ij}}{\partial \alpha_k} \right) \right\} = 0$$

$$\beta_k : \sum_{t=2}^{T} \left\{ \hat{\xi}_{t/T}^{ij} . \sum_{i}^{2} \sum_{i}^{2} \left(\frac{\partial H_t^{ij}}{\partial \beta_k} + \frac{\partial L_t^{ij}}{\partial \beta_k} \right) \right\} = 0$$

where $k = 1, 2$ and $\hat{\xi}_{t/T}^{ij} = P(s_t = j, s_{t-1} = i | Z_{t-1}; \theta)$

$$H_t^{ij} = -\log(\alpha_i + \beta_1 (y_{t-1} - \mu_j)^2)$$

$$L_t^{ij} = -\frac{(y_{t-1} - \mu_i)^2}{\alpha_i + \beta_i (y_{t-1} - \mu_j)^2}$$

Hence, the a and b parameters first order condition given $i = 1, 2$ are given below as:

$$a : \sum_{t=2}^{T} Z_{t-1} \left\{ \hat{\xi}_{t/T}^{11} - p_t^{11} . \xi_{t-1/T}^{1} \right\} = 0$$

$$b : \sum_{t=2}^{T} Z_{t-1} \left\{ \hat{\xi}_{t/T}^{22} - p_t^{22} . \xi_{t-1/T}^{2} \right\} = 0$$

where $\xi_{t-1/T}^{2} = p(s_{t-1} = i | Y_T, z_{T-1}; \theta)$

Therefore, the initial unconditional probability p, first order condition for $i = 1, 2$ is given as:

$$\rho = p(s_t = 1 | Y_T, z_{T-1} : \theta) \tag{3.71}$$

3.5.3.4 Diagnostic Test for Markov-Switching ARCH Model

To ensure the appropriateness of the estimates in the time-varying transition probabilities Markov-Switching ARCH specification model, the test for data characterisation is conducted. The important diagnostic checks associated with the model include testing for regime switching in the ARCH process, the usual test for the ARCH effect and the exogenous variables transition effect in the model (Yuan, 2011).

3.5.3.4.1 Test for Regime Switching in the ARCH Process

This is to test whether the data is given by a single regime or multiple regimes. The null hypothesis is that the data is characterized by a single regime and unidentified Markov-Switching transition probabilities process. This is tested on the intercept of the model and the coefficient of the ARCH process.

$$\alpha_1 = \alpha_2, \beta_1 = \beta_2$$

The decision rule is that the rejection of the hypothesis indicates the existence of two regimes in both the constant and conditional variance of the model.

3.5.3.4.2 Test for ARCH Effect

In this type of models, the mean and variance are assumed to be regime dependent although constant in each regime over time. Therefore, the null of no ARCH effect in the series of exchange rate is tested on:

$$\beta_1 = \beta_2 = 0$$

The rejection of the above hypothesis indicates the existence of the ARCH effect in the specified model.

3.5.3.4.3 Test for Transitional Effect

A test of transitional effect on the exogenous variables which comprise the net inflation rate, interest rate, money supply, income, and the domestic political instability is conducted to check the transitional effect of the macroeconomic determinants of the exchange rate volatility. The null hypothesis of static transition probabilities, non-varying Markov-Switching ARCH model is tested as specified below:

$$a = 0, b = 0$$

Significant probability values of the chi-square test favour the alternative hypothesis of the time-varying Markov-Switching autoregressive conditional heteroscedastic model.

3.5.4 Exchange Rate Fundamentals Model

The fourth objective of the study is achieved using the reduced form of the monetary model of exchange rate fundamentals. The model is presented by Equation 3.72 following Chin *et al*. (2007), Frenkel (1976) and Miyakoshi (2000).

$$s_t = \gamma_0 + \gamma_1(\pi_t - \pi_t^*) + \gamma_2(m_t - m_t^*) + \gamma_3(y_t - y_t^*) + \gamma_4(i_t - i_t^*) \quad (3.72)$$

where s_t is the nominal exchange rate, π_t, m_t, y_t and i_t represent domestic inflation, money supply, income and interest rate respectively whereas, whereas, π_t^*, m_t^*, y_t^* and i_t^* denote foreign inflation, money supply, income and interest rate respectively. The Equation 3.72 is estimated using the asymptotic Granger (1969) causality, Toda-Yamamoto (1996) causality approach and Hacker and Hatemi-J (2006) leverage bootstrapping as well as asymmetric causality in order to provide a comparative analysis on the causal relationship among the variables of the exchange rate fundamental model.

3.5.4.1 Toda-Yamamoto Causality and Leverage Bootstrapping

The concept of causality has gained a considerable debate in the literature. It means and assumes different things to different researchers. The term is being defined variously by different philosophers from both science and social science perspectives (Granger, 1980). Causality in this context refers to the degree to which one variable scientifically influenced changes in another variable. This is usually observed by determining the influence of previous values of a variable on another. However, an instantaneous causality only occurs as a result of slow information generating process and due to omission of important causal variable in the model (Granger, 1969).

According to Granger (1969, 1980) causal relationship is established based on the assumptions that; the present and past phenomenon can influence and cause future occurrences, but the past events cannot be caused by future events; the multivariate stochastic variables are not associated with superfluous information; constant causal relationship exist throughout the period; linearity of predictors exist among the variable and that only stationary variables are included in the model.

The significance of investigating the causal relationship between variables is that it helps to prevent decision-making based on uncertainty. The knowledge of the causal effect will enable appropriate policy prescription and recommendation. It serves as an input for an experiment that leads to a good decision-making. It is also believed that the direction of causality enhances forecasting process (Hacker & Hatemi-J, 2006).

3.5.4.2 Justification for using Toda-Yamamoto Causality Approach

The traditional Granger causality test was developed based on asymptotic distribution theory which is seen to results to a spurious conclusion especially when variables are cointegrated (Granger & Newbold, 1974). Most at times, the method of modeling causality in the traditional sense were found to have overlooked some elements of the forecasting which lead to invalid results of non-causality in the presence of causation. This implies that in some cases causality exists but spuriously not found due to the inefficiency of the employed techniques (Granger, 1988). Most of the causality tests in the past were conducted on the vector error correction models, cointegration as well as simple vector autoregressive framework which all suffer from size distortion and nuisance parameters in the estimates (Guru-Gharana, 2012).

Another limitation of the Granger causality is that the null hypothesis at level estimation suffers from non-standard asymptotic distribution whereas, the integrated Granger causality suffers from independence of nuisance parameter estimates (Sims *et al*, 1990 and Toda & Philips, 1993). Furthermore, most previous studies were carried out based on bivariate model without controlling for possible explanatory variables which may also lead to a different result. The advantage of estimating multivariate model is highlighted in Stock and Watson (2001).

Moreover, vector error correction model's hypothesis of Granger non-causality employs nonlinear parameter restriction matrices. The Wald and likelihood ratio test statistics for Granger test are associated with rank deficiency which leads to size distortion under the null hypothesis (Toda & Philips, 1993). The Granger method also mandates testing for stationarity and cointegration process which are less relevant if the objective of the study is to find a causal relationship between variables (Hacker &

Hatemi-J, 2006). Finally, the traditional Granger causality test loses it powers when structural changes exist between the post sample and actual sample (Granger, 1980).

3.5.4.3 Toda-Yamamoto Causality Model

The prevailing shortcomings of the traditional causality model motivates Toda and Yamamoto (1995) to develop a modified Wald test statistics based on augmented vector autoregressive (VAR) framework that applies the asymptotic chi-square distribution to solve the difficulties encountered in the asymptotic Granger causality test. Their approach is applicable irrespective of whether the series are stationary at level *I*(0), integrated of arbitrary order or arbitrarily co-integrated. The procedure can also test for coefficient linearity and non-linearity restriction through Wald criterion application on estimated level VAR (Hacker & Hatemi-J, 2006).

3.5.4.4 Estimation Procedure of Toda-Yamamoto Causality Model

Toda and Yamamoto (1995) proposed an augmented VAR ($p + d_{max}$) framework that can be employed to test causality among variables of the model depicted in Equation 3.72. The use of this model is based on the argument that causality should be tested within the jurisdiction of an acceptable theory. It simply assists in determining the appropriate variables to be tested in the model. This helps in capturing the required information on causality (Zellner, 1978 and Granger, 1980). Furthermore, including control variables in the test of causality may lead to the presence of causality between variables under investigations. In other words, causality might not be found in the absence of control variables (Granger, 1980). From the model of the monetary theory of exchange rate determination presented in 3.72, the augmented VAR $(p + d)$ model is specified in Equation 3.73 below:

$$y_t = \hat{v} + \hat{A}_1 y_{t-1} + ... + \hat{A}_p y_{t-p} + ... + \hat{A}_{p+d} y_{t-p-d} + \hat{\varepsilon}_t \quad (3.73)$$

The p order of the VAR model is considered to be known, whereas d is the highest integration order of the variables in the model, the circumflex represent estimated variables using ordinary least squares (OLS). The j^{th} element of y_t is not influenced by the k^{th} element unless the restricted hypothesis formulated under Equation 3.76 is rejected. The Wald test statistics of Toda-Yamamoto (1995) causality is asymptotically distributed regardless of the series co-integration level, co-integrated or not (Toda & Yamamoto, 1995). The model in its general form is presented in Equation 3.74 below:

$$y_t = \beta_0 + \beta_1 t + ... + \beta_q t^q + \eta_t \quad (3.74)$$

η_t is k^{th}-order of the VAR process which is further defined as $I(d)$ and possibly $CI(d,b)$.

$$\eta_t = J_1 \eta_{t-1} + ... + J_k \eta_{t-k} + \varepsilon_t \quad (3.75)$$

where k in Equation 3.75 represents a known lag length to be employed in the estimation process. Therefore,

$$y_t = \gamma_0 + \gamma_1 t + ... + \gamma_q t^q + j_1 y_{t-1} + ... + j_k y_{t-k} + \varepsilon_t \quad (3.76)$$

The restricted hypothesis is formulated as:

$$H_0 : f(j) = 0$$

The estimated version of the equation on which the hypothesis is tested is given by Equation 3.77.

$$y_t = \hat{\gamma}_0 + \hat{\gamma}_1 t + ... + \hat{\gamma}_q t^q + \hat{j}_1 y_{t-1} + ... + \hat{j}_k y_{t-k} + \hat{j}_p y_{t-p} + \hat{\varepsilon}_t \quad (3.77)$$

Equation 3.77 is further reduced as presented in Equation 3.78 below:

$$y_t = \hat{\Gamma} \tau_1 + \hat{\phi} x_t + \hat{\Psi} z_t + \hat{\varepsilon}_t \quad (3.78)$$

where

$\hat{\Gamma} = (\gamma_0, ...\gamma_q)$, $\Psi = (\hat{j}_{k+1}, ..., \hat{j}_p)$, $\tau_1 = (1, t, ..., t^q)$, $x_t = (y'_{t-1}, ..., y'_{t-k})'$, $z_t = (y'_{t-k-1}, ..., y'_{t-p})'$ or can be represented in a matrix form as shown in Equation 3.79.

$$\begin{bmatrix} EXC_t \\ INF_t \\ MSS_t \\ INC_t \\ INT_t \end{bmatrix} = \begin{bmatrix} a_0^{EXC} \\ a_0^{INF} \\ a_0^{MSS} \\ a_0^{INC} \\ a_0^{INT} \end{bmatrix} + \begin{bmatrix} a_{11} a_{12} a_{13} a_{14} a_{15} \\ a_{21} a_{22} a_{23} a_{24} a_{25} \\ a_{31} a_{32} a_{33} a_{34} a_{35} \\ a_{41} a_{42} a_{43} a_{44} a_{45} \\ a_{51} a_{52} a_{53} a_{54} a_{55} \end{bmatrix} \begin{bmatrix} EXC_{t-1} \\ INF_{t-1} \\ MSS_{t-1} \\ INC_{t-1} \\ INT_{t-1} \end{bmatrix} + \dots$$

$$+ \begin{bmatrix} a_{11} a_{12} a_{13} a_{14} a_{15} \\ a_{21} a_{22} a_{23} a_{24} a_{25} \\ a_{31} a_{32} a_{33} a_{34} a_{35} \\ a_{41} a_{42} a_{43} a_{44} a_{45} \\ a_{51} a_{52} a_{53} a_{54} a_{55} \end{bmatrix} \begin{bmatrix} EXC_{t-n} \\ INF_{t-n} \\ MSS_{t-n} \\ INC_{t-n} \\ INT_{t-n} \end{bmatrix} + \begin{bmatrix} \varepsilon_{EXC_t} \\ \varepsilon_{INF_t} \\ \varepsilon_{MSS_t} \\ \varepsilon_{INC_t} \\ \varepsilon_{INT_t} \end{bmatrix} \quad (3.79)$$

where *EXC* represents nominal exchange rate, *INF, MSS, INC* and *INT* denote net inflation rate, money supply, income and interest rate respectively. To test the null hypothesis of whether inflation causes exchange rate or not, the following restriction is specified H_0 $a_{12}^{(1)} =, ..., = a_{12}^{(n)} = 0$ where $a_{12}^{(i)}$ are the coefficients of the lag values of inflation rate for $1, ..., n^{\text{th}}$ lags in the model except the unrestricted lag denoted as $d_{\max}$. Similarly, all the other hypotheses follow the same process. The significance of the modified wald (MWALD) statistics of the restricted lagged values of the explanatory variables indicates the rejection of the null hypothesis of no Granger causality.

3.5.4.5 Hatemi-J Asymmetric Causality

Following Hatemi-J (2012) to check the asymmetric causality, the above process is replicated, assuming $y^{+} = (y_{1t}^{+}, y_{2t}^{+})$ and $y^{-} = (y_{1t}^{-}, y_{2t}^{-})$. The following VAR($p$) order is applied as shown in Equations 3.80 and 3.81 respectively.

$$y_t^{+} = \varphi + B_1 y_{t-1}^{+} + ... + B_p y_{t-1}^{+} + e_t^{+} \tag{3.80}$$

$$y_t^{-} = \varphi + B_1 y_{t-1}^{-} + ... + B_p y_{t-1}^{-} + e_t^{-} \tag{3.81}$$

where y_t^{+} and y_t^{-} represent vectors of positive and negative variables (exchange rate, differential inflation rate, money supply, income, and interest rate), φ is a vector of constant parameters. The symbol *B* is a vector of the estimated parameters and e_t^{+} and e_t^{-} denote the vectors of both positive and negative error components for the cumulative sum of positive and negative shocks respectively in the integrated variables analysis and positive and negative changes in the stationary variables. The information criteria in Equation 3.82 is also adjusted to include the square of the number of the variables *n* in the VAR model (Hatemi-J, 2012). The remaining process is as presented in the previous and subsequent sections while taking into account the asymmetric condition of positive and negative shocks in the model.

The emphasised procedure in the lag selection criteria is that the order of the integration should not be above the actual lag length (k), although the order can exceed the lag length if the series are cointegrated. Correct lag length are chosen through testing the significance of the lag lengths in Equation 3.82 for $p > k$ condition (Toda & Yamamoto, 1995) and minimizing the Hatemi-J (2003) information criterion described in Equation 3.82 underneath.

$$HJC = \ell n(|\hat{\Omega}_z|) + z\left(\frac{v^2 \ell nN + 2v^2 \ell n(\ell nN)}{2N}\right) \quad z = 0, \ldots, p. \tag{3.82}$$

where HJC is Hatemi-J information criterion, ℓn is the natural logarithm, $|\hat{\Omega}_z|$ is the lag order of z determinant of the estimated white noise variance-covariance matrix in the VAR framework, v and N denote the number of variables and observations used in the VAR model respectively. Furthermore, Equation 3.80 works better especially if the integration exist among the variables (Hatemi-J, 2003).

3.5.4.6 Justification for using Modified Leverage Bootstrapping

The methodology of Hacker and Hatemi-J (2006, 2010) use two-dimensional VAR of order two to examine the size properties of the modified Wald statistics of Toda and Yamamoto (1995) model. They discover that when normality assumption is not met, and the effect of autoregressive conditional heteroscedasticity exist, the usual asymptotic distribution theory does not work well regardless of the sample size. However, these are found less severe when leverage bootstrap distribution theory is employed (Hatemi-J & Irandoust, 2006).

Furthermore, argument was advanced by Sims, *et al*. (1990) against the application of asymptotic distribution theory on the VAR model to test for causality among level and integrated variables even if they are cointegrated. It leads to size distortion under small sample size (Hacker & Hatemi-J, 2006). Nevertheless, bootstrapped distribution is considered more reliable than asymptotic distribution in a finite sample study in order to avoid size distortion and spurious inferences (Hacker & Hatemi-J, 2010). This was first suggested by Efron (1979) who furnishes more reliable critical values especially for small sample analysis. Moreover, the modified Wald statistics reveals a better result and less size distortion irrespective of whether large or small size is employed.

3.5.4.7 Hacker and Hatemi-J Modified Leverage Bootstrap Model

Hacker and Hatemi-J (2006, 2010) examines the size properties of the modified Wald statistics of Toda and Yamamoto (1995) causality model based on Equation 3.83 below:

$$y_t = v + Ay_{t-1} + By_{t-2} + \varepsilon_t \tag{3.83}$$

$$y_{it}, i = 1, 2, \text{ and } y_t = (y_{1t}, y_{2t})$$

where *A* and *B* are restricted to be diagonal matrices in which a variable is determined by its lag values alone without considering the lag values of the other variables. For every variable y_{it} in y_t the following equation (3.84) is deduced.

$$y_{it} = v_i + (a_{ii} + b_{ii})y_{it-1} - (a_{ii}b_{ii})y_{it-2} + \varepsilon_{it} \tag{3.84}$$

From Equation 3.84 above, the following parameter matrices can be outline for A and B restricted diagonal matrices.

$$A = \begin{pmatrix} a_{11}b_{11} & 0 \\ 0 & a_{22}b_{22} \end{pmatrix} \text{ and}$$

$$B = \begin{pmatrix} -a_{11}b_{11} & 0 \\ 0 & -a_{22}b_{22} \end{pmatrix}$$

If it happens that all variables in the model are integrated of *I*(1), *I*(0) or mutually integrated, VAR(1) model will be utilized. Whereas, if both variables are *I*(2), *I*(1), *I*(0) or mutually integrated, VAR(2) model will then be applied. From Equation 3.73, y_{it} is integrated of order one if $b_{ii} = 0$ and $|a_{ii}| = 1$ and y_{it} is *I*(0) if $|a_{ii}| < 1$.

Hacker and Hatemi-J (2006) independently drew each error term from standard normal distribution for the simulation process. The simulation is conducted taking into account high volatility period in the data generating process to examine the degree of responsiveness of causality test under the prevalence of ARCH effect. This is carried out when variance of the nuisance parameter is explained by the autoregressive conditional heteroscedasticity process.

$$\varepsilon_{it} = w_{it} \times \left[\alpha_i + \gamma_i \varepsilon_{it-1}^2\right]^{1/2}, \; i = 1, 2$$

where w_{it} is the standard normal variable, α_i and γ_i are all constant. This leads to a conditional mean of ε_{it}, $E\left[\varepsilon_{it} \mid \varepsilon_{it-1}\right] = 0$ and a conditional variance of ε_{it} as:

$$Var\left[\varepsilon_{it} \mid \varepsilon_{it-1}\right] = E\left[\varepsilon_{it}^2 \mid \varepsilon_{it-1}\right]$$

$$= E\left[w_{it}^2\right] \times \left[\alpha_i \mid \gamma_1 \varepsilon_{t-1}^2\right]$$

$$= \alpha_i \mid \gamma_1 \varepsilon_{t-1}^2$$

As a result of this, ε_{it} is heteroscedastic conditional on ε_{it-1}. However, the unconditional variance of ε_{it} is given as $Var\left[\varepsilon_{it}\right] = Var\left[\varepsilon_{it-1}\right] = \dfrac{\alpha_i}{1-\gamma_i}$ Therefore, in the final note, Hacker and Hatemi-J (2006, 2010) employ Equation 3.85 to capture ARCH effect in their simulation process.

$$Var\left[\varepsilon_{it} \mid \varepsilon_{it-1}\right] = (1-\gamma_1) + \gamma_1 \varepsilon_{it-1}^2 \tag{3.85}$$

3.5.4.8 Estimation Procedure for Leverage Bootstrapping

The leverage bootstrap critical values are generated with GAUSS using the program procedure developed by Hacker and Hatemi-J (2010). Therefore, following Hacker and Hatemi-J (2006) the leverage bootstrap simulation is conducted in the following procedure. Equation 3.78 is estimated with restriction of no Granger causality, and simulated data is generated for every bootstrap simulation as shown in Equation 3.86 below:

$$y_t^* = \hat{\Gamma}\tau_t + \hat{\phi}x_t + \hat{\psi}z_t + \varepsilon_t^* \tag{3.86}$$

where the bootstrap residuals ε_t^* are estimated on the basis of N random draws with replacement from Equation 3.85 modified residuals with identical probability of $1/N$ in each case. To set the bootstrapped residuals mean value equals zero, the mean value of the modified residuals is deducted from each modified set of residuals. Leverage adjustment is employed to adjust the raw residuals of the regression to arrive at constant variance. Hacker and Hatemi-J (2006) define leverage adjustment for multivariate functions such as y_{it} as follows:

$$\varepsilon_{it}^m = \frac{\varepsilon_{it}}{\sqrt{1-h_{it}}}, \tag{3.87}$$

here ε_{it}^m is the ordinary residuals obtained from the $y_{it} = (i = 1, 2, 3, ..., 4)$, regression. h_{it} is h_i, t^{th} element defined as h_i = diagonal$\left(Y_1 (Y_1'Y_1)^{-1} Y_1'\right)$ and h_j = diagonal$\left(Y (Y_1'Y_1)^{-1} Y'\right)$ for $i = 1, 2, 3, ..., 4$ and $j = i - 1$. Where Y_t is a regression matrix of independent variables that determine y_{it} with no Granger causality restriction and Y is a set of the regression matrix of regressors that explain y_{jt} including the lags of all variables in the estimation. This scenario prevails when testing the null hypothesis of no Granger causality from y_{jt} to y_{it} and vice versa.

In this study, the critical values are generated based on the underlying empirical data through bootstrap simulation. The iteration is conducted 10,000 times and MWALD *t*-statistics are estimated after every iteration to determine the upper quartile of the bootstrapped distribution of the MWALD *t*-statistics in order to generate 1%, 5% and 10% bootstrapped critical values. Finally, the raw data rather than the bootstrapped one is utilized to calculate the MWALD statistics. The hypothesis of no Granger causality is rejected if the MWALD statistics calculated using the original data is greater than the bootstrapped critical values.

3.6 Sources of Data

The data for the purpose of this study are collected on four sub-Saharan African countries of Gambia, Ghana, Nigeria and South Africa. The data on real effective and nominal exchange rate, the inflation rate, interest rate, money supply and income are obtained from the World Development Indicators (WDIs) of the World Bank and International Financial Statistics (IFS) of the International Monetary Funds (IMF). The start date of inflation targeting is obtained from the IFS and the various central banks of the countries under study. The variable inflation targeting is captured as a dummy variable and a construct using Hodrick Prescott filter and assigned zero for the sample period prior to the implementation of inflation targeting and one for the period after the announcement for the dummy variable. The data on political instability for the four countries are collected from the database of the International Country Risk Guide (ICRG).

The annual series from 1979 to 2015 are interpolated into quarterly data using the interpolation method proposed by Gandolfo (1981). The advantage of using Gandolfo

(1981) over the other methods of interpolation is that the total of the four quarters in the method gives an accurate, exact annual series without changing the actual value of the variable. The use of Gandolfo (1981) technique is widely applied in the empirical literature. The application of the technique is found, for example in; Baharumshah, Lau and Khalid (2006); Tang (2008) among others. Moreover, the estimates of the linear interpolated series based on Monte Carlo simulation are found by Smith (1998) in Tang (2008) to be non-bias especially in the analysis of cointegration, even in the presence of small sample size. The following formulas are used in the interpolation process.

First quarter $$y_t = 0.0546875y_{t-1} + 0.234375y_t - 0.0390625y_{t+1} \quad (3.88)$$

Second quarter $$y_t = 0.0078125y_{t-1} + 0.265625y_t - 0.0234375y_{t+1} \quad (3.89)$$

Third quarter $$y_t = -0.0234375y_{t-1} + 0.265625y_t + 0.0078125y_{t+1} \quad (3.90)$$

Fourth quarter $$y_t = -0.0390625y_{t-1} + 0.234375y_t + 0.0546875y_{t+1} \quad (3.91)$$

where y_t is the series under the interpolation, y_{t-1} is the lag variable while y_{t+1} is the lead variable in the process. The original 36 years annual data are interpolated into 140 quarterly series from 1980:Q1 to 2014:Q4.

3.7 Operational Justification of Variables

The first previous section of this chapter established the link between the dependent variables and the explanatory variables of the study. Thus, this section briefly describes the measurement and hypothesised the operational justification of the variables based on the theoretical framework and empirical literature review. In addition to the measurement described below, all differential variables such as the macroeconomic fundamentals (money supply, inflation, interest rate and income) related to the monetary theory of exchange rate determination are derived by deducting the foreign equivalent variables from the domestic variables (Chin *et al*, 2007 and Frenkel, 1976).

3.7.1 Exchange Rate/Exchange Rate Volatility

Exchange rate is the value of local currency in terms of international currencies (Muktadir-al-Mukit, 2013). It represents a unit of foreign currency in the domestic unit of price (Kamal Uddin, 2014 and Mishkin, 2007). However, exchange rate volatility is defined as the degree of uncertainty regarding the size of changes in the value of domestic currency or rather the liability of the domestic currency to fluctuate relative to the basket of foreign currencies (Nnamdi & Ifionu, 2013). Following Arize and Malindretos (1998); Emenike (2010) and Ndako (2012) among others, the volatility of exchange rate is measured in this study using the widely employed method from the family of Autoregressive Conditional Heteroskedasticity (ARCH) models (Bahmani-Oskoosee & Hegety, 2007).

The variable serves a dual purpose: a dependent variable in objective one and three where it is measured as volatility of exchange rate and as a nominal exchange rate in objective two of the study. In the former the exchange rate volatility is expected to be influenced positively by money supply, inflation and interest rate based on the Frenkel hypothesis and negatively influenced by real income, and interest rate based on Dornbusch analysis (Arabi, 2012; Chinn, 2012; Cookey, 2007 and Edwards, 2007). Furthermore, the exchange rate in objective two represents the market expectation of the policy rule (Chinn, 2012). Here it is hypothesised to be positively related to the policy rule of inflation targeting/interest rate (Engel & West, 2005; Felipe, 2009).

3.7.2 Inflation Targeting

Inflation targeting is a framework of monetary policy with well-defined target inflation range or point supported with strong institutional arrangement to achieve the target via an optimal degree of accountability and transparency (Miao, 2009). It is a central bank neoliberal approach that keeps inflation and other macroeconomic variables at a low rate, reduces the support of government deficit by the central bank through the interaction of interest rate and money supply to regulate other macroeconomic variables (Odusola & Onwioduokit, 2005). It is measured using Hodrick-Prescott filter and or the use of dummy representing one for the target period and zero otherwise.

The use of dummy to account for policy shock effect has been used in number of studies such as Aggarwal, Inclan & Leal (1999) and Hamilton and Susmel (1994) out of many studies. Some authors argue that inflation targeting is positively related to exchange rate volatility (Rose, 2007; Miao, 2009 and Berganza & Broto, 2012). However, if the pursuance of the inflation targeting proves to be a hedging strategy for the volatility of exchange rate, then its coefficient is presumed to be negative and significant. This is also advocated by Allsop *et al.* (2006); Josifidis *et al.* (2011) and Khodeir (2012). The assumption is that the policy is predictable and transparent or a framework that mitigates the effect of sudden shocks or news in the market (Edwards, 2007). Furthermore, raising interest rate to restore inflation to its target level also leads to appreciation of domestic currency and stable exchange rate.

3.7.3 Exchange Rate Regime Switching

According to Rose (2011) exchange rate regime switching is the movement in the government set of exchange rate policies from one established exchange rate management style to another. This might be deliberate by the government or as a result of the interaction of the market forces. It has been argued that exchange rate instability highly relates to floating regime due to the changes in the external reserve of the domestic currency (Levy-Yeyati, 2011). Following Yuan (2011), the effect of exchange rate regime switching in this study will be observed endogenously using the time-varying transition probabilities of the Markov-switching ARCH model. This will account for the effect of the regime shift in the stability of exchange rate. Scholars suggest that the regime switching might be one of the alternative specification that can better explain exchange rate disequilibrium (Boutchkova *et al.*, 2012; Chau *et al.*, 2014 and Flood & Rose, 1999). Even though conflicting results have been reported, it is hypothesised that unstructured sudden changes in the exchange rate management will positively affect the stability of exchange rate (Fiess & Chankar, 2009; Walid *et al*, 2011 and Wang & Moore, 2009).

3.7.4 Political Risk

This variable is constructed and defined by the Political Risk Guide (PRG) (2015) as a means of evaluating the political certainty of a given country in terms of every government stability component. These include military presence in politics, socio-economic condition, corruption, investment profile, religious tension, internal and external conflicts, bureaucratic quality, ethnic tensions, law and order and democratic accountability. The Optimum Currency Areas (OCA) theory advocates that exchange rate instability is influenced by political unrest due to frequent changes in regime motivated by the government instability (Cukierman, 1992 and Edwards, 1996). Furthermore, Levy-Yeyati *et al.* (2010) argue that political instability is another factor that tends to affect the equilibrium exchange rate. Therefore, in politically unstable countries of sub-Saharan Africa exchange rate stability is alleged to be affected by the level of political risk (Edwards, 1996 and Eichengreen *et al.*, 1995). However, the degree of the effect will depend on the powerfulness of the countries' macroeconomic fundamentals and level of external reserves (Bussiere & Mulder, 1999 and Klein & Marion, 1997).

3.7.5 Inflation Deviation

Inflation deviation is the difference between the actual inflation and the target inflation. The target inflation in this study is constructed using both linear and quadratic Hodrick-Prescott filtering developed by Hodrick and Prescott (1997). It is the most commonly employed method in the literature in de-trending stochastic series (Clarida, Gali & Gertler, 2000 and Torres, 2003). Taylor (1993) argues that an increase in inflation as a result of the increase in the aggregate demand leads to contractionary monetary policy of raising interest rate to cut down the inflationary pressure in the economy. The inflation deviation in this study is hypothesised to be positively related to the monetary policy rule as obtained in the studies of Aizenman and Hutchison (2011); Carare and Stone (2006) and Yamada (2013) among others.

3.7.6 Output Gap

Output gap is defined as deviation of real output from its potential quantity using Harvey and Jaeger (1993) and Hodrick and Prescott (1997) for the construction of the potential output and output gap as popularly obtained in the literature (Clarida *et al.*, 2000 and Torres, 2003). The higher the output gap, the higher will be the rate of interest in the economy which means a positive linkage between output gap and policy rule. This is equally proved and further formalised in the works of Svensson (1996) and

Woodford (2001). Similarly, increase in the output gap in this study is presumed to be positively related to the interest rate for the monetary policy rule to serve as a nominal anchor in the inflation targeting countries.

3.7.7 Money Supply M2

Money supply in this study is the total quantity of money in the country. In its broader sense, it is measured as M2 which is a combination of M1 and net time deposit with the exception of large certificates of deposit (World Bank, 2010). M1 is the aggregate collection of outside bank currency and demand deposit except those held by the central government. This variable has been employed in the previous exchange rate and macroeconomic fundamentals studies such as Erjavec and Cota (2003); Engel and West (2005) to mention but only a few. An increase in the level of money supply in the domestic economy will induce a rise in the inflationary trend which positively affects exchange rate and cause volatility in the domestic currency (Dornbusch, 1976; Frenkel, 1976 and Zamanian *et al.*, 2013). The variable is also hypothesised to be positively related to the interest rate in the Taylor rule in objective two of the study (Taylor, 1993 and Torres, 2003).

3.7.8 Inflation Rate

The rate of inflation in this study is measured by the Laspeyres formula calculated by the consumer price index as the percentage change in the cost to the average consumer on a basket of commodities and services which may change at a specified interval or fixed over time (World Bank, 2015). Inflation relates to exchange rate right from the early work of Cassel (1916) on the law of one price where it is expected to be positively related to exchange rate (Frenkel & Johnson, 2013). This transmits through an increase in money supply which leads to lower demand for domestic currency and higher exchange rate fluctuations (Frenkel, 1976; Holman & Rioja, 2001; Kamin & Klau, 2003 and Kara, 2011) among others. Despite the fact that, mixed findings are obtained in the empirical studies, still the majority discover a positive relationship. Therefore, this study also hypothesised a positive linkage between inflation and exchange rate volatility.

3.7.9 Interest Rate

Interest rate is the cost of borrowing paid to the lender. In this study, the interest rate is the rate paid for demand, saving and time deposit by commercial banks, other similar banks and other financial institutions in the domestic economy. According to Hnatkovska *et al.* (2013) the relationship between exchange rate and interest rate has not been clear for the past three decades. It is hypothesised that any rise in the interest rate work along way with money demand increase which makes the value of domestic currency to appreciate and reduces the volatility of the exchange rate (Frenkel, 1976; Mundel, 1963 and Hnatkovska *et al.*, 2013). On the other hand, the rise in the domestic interest rate leads to increase in the opportunity cost of holding money leading to reduction in the aggregate output due to fiscal deficit which causes currency depreciation and exchange rate instability (Dornbusch, 1976 and Chinn, 2012). In this study, interest rate can be positive and negative in support of either Frenkel (1976) or Dornbusch (1976) hypotheses respectively.

Furthermore, the variable is treated as dependent variable (policy rule variable) in the second objective of the study. The variable is hypothesised to be positively related to inflation deviation and output gap (Taylor, 1993; Svensson, 1996 and Clarida *et al.*, 2000). Moreover, exchange rate and money supply are also projected to be positively related to the policy rule (Torres, 2003 and Chinn, 2012).

3.7.10 Income

The level of income in this study is proxied by real Gross Domestic Product (GDP) as in the studies of Balassa (1964); Samuelson (1964); Barbosa-Filbo (2004) and Tang (2013). The real GDP is measured by the World Bank as a weighted sum of all the gross value added produced by the resident in the country in addition to product taxes after deducting subsidies not captured in the value of the commodities (World Bank, 2015). According to Balassa-Samuelson productivity model, increase in productivity shock leads to trade balance improvement. This rises earned income such as wages in tradable and non-tradable sectors thereby exchange rate appreciation (Ahmad, Yusof & Masron, 2010). The coefficient of the variable is expected to be negatively related to exchange rate (Masron & Yosuf, 2006). The monetarists argue that currency becomes stronger and stable with the increase in income which causes higher demand for money, even though, Mundell (1964) and Fleming (1962) jointly argue that higher income leads to higher importation and, therefore, weaker currency and unstable exchange rate.

In the recent studies, mixed findings are reported (Harberger, 2003). Numerous studies show negative relationship between income and exchange rate equilibrium (Abbas & Igbal, 2012; Rapetti, Skott & Razmi, 2012; Herberger, 2003 and Rodrik, 2008). While some other studies reveal a positive relation between income and exchange rate equilibrium, such as Attah-Obeng, Enu, Osei-Gyimah and Opoku (2013); Harberger,

(2003) and Khan *et al.* (2012). They argue that economic growth stimulate exchange rate depreciation in a price elastic import and export consumer products.

3.8 Chapter Summary

This chapter discusses the theoretical framework, measurement of exchange rate volatility, stationarity analysis, model specifications and methods of analysis employed in answering the objectives of the study. The methods of TGARCH, GMM, Time-varying transition probabilities Markov-switching ARCH model, Toda-Yamamoto causality and Hacker-Hatemi-J leverage bootstrap models were explained in details. The sources of data, operational justification of variables and finally, the interpolation process of the annual data into quarterly series has also been presented.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The results based on the objectives of the study are estimated and discussed in this chapter. The chapter basically presents descriptive and inferential analyses. It presents descriptive and correlation analyses, results of the test for stationarity with and without structural breaks. The chapter also presents results on; firstly, the effectiveness of inflation targeting as hedging strategy for exchange rate instability; secondly, whether the monetary policy framework of inflation targeting has performed the role of the nominal anchor in the inflation targeting sub-Saharan African economies and the process through which the monetary authorities determine interest rate; thirdly, the influence of the exchange rate regime shift while controlling for political instability on the exchange rate stability in the selected sub-Saharan African countries and finally, discusses results on the causal relationship among the variables of the theory of exchange rate determination using Toda-Yamamoto causality with modified leverage bootstrapping and Hatemi-J (2012) asymmetric causality. The chapter is subdivided into the following sections.

4.2 Descriptive Analysis

The descriptive analysis is conducted to explain the basic features of the data and stimulate the econometrics approaches employed in the study. The analysis includes descriptive statistics and correlation coefficients of key variables of the research. These are presented in the following sub-sections.

4.2.1 Descriptive Statistics

The descriptive analysis of the major variables of the study is presented in Tables 4.2.1A through to 4.2.1D under appendix A-1 for Gambia, Ghana, Nigeria and South Africa respectively. The tables show that the average nominal exchange rate of Gambia for the period of first quarter of 1980 to the last quarter of 2014 is 15.564 Gambian *Dalaci*, with a minimum value of 1.667 and a maximum of 43.953 per USD. The maximum Ghanaian *Cedi* exchange rate for the same period stood at 2.451 with an average of 0.539 and a minimum of 0.0003 *Cedi* per USD. Nigeria recorded an average of 65.925 *Naira* for the period with 0.534 and 162.330 for a minimum and maximum exchange rate per USD. Furthermore, the average South African *Rand* per USD is 5.037 with a minimum of 0.751 and a maximum of 11.526 for the period under study.

From this simple description, the most volatile currency in the sampled countries over the period of study is found to be Nigerian *Naira* with a standard deviation of 63.096. The scenario is similar for South Africa and Gambia with the least volatile currency been the Ghanaian *Cedi*. However, this is only the description of the raw variable which may not be comfortably employed to draw any conclusion on the nature of volatility of the series. Consequently, this study further confirms the existence of volatility of exchange rate based on the existence of clustering volatility and ARCH effect tested on the residuals of the regression model.

The other variables in the sample also show similar pattern in all the sampled countries. The variable that experienced a rapid and inconsistent growth and thus, most unstable is M2 followed by GDP across all the selected countries except for Nigeria where it appears vice versa. One of the anticipated reasons for the instability of most macroeconomic variables including exchange rate in the region is the apparent political instability. According to the US state department and amnesty international, the average Political Instability Index (PIS) based on the maximum scale of 5 points is determined as 2.009, 2.403, 3.400 and 3.510 for Gambia, Ghana, Nigeria and South Africa respectively. The highest politically unstable economy among the sampled countries is shown to be Nigeria and South Africa with a maximum of 5 points at sometimes whereas, the least unstable economies out of the sample are Gambia and Ghana with a maximum score of 3 points. This is anticipated to hinder investments in to the economies which makes the demand for the domestic currencies lower in the international market thereby a volatile exchange rate (Levy-Yeyati *et al*., 2010). Political instability also leads to volatility in exchange rate due to the inability of investors and policymakers to predict future market occurrence (Petterson, 2000: 740).

The normality of the data is tested using skewness, kurtosis and Jarque-Bera test statistic. The different tests for normality indicate that the data are not normally distributed. From the skewness statistic, all the variables are positively skewed except for political instability series for Nigeria and Ghana. The most highly skewed series being the M2 followed by GDP for Gambia and Ghana and vice versa for Nigeria and South Africa. The least skewed variable in all the sampled countries is found to be political instability index. Although the statistics are not far from the ±1.96 bounds (Haniffa & Hudaib, 2006) however, the test is different from the threshold value of zero. Furthermore, the kurtosis statistic also indicates the non-normality of the data. The variables are found to be platykurtic relative to the benchmark[6] of the normal

[6] The benchmark is three (Bai and Ng, 2005).

distribution. However, these tests statistic become less effective when the time series data are correlated (Bai and Ng, 2005).

Similarly, the probability values of the Jarque-Bera statistic further show that the observations of the variables are not normally distributed for all countries under study except the political instability index for South Africa. This shows that the PIS index for each quarter is independent of another quarter. The probability implies that the persistent political instability in South Africa occur independent of one another. The other series for all the countries under study exhibit a typical feature of time series data. The test shows the existence of trend in the data generating process. This is further evident using time series graphs presented in Figures 4.2.1A to 4.2.1D, appendix B-2 for Gambian, Ghanaian, Nigerian and South African variables respectively. The non-normality of the data distribution is in line with previous studies such as Diamandis (2009) for stock returns variables and Swift and Janacek (1991) who argue that raw time series data is hardly normally distributed.

Unlike the test for normality conducted on the residuals of the estimated models which is expected to have normal distribution of the errors, the problem of non-normality in the data generating process is usually observed in the raw time series data. The null hypothesis of time series normality test is that the observations are independent. In reality, the time series data are not expected to be independent due to the trending and seasoning characteristics of most time series data which lead to non-stationarity of the series (Brooks, 2008).

Nevertheless, this study employs the techniques that appropriately determine the stationarity properties of the raw data. This includes the use of LS unit root test with one break LM test to determine structural breaks in the data generating process which can also contribute to the non-normality of the data. The study also employs methods that allow for non-normality and trend in the estimation process. This includes the use of maximum likelihood estimators and leverage bootstrap distribution which performs better in the presence of non-normality in asymptotic distribution, especially of the errors (Hacker & Hatemi-J, 2006).

4.2.2 Correlation and Multicollinearity Analysis

The study conducts correlation analysis to see the magnitude and direction of association between regressors and regressand. The analysis also shows whether there exist high-order of linear correlation (multicollinearity) amongst the regressors. This assists in observing the possibility of getting redundant variables in the estimation process. Multicollinearity is a statistical problem that overestimates standard errors which leads to smaller *t*-statistic thus, a case of size distortion.

Tables 4.2.2A to 4.2.2D in appendix A-2 depict the correlation coefficients and their respective probability values for each pair of the relationship among the variables for Gambia, Ghana, Nigeria and South Africa respectively. The results show that except for interest rate for Ghana and South Africa and political instability for South Africa, all other variables are positively associated with exchange rate and statistically significant mostly at 1% level of significance. The only variable found not significant is interest rate for Ghana which shows negative sign as well. This is a preliminary indication that there would be possibility of relationship between the regressors and regressand. However, this cannot be used for causality and other inferential purposes because it gives only the magnitude and direction of pair wise association in a linear sense which can change when non-normality exist (Cohen and Lea, 2004). Nonetheless, this study rigorously investigates the causal relationship among the variables using a more sophisticated methodology that takes into account non-linearity, violation of normality assumption and existence of ARCH effect. The test also distinguished between causality in good and bad times.

The correlation among the regressors helps to predict the possibility of having multicollinearity in the model. From Tables 4.2.2A to 4.2.2D (see appendix A-2) for Gambia, Ghana, Nigeria and South Africa respectively, the probability values indicate that the null hypothesis of no correlation among pairs of variables is rejected in almost all countries except for the pairs of PIS with CPI, M2 and GDP for South Africa. The correlation of ITF with all variables for Ghana and South Africa is found not significant. The possible explanation of this result might come from the fact that ITF is a constructed variable based on Hodrick-Prescott filter which is not relevant in the estimation that involves the raw fundamental macroeconomic variables. Despite the rejection of the null hypotheses in all other cases for all countries, it is however, observed that the correlation coefficients are below the multicollinearity threshold value of 80% level of association (Kennedy, 2008 in Sufian and Habibullah, 2010). The highly associated regressors are found to be PIS and CPI (.798), M2 and GDP (.699), GDP and M2 (.795) and M2 and GDP (.892) with least correlated variables been PIS and INR (.224), GDP and INR (-.399), CPI and INR (-.279) and PIS and M2 (-.0800) for Gambia, Ghana, Nigeria and South Africa respectively. This analysis indicates that at least the highly correlated variables such as GDP and M2 for South

Africa have to be transformed to avoid spurious conclusion due to the problem of multicollinearity. Nonetheless, this preliminary analysis indicates the absence of multicollinearity among the regressors in all countries except for the M2 and GDP for South Africa which are transformed in to natural logarithm in the estimation process. However, even the highest correlation coefficient is less than 0.90 which is not a crucial issue (Tabachnik & Fidell, 2007).

4.3 Inflation Targeting and Exchange Rate Volatility

This section aimed at finding the effectiveness of inflation targeting as a hedging strategy for exchange rate instability in Ghana and South Africa. The choice of Ghana and South Africa is justified in chapters one as the only countries that adopt the policy of IT framework in the sub-Saharan Africa. The study starts with testing for stationarity properties which consider structural breaks in addition to the traditional ADF test. The consideration of structural breaks in the time series data of developing and emerging countries of Ghana and South Africa respectively is one of the methodological contribution of this study.

The effectiveness of ITF as hedging strategy for exchange rate volatility is determined using TGARCH model. The justification for using the TGARCH model is that it measures asymmetry in volatility which does not enforce constant structure for the entire lags. This is because in asymmetric modelling opposite contributions may arise from different lags. More so, the model uses absolute residuals which are found more efficient in estimating the variance compared to the squared residuals, especially in the normal distribution (Davidian and Carroll, 1987) and finally, the model linearly conserves the properties of the traditional GARCH model which enable two steps least squares estimation (Zakoian, 1994). The model is estimated as outlined under the following subheadings:

4.3.1 Unit Root Test

The test for stationarity is one of the pre-requisites in estimating TGARCH model. The stationarity properties is investigated using the traditional ADF assuming that shocks are temporal and do not have long run effect on the series (Glynn *et al*., 2007). Tables 4.3.1A and 4.3.1D in appendix A-3 present the estimations of the ADF unit root test for Ghana and South Africa on the macroeconomic fundamentals of exchange rate determination. These comprise of natural logarithms of nominal exchange rate (LEXC), inflation differential (LCPI), interest rate differential (LINR), money supply differential (LM2), income differential (LGDP) and inflation target (ITF) constructed using Hodrick-Prescott filter for the countries. The ADF results show that all the series are non-stationary at level under both intercept and intercept with trend models for both Ghana and South Africa except for interest rate differential and inflation target. These two series are found to be trend stationary at level. Nevertheless, the test rejects the null hypothesis of unit root at first difference for LEXC, LCPI, LM2 and LGDP.

However, it is argued that existence of structural break in the data generating process leads to size distortion and spurious conclusion in the ADF model (Lee & Strazicich, 2003 and Perron, 1989). Thus, in addition to the traditional ADF test, this study employs Lee and Strazicich lagrange multiplier with one structural break to further check the unit root properties of the series. The test is break point independent and nuisance invariant under the alternative hypothesis. It shows neither size nor location dependence and unaffected by incorrect estimation irrespective of the existence or otherwise of break (Lee & Strazicich, 2013).

The LS test results are presented in Table 4.3.1B and 4.3.1C and Tables 4.3.1E and 4.3.1F (see appendix A-3) for level and first difference estimations for Ghana and South Africa respectively. Most of the break points are not significant under model A (intercept without trend). However, the break points are apparently significant under model C (intercept with trend). The LS test results are in line with the ADF results except for exchange rate of South Africa which is also found stationary at level at 10% level of significance under intercept with trend model. This is in addition to the interest rate differential and the constructed inflation target. Therefore, the integration order of the variables is determined to be $I(1)$ for all the series for both Ghana and South Africa except for LINR and ITF which are determined to be $I(0)$ in both the countries. Evidence from Figures 4.2.1B and 4.2.1D in appendix B-2 reveal that the series are more characterised by intercept with trend except for LINR and ITF which exhibit a random walk characteristic. In the estimation process, the study makes inference on integration order based on intercept with trend model for all variables except interest rate differential and inflation target.

4.3.2 Estimation of the Threshold GARCH Model

The estimation results are presented in the following sub-sections for Ghana and South Africa. The results are estimated differently for each country, with and without structural breaks. The inflation targeting is measured using two approaches; dummy variable taking one for the adoption period and zero prior to adoption and a constructed inflation target using Hodrick-Prescott filter developed by Hodrick and Prescott (1997). The results are discussed in the following sub-section.

4.3.2.1 Estimation Results and Discussion

The estimation results of the TGARCH model are empirically presented in stages; the test for ARCH effect, clustering volatility and asymmetric test to ensure the appropriateness of employing TGARCH model; the various versions of TGARCH models with different measures of IT framework (TGARCH models 1 to 4) with and without structural breaks and finally the diagnostic tests result to check the adequacy and robustness of the estimated models.

It has been established that for ARCH family models to be estimated, there should exist an evidence of non-constant variance and clustering volatility in the model (Enders, 2004). Furthermore, the TGARCH model is an extension of GARCH model which distinguishes between the effect of positive and negative shocks (Zakoian, 1994). Table 4.3.2.1A in appendix A-3 presents the test for ARCH effect and asymmetric test in the model. The null hypotheses of no ARCH effect are rejected for both Ghana and South Africa which denote the existence of ARCH effect in the residuals of the estimates. Figures 4.3.2.1A and 4.3.2.1B in appendix B-3 show the evidence of clustering volatility in the residuals of Ghana and South Africa respectively. The figures depict the prevalence of volatility movement. It is observed that periods of high volatility are followed by periods of high volatility, so also periods of low volatility are succeeded by periods of low volatility. This establishes another reason for estimating ARCH family models for both countries under study.

Furthermore, the test for asymmetric effect in the data also rejects the null hypotheses of no asymmetric effect in the residuals of the GARCH fitted model for both Ghana and South Africa. The test indicates the presence of both sign and size bias, meaning that negative and positive shocks are associated with different effects on future volatility (Engle and Ng, 1993). The results therefore, statistically justify the need to estimate the TGARCH model instead of standard symmetric GARCH form, at least for Ghana and South Africa.

The prevalence of ARCH effect and clustering volatility necessitate the estimation of ARCH family models. Moreover, the sign and size bias test further justifies the use of TGARCH model. The effectiveness of IT policy on reducing exchange rate volatility is examined based on Equations 3.20 and 3.28 for each of the two countries. The results are presented in Tables 4.3.2.1B and 4.3.2.1C under appendix A-3 for Ghana and South Africa respectively. The study controlled for floating exchange rate regime in both Ghana and South Africa due to the countries' prolonged managed floating regime that lasted up until 1986 and 1990s for Ghana and South Africa respectively. The best lag structure is determined using the maximum likelihood estimation that minimises the Akaike information criteria. This is similarly specified and employed in number of studies such as Enders (2004); Longmore and Robinson (2004); Salimibeni, Zaidi, Karim and Jusoh (2012) among others. Thus, the study estimates different specifications of the TGARCH process and found the results in Table 4.3.2.1B and 4.3.2.1C (in appendix A-3) to be the optimal orders of the models.

The upper most part of Tables 4.3.2.1B and 4.3.2.1C in appendix A-3 present the mean equation for Ghana and South Africa respectively. The equations contain other important variables/information such as the differentials inflation, interest rate, money supply and income as specified by the monetary theory of exchange rate determination. This helps to determine the equilibrium level of exchange rate. Most of the information contained in the variables are found statistically significant in explaining variability in the exchange rate as hypothesised by the theory and reviewed empirical findings.

The results based on the dummy variable proxy, prior to controlling for flexible exchange rate regime indicates that inflation, interest rate, money supply and income differentials are positively and significantly related to volatility of exchange rate. This implies that increase in a percentage change in the exchange rate fundamentals increase the volatility of exchange rate except for income differential which is negatively related to exchange rate volatility in Ghana. The result is in line with Balassa-Samuelson hypothesis and other previous empirical findings such as Abbas and Igbal (2012); Rapetti *et al*. (2012) among others. The sign and significance of the coefficients remain unchanged at least for South Africa even after controlling for the Flexible Exchange Rate (FER) although the magnitude of the coefficients increases. However, the magnitude and significance of the coefficients change after accounting for FER in Ghana. The variables mostly become not statistically significant except for inflation differential which is significant at five percent level of significance. Furthermore, interest rate differential turns negative which is in support of Frenkel (1976) and Mundel (1963) preposition.

The study also employs the Hodrick-Prescott filtered variable to proxy the ITF. The results show that the coefficients in the Ghanaian model are more significant especially after controlling for FER compared to the coefficients in the South African model. The coefficients are also positively related to volatility of exchange rate with the exception of money supply differential for South Africa which is negative but statistically not significant. Nevertheless, the relationship among these variables and exchange rate volatility is widely studied in the literature, therefore not a subject of concern in this study although they help to control for possible explanatory power.

The results of the variance equations for Ghana and South Africa are respectively presented in Tables 4.3.2.1B and 4.3.2.1C (see appendix A-3). In both cases, the first model (model 1) depicts the estimates of TGARCH (1, 1, 1) and TGARCH (2, 1, 1) for Ghana and South Africa respectively without controlling for Flexible Exchange Rate Regime (DFER). The ARCH term measures the impact of previous quarter's news about volatility on the instantaneous volatility. The term is found positively related to exchange rate volatility except for model two under South Africa after controlling for DFER in the estimation process, although not significant. The results show that previous period news about volatility leads to current volatility in both Ghana and South Africa. However, the terms are only statistically significant in the case of Ghana. This shows an evidence of information asymmetry in Ghana compared to South Africa which has a more efficient financial market. The results also reveal that volatility of the previous period is significant in determining current period's volatility. The asymmetric effect (TGARCH term) is found negative in all cases for both countries and statistically significant mostly at 5% and 1% levels of significance. This indicates that exchange rate users react differently during good and bad times.

The estimated coefficient of the Inflation Targeting Framework dummy (DITF) for Ghana and South Africa are found negative and significantly different from zero. The results show that implementation of IT framework leads to reduction in exchange rate volatility by 0.9 percent and 4.3 percent for Ghana and South Africa respectively. This implies that the adoption of IT framework decreases the volatility of exchange rate in the economies. Furthermore, the lag ITF was also found statistically significant indicating that the policy has transition effect on the stability of exchange rate. However, the results indicate a positive transition effect for Ghana and model three for South Africa, meaning that the policy transition increases the volatility of exchange rate, at least for the study period. This might be explained based on the immediate sudden shock that usually occur in nominal interest rate in order to cut aggregate demand and restore inflation to its target level which can cause sudden response of currency price in the exchange rate market. Moreover, a sudden response to changes in the currency prices leads to instability in the prices of currency.

Interestingly, the result does not differ using the constructed ITF series. The variable is also found negatively related to volatility of exchange rate and significantly different from zero. The results of the constructed ITF indicate that the implementation of the framework reduces the volatility of exchange rate by 0.5 percent and 1.1 percent for Ghana and South Africa respectively. Although both the measures of ITF are found negatively related to the volatility of exchange rate, the magnitude is larger using the dummy variable measurement.

The structural break dummy is included in the variance equation to see whether sudden changes influenced the volatility of exchange rate in Ghana and South Africa. The coefficients of the LM break dummy are positive and statistically different from zero. The positive sign and significance level reveal that sudden shocks in the exchange rate series increase the magnitude of exchange rate volatility in both Ghana and South Africa except for models one and three for Ghana and South Africa respectively which are found not significant. The non-significance of the LM estimated break point indicates that the sudden changes in the foreign exchange series lead to neither increase nor decrease in the volatility of the countries' exchange rate, at least without controlling for exchange rate regime.

Surprisingly enough, when we controlled for flexible exchange rate regime in model two, most of the information specified by the monetary theory of exchange rate determination ceased to explain the disequilibrium in the level of exchange rate. The variance equations maintained similar sign and size of the coefficients with a decreasing magnitude of the ITF coefficients from 0.9 percent to 0.1 percent and 10 percent to 0.1 percent for Ghanaian ITF and ITF transition effect respectively. The trend is found similar in South Africa where the magnitude decreases from 4.3 percent to 0.8 percent and in the contrary increases from 0.7 percent to 1.1 percent for ITF and ITF transition effect respectively. The ARCH, GARCH and TGARCH terms maintained both sign and similar magnitude of the coefficients.

The additional variable, flexible exchange rate dummy (DFER) is found statistically different from zero and positively related to volatility of exchange rate in both economies. Meaning that floating exchange rate leads to increase volatility in the exchange rates of Ghana and South Africa. In this case, it is found even more important in explaining exchange rate instability than the fundamental macroeconomic variables of exchange rate determination, at least for Ghana. This is in line with most empirical findings on flexible exchange rate and exchange rate volatility relationship (Edwards, 2007; Ichiue and Koyama, 2011; Kočenda, 2005 and Kočenda and Valachy, 2006). The structural break coefficient also became significant after controlling for FER. Therefore, the sudden shocks in the exchange rate series is also found contributing to increase volatility in the presence of flexible exchange rate regime even in Ghana where LM break coefficient was not significant prior to accounting for DFER in the model.

The study conducts robustness check by constructing an inflation targeting variable using the methodology of Hodrick and Prescott (1997) (H-P filter) apart from the usual dummy variable. This is to ensure reliability and validity of the estimates using an alternative measure different from the dummy variable. The results are presented in model three of Tables 4.3.2.1B and 4.3.2.1C (appendix A-3) for Ghana and South Africa respectively. The coefficients of the mean equations are mostly statistically significant. The coefficients of the variance equations are also similar to that of models one in the Tables (the counterpart models using dummy variable to proxy ITF). However, the coefficients of models three are found more significant, mostly at one and five percent levels of significance for both Ghana and South Africa. The coefficients of the new constructed series to proxy ITF are also found negative and significant. But, the lag ITFs to proxy the policy transition effect are found not significant in the models, at least before controlling for flexible exchange rate for Ghana but significant at 10 percent in South Africa. The break dummy is also positive and statistically significant in influencing exchange rate volatility.

Furthermore, when we controlled for floating exchange rate in models four, all the coefficients in both mean and variance equations become significant for Ghana and mostly significant for South Africa as well. In the variance equations, the magnitude of the ITF ability to serve as a hedging strategy for exchange rate volatility increases and the proxy for ITF policy transition effect also become significantly different from zero even for the Ghanaian estimates. All other variables maintained the usual expected sign and statistically significant. Based on the sensitivity analysis, we can reliably draw inference due to the utmost consistency of the coefficients and their magnitude especially for the inflation targeting framework measured using both dummy and constructed IT variables.

Summarily, the negative values and statistical significance of ITF measured using both dummy and a constructed series using H-P filter reveal that adoption of ITF effectively play a role of hedging strategy for exchange rate instability in Ghana and South Africa. The possible explanation for such effectiveness is that ITF adoption tends to cut excess aggregate demand and restore inflation deviation to its target and minimizes sudden shocks effect on exchange rate due to transparency and predictability of the monetary policy framework of the IT principle.

In support of this result, it has been argued that one of the important characteristics of ITF is that the central banks are expected to enjoy sovereignty in the formulation of monetary policies. The more independent, transparent and accountable about fixing the rate of interest in targeting a certain level of inflation in an economy, the more stable will be the economic and financial systems of the country. This works through the mechanisms of contractionary and expansionary monetary policies in aggregate demand to ensure equilibrium in the level of inflation and output. Furthermore, the stability in the financial system prevents the shocks resulting from the usual uncertainty that occur from speculations especially as it relates to interest rate and inflation.

Additionally, the policy may also aim at dealing with output gaps and inflation deviation if the policy is prioritised to be the economies' nominal anchor. The issue of inflation deviation and output gap are some of the factors that contribute to instability of exchange rate. Therefore, a policy that works towards restoring such deviations is expected to reduce the menace of exchange rate volatility. The overall result is in line with the findings of Edwards (2007) for Brazil, Chile and Israel; Pontines and Siregar (2012) and Kurihara (2013) in the panel of developing sub-Saharan Africa and East Asian IT targeting and non-targeting economies among others.

Furthermore, the study found the existence of asymmetric effect in the model. This shows that exchange rate users react differently during good and bad times. The asymmetric response in the estimation indicates that positive shocks lead to higher volatility of exchange rate in the succeeding quarter compared to the same level of negative shocks. Unlike in stock returns where it is expected to be positive for the negative shocks to have higher impact on the subsequent period's conditional variance, here (modelling exchange rate) positive shocks refers to depreciating or weakening domestic currency in relation to foreign currency. The results reveal that weakening exchange rate in relation to foreign currency leads to higher future volatility than the strengthening domestic currency of the same magnitude. In this case the asymmetry is neither expected to be explained by leverage effect nor volatility feedback. Therefore, the negative results of the coefficients are the most appropriate explanation of the behaviour of exchange rate instability. This is evidently explained in Brooks (2008).

The significance of the structural break in the models is justified by the response of exchange rate to the Structural Adjustment Programmes (SAP) of the International Monetary Fund (IMF) in 1980s. The break dates coincide with the dates of reform towards market based economy in most of the sub-Saharan African economies based on recommendations of IMF in the name structural adjustment programme. One of the conditions of the programme was to devalue and weaken their domestic currency. The devaluation process is identified by LS lagrange multiplier test as the dates of structural break in the data generating process of both the economies. The existence of structural breaks is believed to have brought about a temporal shock which is found positively related to exchange rate volatility.

4.3.2.2 Diagnostic Tests for TGARCH Model

The adequacy of the model is examined using the diagnostic tests reported at the lower part of Tables 4.3.2.1B and 4.3.2.1C in appendix A-3 for Ghana and South Africa respectively. The level and squared Ljung Box serial correlation tests indicate that there is no evidence of serial correlation from lag 1 to 36 in both the economies. Furthermore, the models do not suffer from ARCH LM effect. The normality of residuals was tested using Jarque-Bera statistic. The results show non-normality of residuals for Ghana and South Africa except for Models one and four for South Africa. However, using maximum likelihood estimators, the parameter estimates are consistent and efficient despite the existence of the non-normality of the residuals. To further check and ensure accuracy of the estimates, the study employs the Bollerslev-Wooldridge robust standard errors and covariance, otherwise known as Quasi-maximum Likelihood (Bollerslev and Wooldridge, 1992) to take care of the problem of non-normality of residuals in the ARCH modelling process.

4.4 Inflation Targeting Framework and Nominal Anchor Hypothesis

Under this section, the study examines whether the inflation targeting framework has performed the role of the nominal anchor and the process through which interest rate is determined in Ghana and South Africa. The study starts with investigating the unit root properties; ADF and LS with one structural break LM test. The proper estimation procedure adopted in this section is the time series generalized method of moments estimators proposed by Hansen (1982) and Hansen and Singleton (1982).

The use of the GMM estimators is justified by the anticipated overlapping data problem resulting from the variable construction and non-constant variance in the forecast error. The non-constant variance leads to moving average process which prevents the consistency of the usual variance covariance matrix. Thus, might not be efficient in testing hypotheses. The GMM approach solves the problems by replacing the unobserved disturbances with observed values and real parameter vector in the orthogonal condition using expected cross multiplication which usually converge to the true parameter vector in terms of the asymptotic distribution (Hansen, 1982). The technique relaxes the usual unrealistic assumption of the normal distribution of the errors (Ogaki, 1993). Moreover, the approach allows for both conditional heteroscedasticity and serial correlation in the orthogonal construction. The study estimates Taylor rule under the following subsections:

4.4.1 Unit Root Test

The unit root properties of the series; natural logarithm of interest rate (INR), inflation deviation (INFD), output gap (OUTG), first log difference of real money supply (RM2) and real effective exchange rate (RER) are investigated using two different techniques; Augmented Dickey-Fuller (ADF) and Lee and Strazicich (LS) with one break LM tests. The first log difference measures the quarterly variation in real money supply and real exchange rate. The results of the ADF tests are presented in Tables 4.4.1A and 4.4.1C under appendix A-4 for Ghana and South Africa respectively. The results indicate that all the series are stationary under both constant without trend and constant with trend for both Ghana and South Africa. Nevertheless, it has been argued that presence of structural break leads to size distortion and spurious conclusion in the traditional ADF estimations (Lee & Strazicich, 2013 and Perron, 1989).

To check the sensitivity of the ADF result especially in the presence of structural breaks, the study further applies LS with one structural break LM test to correct for size distortion, location dependence and nuisance parameter estimate associated with the traditional ADF test statistic (Lee & Strazicich, 2013). The LS results are presented in Tables 4.4.1B and Tables 4.4.1D (see appendix A-4) for Ghana and South Africa respectively. The results show that the variables are stationary at level under both intercept and intercept with trend with the exception of LINR for Ghana and OUTG for South Africa under the intercept model but found to be trend stationary. The break points are not statistically significant under the intercept model. However, the break points are statistically significant under the intercept with trend model. This implies that the data generating process is characterised by structural breaks in the trend, hence making conclusion based on ADF might be erroneous.

4.4.2 Estimation of the Taylor rule using GMM estimators

The study tests the hypothesis of whether the monetary policy of inflation targeting in Ghana and South African have fulfilled the requirement to serve as a nominal anchor and whether the policy represents the process through which the central banks determine their interest rate. The results are estimated based on the baseline and augmented forward-looking monetary policy rules. The findings of the inflation targeting monetary policy rule for Ghana and South Africa are presented under the following subheadings.

4.4.2.1 Estimation Results and Discussion

The results of the Taylor rule model are empirically presented in phases: first, the results of the baseline forward-looking IT policy rule; second, the estimates of the augmented forward-looking IT policy rule and finally the diagnostic tests result to assess the moments condition of over-identification.

The study uses a four quarter horizon data. The deviation of inflation and output from their target and potential level respectively are constructed using an ex-post observed data. The study further employs the standard procedure of Hodrick-Prescott filter to estimate the gaps and deviations in output and inflation respectively. Following Lee and Lee (1997); Shabri, Kameel, Azmi and Abdul Aziz (2009) and Torres (2003) among others, the study employs the lags of the observed and constructed series to represent information that help in forecasting expected inflation deviation from its target and actual output from its potential level.

4.4.2.1.1 IT and Monetary Policy: The Baseline Case

The results of the IT baseline monetary policy rule are presented in Tables 4.4.2.1A and 4.4.2.1C under appendix A-4 for Ghana and South Africa respectively. The parameter *k* represents the values of the long run nominal interest rate which are expected to vary over time. In both cases (Ghana and South Africa), the values of the parameter are found not significant prior to the implementation of the IT framework in the economies. However, for the periods after IT implementation and full sample periods, the nominal interest rate attained its equilibrium level under the framework of IT. This implies that there is a gradual adjustment process in converging towards the target interest rate immediately after the adoption of IT.

The results further show that the nominal interest rate react to the target interest rate represented by α in both the economies. The values indicate that the response of the nominal interest rate to the real rate is more sensitive in South Africa than Ghana (see the coefficients of α in Tables 4.4.2.1A and 4.4.2.1C under appendix A-4, for Ghana and South Africa respectively). The results reveal that South Africa requires a little adjustment in the nominal interest rate to restore real interest rate to its target level in the economy.

The significance of the interest rate smoothening parameter, *p* after the implementation of the IT framework confirms the gradual adjustment process to the target interest rate. It further shows the magnitude of the smoothening process. The coefficients of the parameter reveal that the speed of adjustment is greater in South Africa compared to Ghana. This is evident from the magnitude of the coefficients of the parameter. The coefficients for South Africa reveal about 28 percent for post-IT and 82 percent for full sample period. This compares with 16 percent for post-IT and 19 percent full sample for Ghana. The reason for such a difference might be as a result of relatively shorter period of IT adoption in Ghana compared to South Africa.

The coefficients of inflation deviation (β) in the pre-IT adoption are found not statistically significant in both Ghana and South Africa. Therefore, the estimates of the Pre-IT period show that despite the rise in the nominal interest rate by the South African Reserve Bank and Bank of Ghana, the rise was not sufficient enough to upswing the real interest rate. This implies that the increase was not enough to lower aggregate demand in order to bring inflation back to its equilibrium level in the economies. However, the significant positive and greater than one values of β $(\beta > 1)$ in the post-IT adoption, 2.666 and 5.094 and for the full sample period, 1.899 and 7.258 for Ghana and South Africa respectively indicate that the monetary authorities have performed the role of a nominal anchor in the economies. The results in the post-IT adoption indicate that the real interest rate responds to the rise in the nominal rate, thereby cutting the aggregate demand which in turn cuts inflation to its target rate. Furthermore, the full sample period also follows the trend of the post-IT adoption which depicts the pursuance of extreme and true IT frameworks for Ghana and South Africa respectively.

Moreover, the coefficients of the output gap also carry the expected magnitude and sign $\gamma > 0$. This further confirms the policy rule specification. The significance of $\gamma > 0$ suggests that regulating interest rate while allowing actual output to fluctuate around the potential level regulates the excess inflationary pressure in the economies. However, the non-significance of the coefficient of output gap in the full sample period for Ghana reveals a further indication of an extreme full pledged adoption of the IT framework in the economy. This result is similar to the findings of Torres (2003) for Mexico after 1996 where output gap coefficients were found to be lower than that of inflation deviation.

The study rejects the null hypotheses that $\beta \leq 1$ and $\gamma \leq 0$ for both the economies. Furthermore, the results show that the major hypothetical response of the monetary instruments to inflation deviation and output gap is stronger in South Africa compared to Ghana. This is shown by the magnitude of the coefficients of inflation deviation and output gap presented in Tables 4.4.2.1A and 4.4.2.1C (appendix A-4) for Ghana and South Africa respectively. The estimates also reveal that South Africa extremely targeted inflation immediately after the adoption of the IT framework without much concern about output gap, whereas in Ghana such a scenario only occurred when full sample period is considered. Additionally, the results reveal that the monetary policy is an automatic stabilizer of inflation deviation and output gap around their targets levels in the economies.

The study confirms the results of the baseline estimates by comparing the actual interest rate and estimated policy rate. This is shown in Figures 4.4.2.1A and 4.4.2.1B (see appendix B-4) for Ghana and South Africa respectively. The dotted lines represent the policy rate and the ticked lines indicate the actual interest rate. The graphs show that the actual rate is not followed by the policy rate for a greater part of the sample period. The Figures show that when IT was implemented in Ghana sometimes in 2007, the policy rate suggests a lower interest rate. This is an indication that the economy was in recession, reflecting negative output gaps and deflation. The economy later recovered and the policy rate recommends a higher interest rate than the policy rate. This scenario only hold between 2009 and the last quarter of 2012 after which the policy rate resumes back to the recommendation of lower interest rate.

However, South African policy rate suggests higher interest rate when IT was adopted in 2000. The behaviour has been fluctuating over the sample period but the graph indicates suggestion of lower interest rate from the last quarter of 2012 in order to revamp the economy. The deviations show that the baseline monetary policy rule is not the best approximation of how interest rate is determined in the two economies. This suggests that the baseline case should be augmented for the monetary policy instrument to be appropriately represented.

4.4.2.1.2 IT and Monetary Policy: The Augmented Rule

The augmented monetary policy rule for small open economies like Ghana and South Africa accommodates the influence of other variables such as, real exchange rate and real money supply (Taylor, 1993 and Torres, 2003) in determining the equilibrium interest rate. Tables 4.4.2.1B and 4.4.2.1D in appendix A-4 depict the estimates of the augmented forward-looking policy rule for Ghana and South Africa respectively. In the period prior to the adoption of IT, the coefficients of β are found to be statistically not significant in both Ghana and South Africa. This implies that the information contained in real exchange rate and money supply are embedded into the expected inflation deviation and output gap. This is an explanation of why the parameters lost their significance and a further evidence that the economies did not follow the IT policy rule in the period before the implementation of the IT framework.

However, the statistical significance of the coefficients of β and γ in the post-IT adoption indicates the independence of each variable augmented in the model. The fact that including the additional variables does not alter the expected signs and magnitude of the baseline result, it is an indication that none of the variables is correlated with the output gap and inflation deviation. Therefore, the information obtained in the real exchange rate and real money supply is independent and not included into the expected inflation and output gap in the economies. Moreover, the two series are found statistically significant and positive. Therefore, any increase in the variation in real exchange rate and money supply will require the monetary authorities to rise the nominal interest rate in the economies to restore the deviations in real exchange rate and money supply back to equilibrium level.

The full sample period in the augmented policy rule also follows the IT principle. The results in the full sample period also report a significant and positive non-zero parameters for the real exchange rate and real money supply; meaning that any increase in the variation in real money supply and exchange rate in Ghana and South Africa can be restored by a sufficient rise in the nominal interest rate which stimulates the real rate except for the real money supply for South Africa. The parameters β and γ are found to be positive and greater than 1 and 0 respectively. However, the coefficient of the γ is only significant in South Africa. This finding augments the result of the baseline policy rule which characterised Ghana as an extreme full pledged inflation targeting economy. Moreover, the results indicate that the combination of the expected inflation deviation, output gap, real money supply and real exchange rate represent the approximation of the mechanism through which the South African Reserve Bank and Bank of Ghana determine their monetary instrument of interest rate.

The study accounts for the existence of structural breaks in the data generating process. The break points coincide with the structural change from the policy of reserve/exchange rate targeting to implicit inflation targeting due to the excess exchange rate depreciation in Ghana and a shift from monetary targeting to inflation targeting in South Africa. However, the break points are found not significant. Despite the inclusion of the break dummies in the estimation process, the results do not change the conclusions of the baseline policy rule. In a nut shell, despite employing longer sample, use of Taylor rule and GMM estimators this study further supports the nominal anchor hypothesis and adoption of the full-fledged inflation targeting in Ghana and South Africa as in the baseline case. The findings are in line with Taylor principle as in, Aron and Muellbauer (2007); Gupta *et al.* (2010); Kabundi *et al.* (2015) for South Africa; Torres (2003) for Mexico and Clarida, Gali and Gertler (2001) for the United States among others.

4.4.2.2 Diagnostic Test for GMM Model

The appropriateness, consistent, unbiased and efficient findings based on GMM estimators depend highly on the suitability of the employed instruments in the estimation process (Hansen, 1982 and Karim & Zaidi, 2015). The instruments employed in the estimation process are reported beneath Tables 4.4.2.1A and 4.4.2.1C for the baseline policy rule and Tables 4.4.2.1B and 4.4.2.1D for augmented policy rules all under appendix A-4 for Ghana and South Africa respectively. The instruments are expected to contain the necessary information at the time of setting the rate of interest by the monetary authorities and anticipated to be vital in determining the output gap and inflation deviation. As obtained in, Lee and Lee (1997); Shabri, *et al*. (2009) and Torres (2003) among others, numerous lag lengths of different observed variables are estimated as instruments due to the difficulty in determining the appropriate instrument variables.

The results reported in Tables 4.4.2.1A to 4.4.2.1D (see all under appendix A-4) show the appropriate lags that certify the requirements of the model adequacy and adequately take part in forecasting output and inflation gaps which aid in adjusting the policy rule in the economies[7]. The moment condition of over-identification is evaluated using an objective function via generalised Sargan statistics, *J*-statistic. The models are assessed using the *J*-statistic with a null hypothesis that the over-identifying restriction is fulfilled. The models are not rejected at any conventional level of significance which shows that the GMM estimators are asymptotically normally distributed and consistent (Hansen and Singleton, 1982).

4.5 Exchange Rate Regime Switching and Exchange Rate Volatility

Despite the ample studies conducted on the non-linear relationship between the macroeconomic fundamentals and exchange rate such as Killian and Taylor (2003); Taylor and Peel (2000) and Taylor *et al*. (2001) among others, only few studies have investigated the transitional effect of the macroeconomic fundamentals on the exchange rate (Diebold *et al*., 1994 and Yuan, 2011). This follows the proposition that no macroeconomic fundamentals are able to fully explain the dramatic exchange rate volatility, since the beginning of floating exchange rate regime (Flood and Rose, 1999 and Yuan, 2011). Following the methodology specified by Diebold *et al*. (1994) and Yuan (2011), the present study investigates the influence of regime switching on exchange rate volatility through transition probabilities in a Markovian process.

[7] Furthermore, the results are obtained based on suggestion by Newey and West (1987) using Barlett estimators to ensure correct weighting and covariance matrixes of the orthogonality condition. The study estimates Newey and West (1994) lag truncation parameter with a fixed bandwidth. Moreover, using alternative procedure suggested by Andrews (1991) does not show different estimates, at least for the employed dataset.

The use of the Markov process is justified by the market believe in the possible changes in staying in a certain regime for the subsequent quarter(s). Therefore, the Markov-switching is found successful in modelling changes in regime especially in a latent manner (Engel & Hamilton, 1990; Hamilton, 1988, 1989 and Psaradakis, Sola & Spagnolo, 2004). The technique also accurately traces the movement of the economy and determines multiple optimal equilibrium to account for asymmetry especially as it relates to frequent speculations in the exchange rate market. Furthermore, the model successfully captured the deliberate government policies and persistent political instability (Ang & Bekaert, 2002). The methodology also accounts for time-varying conditional variance effect. It takes care of the shocks in the international monetary policies, changes in global trade relationship, financial market crisis and sudden financial shocks which affect the normal workings of the exchange rate movements (Yuan, 2011).

4.5.1 Unit Root Analysis

The analysis of the unit root properties of the series is an important feature of time series analysis such as Markov-switching ARCH models. The unit root analysis conducted in section 4.3.1 is also applicable for this objective except for the variable of ITF. In addition to the results presented in Tables 4.3.1A to 4.3.1C (in appendix A-3) for Ghana and Tables 4.3.1D to 4.3.1F (in appendix A-3) for South Africa, the study further presents the unit root analysis of the two remaining selected sub-Saharan African countries, Gambia and Nigeria. The results of the tests are presented in Tables 4.5.1A to 4.5.1C (appendix A-5) for Gambia and Tables 4.5.1D to 4.5.1F (appendix A-5) for Nigeria. Furthermore, the objective deals with political instability variables which is not part of the analysed fundamental variables of exchange rate determination.

The ADF results of the political instability variable for the selected countries are presented in Table 4.5.1G under appendix A-5 whereas, Tables 4.5.1H and 4.5.1I in the same appendix A-5 present the LS results at level and first difference respectively. The overall results indicate that the series are stationary at first difference except for the interest rate differential which is found stationary at the conventional levels of significance under both ADF and LS tests for all countries under study as well as exchange rate for South Africa under the LS trend model. However, the tests strongly reject the null hypotheses of unit root at first difference for all the series in the selected countries. The non-stationarity characteristics of the data allows for the endogenous determination of being in state one unconditional probability.

4.5.2 Estimation of Time Varying Markov Switching ARCH Model

The estimates under this sub-section determine the influence of exchange rate regime switching on the volatility of exchange rate especially in the presence of political instability. The estimation is carried out under the following steps; the test for ARCH effect to ensure the appropriateness of the model, the estimation of the stationarity for deviation of exchange rate from the fundamental values and estimation of the two state time-varying Markov-switching ARCH model. The discussion on the results of the estimations is presented under section 4.5.2.1.

4.5.2.1 Estimation Results and Discussion

The results of the time-varying Markov-switching ARCH model are presented in Table 4.5.2.1 (see appendix A-5). The exchange rate mean changes in the downward regime (regime 1) is represented by 2.259, -0.099, 4.621 and 1.959 whereas, the coefficients of mean changes in the upward regime (regime 2) are 2.065, -0.102, 4.885 and 0.929 for Gambia, Ghana, Nigeria and South Africa respectively. The results indicate that the exchange rate series for the countries are characterised by decline in the downward regime, except for Nigeria where the coefficient in the upward regime is higher than that of the downward regime. This might be as a result of uncertainty in the foreign exchange rate market due to the country's energy resources which may lead to high unpredictability in the demand for Nigerian *Naira* in the upward regime. However, the coefficients of the exchange rate mean changes are of less concern in the time-varying Markov-switching ARCH models.

The main parameter of interest is the ARCH term coefficient. The significance of the coefficients of ARCH term points out that the series (exchange rates) are associated with ARCH effect in the variance structure. The effect is widely evident in the appreciation state during a high variance regime across all the countries. These results are in line with previous positive findings on the parameter. Such studies include Diebold (1988); Diebold *et al*. (1994) and Yuan (2011) for British pound, Canadian dollar and Japanese yen. The presence of ARCH effect in the model is further confirmed and supported by the test for ARCH effect under section 4.5.2.2. The tests indicate the existence of ARCH process across all the economies under study. Moreover, the results of ARCH process show that South Africa and Nigeria exhibit amazingly high variance compared to Gambia and Ghana.

The parameters a and b measure the effect of exogenous variables including the deviations of exchange rate from fundamental values determined by macroeconomic fundamentals. These include inflation rate, interest rate, income and money supply differentials as well as political instability. The results reveal that the deviation of macroeconomic fundamental values affect the transition probabilities in the models. This is shown by the significance of the parameters in all countries. Furthermore, the coefficients of the parameter a (0.992, 0.976, 0.894 and 0.991 for Gambia, Ghana, Nigeria and South Africa respectively) indicate high transition probability in the data. This is an indication that the data on exchange rates do not stay within one (1) state for a prolonged period. These results are further confirmed by the coefficients of staying probability, ρ. The coefficient are generally different from zero and found very low except for Nigeria which is also not high (moderate).

The significance and low probabilities of the ρ indicate frequent volatility in exchange rate, meaning that exchange rates frequently shift between different regimes in subsequent periods. The results further highlight an evidence of transition in the exogenous variables. This is due to the sensitivity of the staying probability to the magnitude of the transition probability which is affected by the changes in the observed macroeconomic fundamentals and or changes in the exchange rate. Moreover, it is hypothesised that high deviations in the macroeconomic fundamentals and or changes in the exchange rates lead to high transition probability of not staying in the same regime in the subsequent period which leads to low staying probability (Yuan, 2011). The results of the specified models are in line with such a hypothesis.

From the results of the estimated models, it is shown that the deviations in the fundamental variables such as inflation rate, interest rate, money supply and income differentials as well as political instability affect the stability of exchange rate in a non-linear sense. This is revealed by the time-varying Markov switching transition probabilities. The positive evidence and distinction between high variance and low variance revealed by the models across all the economies are in line with previous findings on financial time series, like exchange rate and stock returns which tend to follow ARCH error process subject to changes in regime. Similar findings are obtained in Diebold *et al*. (1994) and Yuan (2011) among others. The validity of the results is subjected to the diagnostic test for time varying transition probabilities Markov-switching ARCH model. The results of the tests are discussed under the following sub-section.

4.5.2.2 Diagnostic Test for Time Varying MS-ARCH Model

The validity of the estimates and conclusions based on the time-varying Markov-switching ARCH model depend on the following diagnostic tests; the existences of ARCH effect in the exchange rate error process, regime shift in the conditional variance process and whether there exist transitional effect of the macroeconomic determinants on the evolution of the data process. Furthermore, the superiority of the time-varying Markov-switching transition probabilities is that it assumes two regimes in the mean changes in the exchange rate. The results of the diagnostic tests are presented in Table 4.5.2.2 under appendix A-5.

The null hypotheses of no ARCH effect are tested using the state-dependent ARCH terms, β_1, β_2. The assumption of the test is deduced based on Diebold *et al*. (1994), that mean and variance are regime-dependent although constant within each state over time. The null hypotheses are rejected for all countries, which indicate the existence of ARCH effect in the exchange rate/currencies. This justifies the estimation of the time-varying Markov- switching transition probabilities.

The second diagnostic test is the test of regime switching in the ARCH process. The null hypotheses, $\alpha_1 = \alpha_2, \beta_1 = \beta_2$ are tested on the presumption that there exist single state on the intercepts and coefficients of the ARCH terms. This further distinguishes whether there is difference between high and low variance in the conditional variance process of the model. The results reject the null hypotheses of no regime switching in the models for all countries under study. Thus, there is a strong evidence of the existence of regime changes in the ARCH process.

The final test investigates the transitional effect of the macroeconomic determinants (exogenous variables) on the dynamism of exchange rates. The tests impose the null hypotheses of static transition probabilities in the models. The results reject the null hypotheses for all countries. The rejection of the null hypotheses indicates the existence of time-varying transition probabilities in a Markovian process. Conclusively, the estimates of time-varying Markov-switching ARCH model are appropriate at least for the employed dataset.

4.6 Causality among Exchange Rate Fundamental Variables

Under this section, the study presents a comparative causality analysis among the variables of the theory of exchange rate determination using three methods; asymptotic Granger, dynamic Toda-Yamamoto with leverage bootstrapping and asymmetric causality for Gambia, Ghana, Nigeria and South Africa. Although the two newly employed methods - dynamic Toda-Yamamoto and asymmetric causality are not concerned about the unit root properties of the series, the stationarity analysis is conducted to determine the maximum order of integration among the variables for the purpose of lag augmentation in the VAR model as proposed in Toda and Yamamoto (1995) and Hatemi-J (2012) techniques.

The obvious reasons for the comparative causality analysis are associated with the size distortion, independence of nuisance parameter estimates and spurious conclusion based on the asymptotic distribution of the traditional Granger causality (Guru-Gharana, 2012 and Toda & Yamamoto, 1996). Furthermore, when normality assumption is not fulfilled, and the effect of autoregressive conditional heteroscedasticity exists, the usual asymptotic distribution theory does not work well (Hatemi-J & Irandoust, 2006 and Hatemi-J, 2012). Thus, the need for more reliable leverage distribution theory and asymmetric causality especially in this kind of finite sample, to avoid size distortion and spurious inferences. The use of asymmetric causality also distinguishes the existence of causality between good and bad times.

4.6.1 Unit Root Analysis

Despite the fact that the methodology of asymmetric and Toda-Yamamoto causality are applicable irrespective of the integration properties of the variables (Hacker and Hatemi-J, 2006 and Toda & Yamamoto, 1995), the study employs the traditional ADF and Lee and Strazicich (2013) minimum LM with one structural break to determine the maximum order of the integration. For the purpose of this objective, the study revisits the unit root tests on; exchange rate and differentials inflation, interest rate, money supply and income presented in appendix A-3, Tables 4.3.1A, 4.3.1B and 4.3.1C for Ghana and Tables 4.3.1D, 4.3.1E and 4.3.1F for South Africa. Moreover, Tables 4.5.1A, 4.5.1B and 4.5.1C and Tables 4.5.1D, 4.6.1E and 4.6.1F in appendix A-5 for Gambia and Nigeria respectively present results for both ADF and LS unit root test. The tests establish that the maximum order of integration of all the variables for all countries are $I(1)$ order. This implies that the lag augmentation $(d_{\max})$ in estimating the vector autoregressive model for all the countries is determined as one. The results further allow the opportunity to estimate the cumulative positive and negative shocks of the asymmetric causality analysis.

4.6.2 Estimation of Granger, Toda-Yamamoto and Asymmetric Causality

This objective here investigates causality among the fundamentals of exchange rate determination in the selected sub-Saharan African countries (Gambia, Ghana, Nigeria and South Africa) using three different techniques; asymptotic Granger, dynamic Toda-Yamamoto with leverage bootstrapping and non-linear asymmetric causality. The findings are presented in the following subsection.

4.6.2.1 Estimation Results and Discussion

The estimate results of the asymptotic Granger non-causality, modified *WALD* statistics and critical values of the modified *WALD* test for the leverage bootstrap and asymmetric causality are presented in Tables 4.6.2.1A, 4.6.2.1B, 4.6.2.1C and 4.6.2.1D, appendix A-6 for Gambia, Ghana, Nigeria and South Africa respectively. The bootstrap critical values are simulated based on the underlying empirical data using GAUSS software.

The results of non-Granger causality in column two of Table 4.6.2.1A indicate the existence of bidirectional causality between inflation differentials and exchange rate, a unidirectional causality running from interest rate differentials to exchange rate and exchange rate to money supply differentials. However, the results indicate absence of causality between income differentials and exchange rate in Gambia. The results presented in Table 4.6.2.1B show the existence of unidirectional causality running from money supply, inflation, interest rate and income differentials to exchange rate in Ghana without any feedback relationship. Moreover, the estimates presented in Table 4.6.2.1C reveal a unidirectional causality from exchange rate to money supply and interest rate differentials without any causality from inflation and income to exchange rate and vice versa for Nigeria. Similarly, the results presented in Table 4.6.2.1D show the existence of only a one way causality from exchange rate to inflation differentials without any causal relation between the other variables of the monetary theory of exchange rate determination in South Africa.

However, the non-Granger causality was developed based on asymptotic distribution theory which is seen to cause a spurious conclusion. The null hypothesis at level estimation suffers non-standard asymptotic distribution, whereas, the integrated Granger causality suffers the independence of nuisance parameter estimates (Sims *et al*., 1990 and Toda & Philips, 1993). Furthermore, the existence of ARCH effect and non-normal distribution of the residuals in the VAR model also render the usual asymptotic distribution theory to be less relevant (Hacker & Hatemi-J, 2006 and Hatemi-J, 2012). Table 4.6.2.1E in appendix A-6 presents the ARCH effect and normality results on the standard VAR models for the countries. The null hypotheses of both ARCH effect and normality in the VAR model are rejected for all countries under study. Thus, using the asymptotic distribution theory in this scenario would lead to size distortion and nuisance parameter estimates in establishing causality (Hacker & Hatemi-J, 2006).

Nevertheless, the results of the modified *WALD* test show different findings compared to the Granger non-causality. Considering Toda and Yamamoto (1995) modified *WALD* result with leverage bootstrapped critical values without asymmetric effect, the results establish a one way causation from interest rate and income differentials to exchange rate in Gambia without feedback from exchange rate and neither causation between exchange rate and its fundamentals in Ghana, Nigeria and South Africa.

Nonetheless, Hatemi-J (2012) argues that response to positive and negative asymmetric shocks may lead to varying causal relationships which has been neglected in the previous literature. Therefore, the main concern of this study is the newly developed asymmetric causality proposed in Hatemi-J (2012). The study further investigates whether causality among variables differs between good and bad times.

The asymmetric causality test for Gambia indicates a rejection of null hypothesis of non-Granger causality running from positive cumulative shocks (decrease) in money supply and inflation differentials to positive cumulative exchange rate shocks (exchange rate appreciation) without any reverse effect. This indicates that decrease in the difference between domestic and foreign money supply and inflation cause appreciation in the Gambian exchange rate. The results also reveal the existence of causality from the negative cumulative shocks in exchange rate (exchange rate depreciation) to negative cumulative shocks (increase) in interest rate and income differentials. However, there is neither evidence of feedback causality nor positive cumulative causal relationship among income, interest rate and exchange rate in Gambia.

As for the case of Ghana, the asymmetric causality flows from the negative cumulative exchange rate shocks to negative cumulative changes in money supply, inflation, interest rate and income differentials. This reveals that exchange rate depreciation causes increase in the difference between domestic and foreign money supply, differential inflation, interest rate and income. The results do not show any evidence of feedback. This means that increase in the differential income, interest rate and inflation do not lead to depreciation in Ghana. Furthermore, there exist no causal relationship in the good times (during exchange rate appreciation and decrease in the differential income, interest rate and inflation rate).

The results for Nigeria presented in Table 4.6.2.1C (see appendix A-6) show an evidence of causal relationship running from inflation differentials to exchange rate in the positive periods. Impliedly, decrease in inflation causes exchange rate appreciation in the country. Furthermore, exchange rate is also found causing income differentials but only in the bad times. Meaning that exchange rate depreciation causes increase in the differential income between the domestic and foreign economies. However, the results do not reject the null hypotheses of no causality between exchange rate and money supply as well as interest rate differentials irrespective of during the period of exchange rate appreciation or depreciation as well as decrease or increase in the differentials money supply and interest rate.

The results from the estimates for South Africa also reveal that only money supply differentials can cause exchange rate. This only holds in the good times without any feedback neither in the good nor bad times. This shows that decrease in the level of income differentials causes exchange rate appreciation. Nonetheless, exchange rate depreciation is also found causing increase in the interest rate and income differentials. However, increase in the differential income and interest rate do not leads to exchange rate depreciation. Furthermore, the feedback causality does not exist regardless during exchange rate appreciation or depreciation states.

The findings portray the advantage of employing asymmetric causality test which differentiates the existence of causality during good and bad times. The results indicate that decrease in excess money supply leads to exchange rate appreciation in Gambia and South Africa. However, there is no indication of feedback in the process and such a result does not hold for Ghana and Nigeria although the reverse exists in Ghana where it is shown that depreciation in exchange rate would cause excess money supply differential in the economy.

The results further reveal that decrease in inflation differentials influence exchange rate appreciation in Gambia and Nigeria. The reverse of the outcome is only established in Ghana where the results indicate that exchange rate depreciation causes inflationary pressure. Moreover, the results indicate that exchange rate depreciation leads to increase in the disparity in income and interest rate in all countries except for interest rate differentials in Nigeria. The results do not have any feedback effect either during the period of exchange rate appreciation or depreciation.

4.7 Chapter Summary

The chapter presents and discusses results of the four objectives of the study. First, the effectiveness of inflation targeting as hedging strategy for exchange rate volatility using TGARCH model. The results indicate that the menace of exchange rate volatility reduces when IT policy was adopted in Ghana and South Africa. However, the policy transition period is found to have increased the ruin of exchange rate at least in the immediate next quarter based on the data of the sampled countries. The coefficients of floating exchange rate regime are also positive and significantly different from zero, so also the structural break accounted for in the data generating process especially after controlling for floating exchange rate regime in the models.

Second, the test of whether ITF performs the role of the nominal anchor and represents the process followed by Ghana and South Africa in determining their interest rate. The results of the baseline and augmented models reveal that prior to the adoption of ITF, the economies do not follow the IT principle. However, the post-IT adoption and full sample periods indicate that ITF become a nominal anchor in the economies. Furthermore, the major hypothetical response of interest rate to inflation deviation and output gap is greater in South Africa compared to Ghana. This is found similar under both baseline and augmented policy rules specification. The results further reveal that the monetary policy is an automatic stabilizer of inflation deviation and output gap around their target levels. The augmented policy rule reveals that interest rate is best approximated by inflation deviation, output gap, real exchange rate and real money supply except for South Africa where real money supply plays a minimal role in determining interest rate for the economy.

Third, the chapter investigates the influence of exchange rate regime switching on the volatility of exchange rate in Gambia, Ghana, Nigeria and South Africa. The results indicate that the exchange rates of the countries are characterised by decline in the downward regime except for Nigeria which shows high decline in the upward regime. The estimates further reveal the existence of ARCH effect in the appreciation state. The existence of ARCH effect depends on regime changes. Moreover, the deviation of macroeconomic fundamentals from equilibrium value affects the transition probabilities for all countries. Finally, the results indicate that exchange rate frequently changes/shift from one regime to another over time.

Fourth, the comparative results among the asymptotic Granger, Toda-Yamamoto with leverage bootstrapping and asymmetric causality reveal the existence of size distortion and nuisance parameter estimate when the former is used and spurious inference when ARCH effect exist and normality assumption is violated. Furthermore, the study uses a more reliable leverage distribution theory and asymmetric causality. The later distinguishes the existence of causality in good and bad times. This is carried out using data on the fundamentals of the monetary theory of exchange rate determination for Gambia, Ghana, Nigeria and South Africa.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the main findings of the study. It suggests policy implications of the findings. The chapter also offers recommendations for future research and finally highlights limitations of the study.

5.2 Summary of Findings

The study investigates four objectives in the selected sub-Saharan African economies using time series dataset spanning 1980:Q1 to 2014:Q4. The first two objectives are investigated on Ghana and South Africa. The justification for investigating the first two objectives on Ghana and South Africa is due to the fact they are the only economies that have adopted IT framework in the sub-Saharan Africa. The remaining two objectives are investigated on Gambia and Nigeria in addition to Ghana and South Africa. The selection of this sample is based on at least three criteria. Firstly, the persistent historic and clustering volatility. This is largely exhibited in Gambia, Ghana, Nigeria and South Africa. Secondly, the adoption of the monetary policy of IT framework in the sub-Saharan African economies. This is only adopted in Ghana and South Africa among the sub-Saharan African countries. Finally, availability of data in the sampled countries.

The first objective of the study investigates the effectiveness of the IT framework as a hedging strategy for exchange rate volatility in Ghana and South Africa using threshold generalised autoregressive conditional heteroscedasticity model. The study utilises two measures of IT framework; a dummy variable and a constructed IT series using a Hodrick-Prescott filter. The use of a dummy variable in policy related studies is well established in the literature. This is found in the studies of Aggarwal *et al.* (1999); Hamilton and Susmel (1994); Lamoureux and Lastrapes (1990) among others. However, the constructed variable is used as a robustness check to the other estimation approach using the dummy variable.

The estimated coefficients of both the dummy and constructed IT series are found significant and negatively related to volatility of exchange rate for both Ghana and South Africa. The magnitude of the significance based on the dummy inflation targeting (DIT) is higher in South Africa compared to Ghana and vice versa using the constructed IT series. This shows an evidence that implementation of IT framework decreases the instability of exchange rate in the two sub-Saharan African IT economies. The result exists irrespective of controlling or otherwise for flexible exchange rate. The possible explanation of the result is that ITF adoption tends to restore inflation deviation and output gaps to their target levels and minimizes sudden shocks effect on exchange rate due to transparency and predictability of the monetary policy framework of the IT principle. The transparency and accountability in setting interest rate ensure stability of the financial system. This prevents the shocks emanating from the usual uncertainty that occur from speculations especially as it relates to interest rate and inflation.

However, the lag ITF is found positive and statistically different from zero. This indicates that the IT policy transition increases the volatility of exchange rate. This might be explained based on the immediate sudden shock that usually occur in the nominal interest rate in order to cut aggregate demand and restore inflation to its target level. The shocks might cause sudden reaction in currency price in the exchange rate market. Moreover, a sudden response to changes in the currency prices leads to instability in the prices of currency. The study controlled for flexible exchange rate regime in the two economies due to their prolonged changes in the regimes of exchange rate. Interestingly, the results of the IT coefficients did not change and the flexible exchange rate regime dummy is found positive and significant in influencing volatility of exchange rate.

The outcomes of this study are in line with the expectation from theory and empirical results. The structural breaks/sudden shocks in the exchange rate are also found positive and statistically significant in most cases in both Ghana and South Africa. This is an indication that increase in sudden shocks in the prices of domestic currencies in relation to foreign currencies also aggravates the instability of exchange rate in Ghana and South Africa. Furthermore, the study found the existence of asymmetric effect in the model. This means that exchange rate users react differently during good and bad times. The asymmetric response in the estimation indicates that positive shocks leads to higher volatility of exchange rate in the succeeding quarter compared to the same level of negative shocks.

The second objective of the study examines whether the monetary policy of inflation targeting framework has performed the role of the nominal anchor and the process through which interest rate is determined in Ghana and South Africa. The findings of the study indicate that the coefficients of inflation deviation and output gap are not statistically significant prior to implementation of ITF in both Ghana and South Africa.

Thus, the estimates of the Pre-IT period reveal that the rise in the nominal interest rate by the South African Reserve Bank and Bank of Ghana, was not sufficient to rise the real interest rate in order to lower aggregate demand which restores inflation back to its equilibrium level in the economies. The results in the post-IT and full sample periods show that Ghana and South Africa respectively practice extreme and full pledged inflation targeting. This means that the real interest rate responds to the rise in the nominal rate to cut down the level of aggregate demand and inflationary pressure to the appropriate levels. This indicates compliance with the nominal anchor hypothesis. The results further indicate that the major hypothetical response of the monetary instrument to inflation deviation and output gap is stronger in South Africa compared to Ghana. This shows that South Africa extremely targets inflation immediately after the adoption of the IT framework without much concern about output gap whereas in Ghana, such a scenario only occurred when full sample is estimated. This is similarly found in the augmented policy rule as well.

Overall, the results reveal that monetary policy is an automatic stabilizer of inflation and output around their targets level under both the baseline and augmented policy rules. Furthermore, the augmented policy rule reveals that the combination of inflation deviation, output gap, real exchange rate and real money supply represent an appropriate approximation of the mechanism through which interest rate is determined in Ghana and South Africa. However, the findings indicate that real money supply plays a minimal role in determining interest rate in South Africa. Moreover, the study accounts for the presence of structural breaks in the dataset. The break points coincide with the movement from exchange rate to implicit IT framework and monetary targeting to full-fledged IT policy in Ghana and South Africa respectively. The break points are found not significant and do not alter the overall result of the baseline policy rule.

The third objective of the study investigates the influence of exchange rate regime switching on exchange rate volatility in Gambia, Ghana, Nigeria and South Africa. The results indicate that the exchange rates of the countries are characterised by decline in the downward regime except for the Nigerian currency which shows high decline in the upward regime. This might be explained by the *Naira*'s high uncertainty in the foreign exchange rate market due to the Nigeria's dependence on energy resources which may leads to high unpredictability in the demand for the country's currency especially in the upward regime.

The estimates further reveal the existence of ARCH effect in the appreciation state and that the existence of ARCH effect depends on regime changes. The significance of the coefficients of ARCH term point out that the series (exchange rates) are associated with ARCH effect in the variance structure. The effect is widely evident in the appreciation state during a high variance regime across all the countries. These results are in line with previous positive findings such as; Diebold (1988); Diebold *et al*. (1994) and Yuan (2011) for British pound, Canadian dollar and Japanese yen.

Moreover, the findings further reveal that deviation of macroeconomic fundamentals such as inflation rate, interest rate, income and money supply differentials as well as political instability from equilibrium value affect the transition probabilities of all the countries. The coefficients of the parameter indicate high transition probability in the data. This is an indication that the data on exchange rates do not stay within a single regime for a prolonged period.

Finally, the results indicate that exchange rates frequently shift from one regime to another over time. The results further reveal an evidence of transition in the exogenous variables. This is due to the sensitivity of the staying probability to the magnitude of the transition probability. Therefore, the stability of exchange rates are highly affected by the changes in the observed macroeconomic fundamentals and or regime changes in the exchange rates series. The positive evidence and distinction between high variance and low variance revealed by the models across all the economies are in line with previous findings on financial time series, like exchange rate and stock returns which tend to follow ARCH error process subject to changes in regime. Similar results are obtained in Diebold *et al.* (1994) and Yuan (2011), among others.

The fourth objective of the study determines the causal relationship among the variables of the monetary theory of exchange rate determination in Gambia, Ghana, Nigeria and South Africa. The study compares among the asymptotic Granger, dynamic Toda-Yamamoto and asymmetric tests for causality. The critical values used in the leverage distribution and asymmetric causality are simulated using the underlying empirical data. The results show the existence of one way causation in the asymptotic Granger causality test running from money supply differentials to exchange rate in Ghana without any feedback. The reverse of the relationship only holds in Gambia and Nigeria. In the same vein, inflation differentials cause exchange rate in Gambia and Ghana with only a feedback in Gambia. The unidirectional causality from exchange rate to inflation differentials exist in South Africa without having exchange rate caused by the inflation differentials. Similarly, interest rate differentials unidirectionally cause exchange rate in Gambia and Ghana without response from exchange rate to interest rate differentials. However, exchange rate is found to have caused interest rate differentials only in Nigeria. The causality is further examined between income and exchange rate. The results show an evidence of one way direction from income differentials to exchange rate in Ghana without feedback causality. This however, does not hold for Gambia, Ghana, Nigeria and South Africa.

The modified Toda-Yamamoto results based on leverage bootstrap critical values reveal a unidirectional causality running from income and interest rate differentials to exchange rate in Gambia without any response from exchange rate. Furthermore, there exist no causality between other exchange rate fundamentals (money supply, inflation, interest rate and income differentials) and exchange rate in the selected economies.

The asymmetric causality distinguishes between positive and negative cumulative causality. The results of the asymmetric causality indicate that in the good times, that is, decrease in excess money supply leads to exchange rate appreciation in Gambia and South Africa. However, there is no indication of feedback causality and such a result does not hold for Ghana and Nigeria although the reverse is found in Ghana. This implies that exchange rate depreciation causes excess money supply differentials. The finding further reveals that in the good times (decrease in inflation differentials) causes exchange rate appreciation in Gambia and Nigeria. The reverse of the outcome is only established in Ghana where the result indicates that exchange rate depreciation causes inflationary pressure. Furthermore, the results show that exchange rate depreciation leads to increase in the disparity in income and interest rate in all countries except for interest rate differentials in Nigeria. The results do not have any feedback effect either in the periods of exchange rate appreciation and depreciation.

The study discovers that using the asymptotic Granger causality based on asymptotic distribution irrespective of the integration order of the variables leads to size distortion, rank deficiency and nuisance parameter estimates. This is evident by the non-existence of causality between income differentials and exchange rate based on asymptotic distribution whereas, causality among the variables exist using leverage distribution and asymmetric causality in Gambia. Another instance is the existence of asymptotic Granger causality from exchange rate to money supply and interest rate differentials in Nigeria. However, there is no causality among such variables using both leverage bootstrapping and asymmetric causality. Furthermore, the existence of causality from exchange rate to inflation differentials in the asymptotic Granger causality without a similar occurrence using the simulated critical values based on the underlying empirical data is also a pointer to the existence of size distortion when South African data is employed.

5.3 Policy Implication of the Findings

The results of the study indicate that adoption of IT framework serves as a hedging strategy for exchange rate volatility in the two inflation targeting economies. Thus, to achieve a more stable exchange rate, the inflation targeting economies should efficiently manipulate their monetary policy instrument (interest rate) to ensure effective IT policy. This can be achieved through increase in the autonomy, accountability and transparency of the monetary authorities. The autonomy in ensuring transparency and accountability in interest rate determination will lead to stability in the financial system. This will prevent the shocks emanating from the usual uncertainty that occur from speculations especially as it relates to interest rate and domestic inflation. Furthermore, the economies should work towards policies that promote exchange rate appreciation and those that discourage exchange rate regime changes. The former can be actualised through increase in investment and productivity as well as external trade that would encourage more demand for the domestic currencies. Moreover, money supply should be kept to the barest minimum to discourage persistent level of consumer prices (inflation) in the economies. On the other hand, the other sub-Saharan African countries that are non IT economies should adopt IT lite policy in order to hedge against the menace of exchange rate volatility confronting most of the sub-Saharan economies. Abdullah, Ali and Matahir (2010) similarly recommend IT framework for ASEAN-5 economies based on "higher inflation elasticity of money demand" while monitoring the effect of changes in inflation growth, commodity prices and monetary aggregates.

On the nominal anchor hypothesis which holds for both Ghana and South Africa, government should through effective monetary and fiscal policies embark on contractionary/expansionary policies in aggregate demand. This can be achieved through an appropriate increase/decrease in nominal interest rate to restore inflation to its target and output to its potential levels during inflationary or economic boom and deflationary or economic recession respectively. This can be easily actualised when there is a reasonable degree of central banks' autonomy, transparency, accountability and independence. Moreover, the uncertainties arising from other macroeconomic indicators such as exchange rate instability and excess money supply in the economies should be appropriately regulated by the mechanism of interest rate in the economies.

This requires sufficient rise in nominal interest rate to rise the real rate in order to cut the level of aggregate demand and restore the economy back to equilibrium. In restoring the economy to equilibrium, the Bank of Ghana requires high degree of discretion to rationally manage the cost of inflation from the external shocks compared to Reserve Bank of South Africa. Furthermore, for the monetary authorities of Ghana and South Africa to achieve their objective of price stability, the monetary policies of these economies should focus more on restoring inflation to its equilibrium level compared to output gaps. This also requires using interest rate to monitor inflation through money supply especially in the Ghanaian economy.

Another implication of the findings of this study is that exchange rate regime changes have impact on the stability of exchange rate in the selected sub-Saharan African economies. Thus, the policymakers should focus on policies that will work towards minimising the deviations in the macroeconomic fundamentals such as inflation rate, interest rate, money supply and income differentials from their equilibrium values. The influence of the changes is more established in Gambia followed by South Africa, Ghana and lastly Nigeria. Furthermore, the governments should minimise rampant changes in financial and other economic policies. Thereby ensuring political stability in the economies. These measures should be prioritised in the high variance and downward regime such as periods of exchange rate depreciation. For the exchange rates to stay relatively in a single state over a prolonged period of time, the policymakers should manipulate the interest rate, money supply, inflation rate to ensure demand in the domestic currencies thereby appreciation in the exchange rates in relation to other currencies in the foreign exchange market.

Other important implication of the findings of this study is that the monetary authorities of Gambia and South Africa can stabilise exchange rate fluctuations by regulating (decreasing) the level of money supply. Specifically, this can be achieved using contractionary monetary policy where policies toward decrease in money supply can lead to low inflation whereby exchange rate appreciation. The findings suggest that such policies can only work during exchange rate appreciation. Moreover, the authorities can only manipulate exchange rate to stabilize money supply differentials during bad times in Ghana. This implies that only Ghanaian monetary authority can ensure stability of money supply using sterilization policies especially during the era of exchange rate depreciation.

Similarly, the monetary authorities of Gambia and Nigeria can actively influence exchange rate appreciation by manipulating inflation differentials. This implies that monitoring the rate of inflation in these countries can regulate the level of instability in the exchange rates. Specifically, this can be achieved through contractionary monetary policies that work towards decrease in the domestic inflation which leads to appreciation of exchange rate. However, the other instrument (exchange rate) can only be manipulated in Ghana to avoid inflationary spirals in the economy. The use of sterilization policies to maintain a stable inflation rate can only hold in Ghana without similar response in Gambia, Nigeria and South Africa.

Furthermore, the policymakers can regulate exchange rate to achieve a stable level of income and interest rate during exchange rate depreciation and economic recession in all the economies except for Nigeria where sterilizing exchange rate cannot stabilise interest rate irrespective of economic situation, boom or recession. Therefore, the

Gambian, Ghanaian and South African monetary authorities can efficiently regulate international capital mobility at least for the period under study.

5.4 Recommendations for Future Research

Despite the fact that this study tries to address a number of issues emphasised in the literature that hampered appropriate policy making, the study does not completely address all the shortcomings of the previous studies. The first objective of the study uses TGARCH model to investigate the effectiveness of IT framework as a hedging strategy for exchange rate volatility in Ghana and South Africa. Based on the limited sample of the IT economies in the sub-Saharan Africa, the study recommends that further studies may be conducted considering other countries of the world that targeted inflation and confronted with exchange rate volatility. Further studies should extend the present research using similar and different methodologies such as EGARCH, FGARCH and BKK GARCH family models especially in the sub-Saharan Africa when IT economies increase with time. Moreover, one of the advantages of TGARCH over EGARCH and other ARCH family models is forecasting and the fact that forecasting is outside the scope of this study, it is recommended that further studies should consider forecasting the menace of exchange rate volatility in IT and non-IT sub-Saharan African economies.

The second objective of the study employs an ex-post type of data to test the nominal anchor hypothesis in the forward-looking monetary policy rule specification. The study recommends using a forecast data on inflation and output to test the nominal anchor hypothesis using an augmented forward-looking policy rule model. Future studies should consider new set of information to further identify the factors that determine interest rate in the IT economies. Moreover, in the small open economies like sub-Saharan African countries confronted with economic instability and rampant interest rate liberalisation, such factors like; country risk perception index and interest rate liberalisation among others (Torres, 2003 and Clarida *et al*., 2001) should also be considered in the estimation process. Although the structural breaks identified by the LS test are accounted for using a dummy variable in the GMM estimation, the less significance of the break points in the estimation process should be checked using methodologies that detect existence of break beyond its prevalence in the data generating process. These methods might be more informative. The methods include but not limited to; Gregory and Hansen (1996); Johansen, Mosconi and Nielsen (2000) and Lütkepohl, Saikkonen and Trenkler (2001) for analysing co-integration and vector autoregressive modelling in the presence of structural breaks.

From the estimates of the third objective, the influence of the regime switching on the volatility of exchange rate should be complemented with other variables apart from the political instability considered in this study. These variables should include financial stress especially for studies that would be carried out in economies that are vulnerable to financial crisis. Other important variables to be considered should include institutional variables such as corruption. This is due to the prevalence of high level of corruption in the sub-Saharan African economies. The institutional quality variables may build investors' confidence and encourage investment into the domestic economy. This will lead to increase in the demand for local currency and stabilize the exchange rate and reduce its volatility (Yartey, 2007). The study further recommends that similar studies should be conducted using models other than time varying transition probabilities Markov-Switching ARCH model. These may include GARCH

Markov-switching modelling where conditional variance is designated as a function of entire past history of the state variables and those models that employ observed phenomenon rather than latent variables.

The fourth objective deals with causal relationship between exchange rate and the fundamentals of exchange rate determination in Gambia, Ghana, Nigeria and South Africa. The study compares among the asymptotic Granger causality and the new methodologies; modified Toda-Yamamoto and asymmetric causality proposed by Toda and Yamamoto (1995) and Hatemi-J (2012) respectively to check the existence of size distortion and nuisance parameter estimates associated with the former method. However, this is limited to a few combinations, the test of causality between exchange rate and fundamental variables and vice versa without looking at the possible other combinations among the variables in the model. It is recommended that further studies should investigate the causality among the other possible combinations in order to prove some other hypotheses such as money-income relationship among others. The study also recommends comparing between the asymptotic Granger causality and asymmetric causality in other sub-Saharan African economies to allow for more general conclusions.

5.5 Limitations of the Study

This study is not without limitations. Some of the limitations of the study include; unavailability of longer sample data, say monthly frequency to estimate TGARCH model to allow for higher volatility. The study covers four countries out of the many economies in the sub-Saharan African region. These include Ghana and South African economies that adopt IT framework and Gambia and Nigeria that exhibit high prevalence of clustering volatility as at the time the study was conducted. Moreover, one of the advantages of TGARCH over EGARCH and other ARCH family models is forecasting, however, this is not part of the objectives of the study.

The use of inflation and output forecast data is an important but not a mandatory requirement in estimating forward-looking Taylor rule. This study uses ex-post inflation deviation and output gap data following Torres (2003) and Clarida *et al*. (2001) among others. The forecast data is not readily available in emerging and developing economies of South Africa and Ghana respectively. This would have made nominal interest rate more responsive to inflation deviation and output gap especially in the augmented forward-looking policy rule specification (Torres, 2003).

Furthermore, this study estimates asymmetric causality using the latest methodology developed in Hatemi-J (2012) to distinguish between causality in good and bad times. However, another limitation of the study is the inability to estimate the causal relationship across all the sub-Saharan African economies and among the various combinations of the variables of the monetary theory of exchange rate determination. Although this is outside the scope of this study but would have tested the applicability or otherwise of other hypotheses in the sub-Saharan Africa.

REFERENCES

Abbas, Q., & Iqbal, J. (2012). Relationship between GDP, inflation and real interest rate with exchange rate fluctuation of African countries. *International Journal of Academic Research in Accounting, Finance and Management Sciences, 2*(3), 132-141.

Abdul Karim, Z., & Abdul Karim, B. (2014). Interest rates targeting of monetary policy: An open economy SVAR study of Malaysia. *Gadjah Mada International Journal of Business, 16*(1), 1-23.

Abdul Karim, Z., Said, M., Faezah, F., Jusoh, M., Thahir, M., & Zyadi, M. (2009). *Monetary policy and inflation targeting in a small open-economy*. MPRA paper No. 23949 retrieved at http://mpra.ub.uni-muenchen.de/23949/.

Abdullah, H., Ali, J., & Matahir, H. (2010). Re-examining the demand for money in ASEAN-5 countries. *Asian Social Science, 6*(7), 146-155.

Achsani, N., Fauzi, A. J. F. A., & Abdullah, P. (2010). The relationship between inflation and real exchange rate: comparative study between Asean+3, the EU and North America. *European Journal of Economics, Finance and Administrative Sciences, 18*(2010), 1450-2275.

Adebola, S. S., & Dahalan, J. (2011). Capital mobility: An application of saving-investment link for Tunisia. *International Journal of Economics and Financial Issues, 2*(1), 1-11.

Adrangi, B., & Allender, M. (1995). US interest rates and the exchange value of the dollar: A test of causality. *Journal of Economics and Finance, 19*(1), 51-61.

Aggarwal, R., Inclan, C., & Leal, R. (1999). Volatility in emerging stock markets. *Journal of Financial and Quantitative Analysis, 34*(1), 33-55.

Aghion, P., Bacchetta, P., Ranciere, R., & Rogoff, K. (2009). Exchange rate volatility and productivity growth: The role of financial development. *Journal of Monetary Economics*, *56*(4), 494-513.

Ahmad, M. N., Yusop, Z., & Masron, T. A. (2010). How did the Malaysian real exchange rate misalign during the 1997 Asian crisis?. *International Journal of Economics, Management and Accounting*, *18*(2), 161-195.

Aizenman, J., & Hutchison, M. (2011). The emerging global financial architecture and exchange rate regimes in a volatile world. *International Review of Economics & Finance, 20*(1), 1-4.

Aizenman, J., Hutchison, M., & Noy, I. (2011). Inflation targeting and real exchange rates in emerging markets. *World Development*, *39*(5), 712-724.

Akhtar, M. A., & Hilton, R. S. (1984) Effects of exchange rate uncertainty on German and U.S. trade. *Federal Reserve Bank of New York Quarterly Review, 9*(Spring), 7-16.

Akinbobola, T. O. (2012). The dynamics of money supply, exchange rate and inflation in Nigeria. *Journal of Applied Finance & Banking*, *2*(4), 117-141.

Alimi, S. R., & Ofonyelu, C. C. (2013). Toda-Yamamoto causality test between money market interest rate and expected inflation: The Fisher hypothesis revisited. *European Scientific Journal*, *9*(7), 125-142.

Aliyu, S. U. R. & Englama, A. (2009). *Is Nigeria ready for inflation targeting?*. MPRA paper No 14870, available at http://mpra.ub.uni-muenchen.de/14870/.

Aliyu, S. U. R. (2012). Does inflation have an impact on stock returns and volatility? Evidence from Nigeria and Ghana. *Applied Financial Economics, 22*(6), 427-435.

Allsopp, C., Kara, A., & Nelson, E. (2006). United Kingdom inflation targeting and the exchange rate. *The Economic Journal*, *116*(512), F232-F244.

Alvarez, F., Atkeson, A., Kehoe, P.J. (2002). Money, interest rates and exchange rates with endogenously segmented markets. *Journal of Political Economy, 110*(1), 73–112.

Amemiya, T. (1975). The nonlinear limited-information maximum-likelihood estimator and the modified nonlinear two-stage least-squares estimator. *Journal of Econometrics*, *3*(4), 375-386.

Andrews, D. W. (1991). Heteroskedasticity and autocorrelation consistent covariance matrix estimation. *Econometrica: Journal of the Econometric Society, 59*(3), 817-858.

Ang, A., & Bekaert, G. (2002). Regime switches in interest rates. *Journal of Business & Economic Statistics*, *20*(2), 163-182.

Antoni, A. (2010). Monetary policy and inflation targeting in a small open economy. *Economic Journal of Emerging Markets, 2*(2), 187-198.

Arabi, K. A. M. (2012). Estimation of exchange rate volatility via GARCH model: Case study Sudan (1978–2009). *International Journal of Economics and Finance, 4*(11), 183-192.

Arize, A. C., & Malindretos, J. (1997). Effects of exchange-rate variability on inflation variability: Some additional evidence. *Applied Economics Letters, 4*(7), 453-457.

Arize, A. C., & Malindretos, J. (1998). The long-run and short-run effects of exchange-rate volatility on exports: The case of Australia and New Zealand. *Journal of Economics and Finance*, *22*(2-3), 43-56.

Arize, A. C., Malindretos, J., & Shwiff, S. S. (1999). Structural breaks, cointegration, and speed of adjustment evidence from 12 LDCs money demand. *International Review of Economics & Finance, 8*(4), 399-420.

Aron, J. & Elbadawi, I. (1999). *Reflections on the South African rand crisis of 1996 and its consequences*." Working paper series 1999:13. Centre for the study of African Economics. Oxford University.

Aron, J., & Muellbauer, J. (2007). Review of monetary policy in South Africa since 1994. *Journal of African Economies, 16*(5), 705-744.

Ashfan, G. & Batul, T. (2014). Relationship among exchange rate, trade, interest rate and inflation in Pakistan and India: A time series modeling approach. *International Researcher, 3*(3), 34-53.

Assery, A., & Peel, D. (1991). The effects of exchange rate volatility on exports: Some new estimates. *Economics Letters, 37*(2), 173-177.

Attah-Obeng, P., Enu, P., Osei-Gyimah, F., & Opoku, C. D. K. (2013). An econometric analysis of the relationship between GDP growth rate and exchange rate in Ghana. *Journal of Economics and Sustainable Development, 4*(9), 1-8.

Awe, O. O. (2012). *On pairwise Granger causality modelling and econometric analysis of selected economic indicators*. Interstat Statjournals. net/YEAR/2012/articles/1208002. pdf, 1-17.

Azeez, B. A., Kolapo, F. T., & Ajayi, L. B. (2012). Effect of exchange rate volatility on macroeconomic performance in Nigeria. *Interdisciplinary Journal of Contemporary Research in Business, 4*(1), 149-155.

Bachman, D. (1992). The effect of political risk on the forward exchange bias: the case of elections. *Journal of International Money and Finance, 11*(2), 208-219.

Baharumshah, A. Z., Lau, E., & Khalid, A. M. (2006). Testing twin deficits hypothesis using VARs and variance decomposition. *Journal of the Asia Pacific Economy, 11*(3), 331-354.

Bahmani-Oskooee, M., & Hegerty, S. W. (2007). Exchange rate volatility and trade flows: A review article. *Journal of Economic Studies, 34*(3), 211-255.

Bai, J., & Ng, S. (2005). Tests for skewness, kurtosis, and normality for time series data. *Journal of Business & Economic Statistics, 23*(1), 49-60.

Balassa, B. (1964). The purchasing-power parity doctrine: a reappraisal. *The Journal of Political Economy, 72*(6), 584-596.

Ball, L. (1999). Efficient rules for monetary policy. *International Finance, 2*(1), 63-83.

Ball, L. M., & Sheridan, N. (2004). *Does inflation targeting matter?* In: Bernanke, B.S., Woodford, M. (Eds.), the Inflation-Targeting Debate (pp. 249-282). University of Chicago Press.

Banerjee, A., Lumsdaine, R. L., & Stock, J. H. (1992). Recursive and sequential tests of the unit-root and trend-break hypotheses: theory and international evidence. *Journal of Business & Economic Statistics*, 10(3), 271-287.

Barbosa Filho, N. H. (2004). Growth, exchange rates and trade in Brazil. *Nova Economia_Belo Horizonte, 14*(2), 59-86.

Bassey, G. E., & Essien, E. B. (2014). Inflation targeting framework for monetary policy in Nigeria: issues, problems and prospects. *Journal of Economics and Sustainable Development, 5*(12), 88-101.

Batini, N., Harrison, R., & Millard, S. P. (2003). Monetary policy rules for an open economy. *Journal of Economic Dynamics and Control, 27*(11), 2059-2094.

Beaulieu, M. C., Cosset, J. C., & Essaddam, N. (2006). Political uncertainty and stock market returns: evidence from the 1995 Quebec referendum. *Canadian Journal of Economics/Revue canadienne d'économique, 39*(2), 621-642.

Behera, H., Narasimhan, V., & Murty, K. N. (2008). Relationship between exchange rate volatility and Central Bank intervention: An empirical analysis for India. *South Asia Economic Journal, 9*(1), 69-84.

Beine, M., & Laurent, S. (2001). *Structural change and long memory in volatility: New evidence from daily exchange rates. Developments in Forecast Combination and Portfolio Choice*, Wiley Series in Quantitative Analysis, Wiley, 145-157.

Beine, M., Bènassy-Quéré, A., & MacDonald, R. (2007). The impact of central bank intervention on exchange-rate forecast heterogeneity. *Journal of the Japanese and International Economies, 21*(1), 38-63.

Beine, M., Laurent, S., & Lecourt, C. (2003). Official central bank interventions and exchange rate volatility: Evidence from a regime-switching analysis. *European Economic Review, 47*(5), 891-911.

Beine, M., Laurent, S., & Palm, F. C. (2009). Central bank forex interventions assessed using realized moments. *Journal of International Financial Markets, Institutions and Money, 19*(1), 112-127.

Bera, A. K., & Higgins, M. L. (1993). ARCH models: Properties, estimation and testing. *Journal of Economic Surveys, 7*(4), 305-366.

Berganza, J. C., & Broto, C. (2012). Flexible inflation targets, forex interventions and exchange rate volatility in emerging countries. Journal of International Money and Finance, 31(2), 428-444.

Bernanke, B. S., Gertler, M., & Gilchrist, S. (1999). *The financial accelerator in a quantitative business cycle framework*. In Taylor and Woodford (ed). Handbook of macroeconomics, 1(C), 1341-1393.

Bernanke, B. S., Laubach, T., Mishkin, F. S., & Posen, A. S. (1999). *Inflation targeting*. New Jersay; Princenton University Press.

Bernhard, W., & Leblang, D. (1998). *Political uncertainty and exchange rate volatility in parliamentary democracies*. Presented at the annual meeting of the American political science association, Boston, MA. *51*, 61801.

Bernhard, W., & Leblang, D. (2002). Democratic processes, political risk, and foreign exchange markets. *American Journal of Political Science*, *46(2)*, 316-333.

Berument, H., & Pasaogullari, M. (2003). Effects of the real exchange rate on output and inflation: evidence from Turkey. *The Developing Economies*, *41(4)*, 401-435.

Bilson, J. F. (1981). *Profitability and stability in international currency markets*. NBER Working paper No. 664, April.

Bleaney, M., & Greenaway, D. (2001). The impact of terms of trade and real exchange rate volatility on investment and growth in sub-Saharan Africa. *Journal of Development Economics*, *65(2)*, 491-500.

Blomberg, S. B., & Hess, G. D. (1997). Politics and exchange rate forecasts. *Journal of International Economics*, *43(1)*, 189-205.

Boafo-Arthur, K. (2008). *Democracy and stability in West Africa: the Ghanaian experience*. Department of Peace and Conflict Research, Uppsala University.

Bodart, V., & Reding, P. (1999). Exchange rate regime, volatility and international correlations on bond and stock markets. *Journal of International Money and Finance*, *18(1)*, 133-151.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31(3)*, 307-327.

Bollerslev, T., & Wooldridge, J. M. (1992). Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances. *Econometric Reviews*, *11*(2), 143-172.

Bonser-Neal, C., & Tanner, G. (1996). Central bank intervention and the volatility of foreign exchange rates: evidence from the options market. *Journal of International Money and Finance, 15(6),* 853-878.

Boutchkova, M., Doshi, H., Durnev, A., & Molchanov, A. (2012). Precarious politics and return volatility. *Review of Financial Studies*, 25(4), 1111-1154.

Brada, J. C., A. Kutan and T. Yigit (2004) "*The effects of transition and political instability on foreign direct investment inflows: Central Europe and the Balkan*", William, Davidson Working Paper No. 729.

Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica: Journal of the Econometric Society, 47(5),* 1287-1294.

Brito, R. D., & Bystedt, B. (2010). Inflation targeting in emerging economies: panel evidence. *Journal of Development Economics, 91(2),* 198-210.

Brooks, C. (2008). *RATS Handbook to accompany introductory econometrics for finance*. UK: Cambridge Books.

Bussière, M. & Mulder, C. (1999). *Political instability and economic vulnerability*. IMF Working paper No. WP/99/46. Available at SSRN: http://ssrn.com/abstract=727423 or http://dx.doi.org/10.2139/ssrn.727423.

Caginalp, O. A. (1982). Inflation differentials and exchange rates: Theory and empirical evidence. *Nebraska Journal of Economics and Business, 21*(4), 19-31.

Cai, J. (1994). A Markov model of unconditional variance in ARCH. *Journal of Business and Economic Statistics, 12(3),* 309-316.

Cairns, J., Ho, C., & McCauley, R. N. (2007). Exchange rates and global volatility: Implications for Asia-Pacific currencies. *BIS Quarterly Review, 2007(1),* 41-52.

Carare, A., & Stone, M. R. (2006). Inflation targeting regimes. *European Economic Review, 50(5),* 1297-1315.

Cassel, G. (1916). The present situation of the foreign exchanges. *The Economic Journal, 26(101),* 62-65.

Central Bank of Nigeria (CBN), (2010). *Monetary policy transmission mechanism in Nigeria*. Research Department CBN, Abuja.

Central Bank of Nigeria (CBN), (2012). *Statistical Bulletin*, 23, December. www.cenbank.org/.../2012/...192%202012%20statistical%20bulletin%20.

Central Bank of Nigeria (CBN), (2013). *Quarterly Statistical bulletin*, March. www.cenbank.org/OUT/2013/PUBLICATIONS/STATISTICS/2012/PartA/PartA.html.

Chan, Y. C., & Wei, K. J. (1996). Political risk and stock price volatility: the case of Hong Kong. *Pacific-Basin Finance Journal, 4(2),* 259-275.

Chau, F., Deesomsak, R., & Wang, J. (2014). Political uncertainty and stock market volatility in the Middle East and North African (MENA) countries. *Journal of International Financial Markets, Institutions and Money, 28*(January), 1-19.

Chen, S. L., & Wu, J. L. (1997). Sources of real exchange-rate fluctuations: Empirical evidence from four Pacific basin countries. *Southern Economic Journal, 63(3),* 776-787.

Chin, L., Azali, M., Yusop, Z. B., & Yusoff, M. B. (2007). The monetary model of exchange rate: evidence from the Philippines. *Applied Economics Letters, 14(13),* 993-997.

Chinn, M. D. (2008). Non-linearities, business cycles and exchange rates. *Economic Notes, 37(3),* 219-239.

Chinn, M. D. (2012). *Macro approaches to foreign exchange determination*. J. James, I. Marsh, L. Sarno, Handbook of Exchange Rates, Wiley, 45-72.

Chinn, M. D., & Moore, M. J. (2011). Order flow and the monetary model of exchange rates: Evidence from a novel data set. *Journal of Money, Credit and Banking, 43(8)*, 1599-1624.

Choi, I., & Park, D. (2008). Causal relation between interest and exchange rates in the Asian currency crisis. *Japan and the World Economy, 20(3)*, 435-452.

Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: A new Keynesian perspective. *Journal of Economic Literature, 37(4)*, 1661-1707.

Clarida, R., Gali, J., & Gertler, M. (2000). Monetary policy rules and macroeconomic stability: Evidence and some theory. *The Quarterly Journal of Economics, 115(1)*, 147-180.

Clarida, R., Gali, J., & Gertler, M. (2001). *Optimal monetary policy in closed versus open economies: An integrated approach*. National Bureau of Economic Research Working paper No. w8604.

Clark, P., Tamirisa, N., Wei, S. J., Sadikov, A., & Zeng, L. (2004). *Exchange rate volatility and trade flows-some new evidence*. IMF Occasional Paper, 235.

Cohen, B. H. & Lea, R. B. (2004). *Essentials of statistics for the social and behavioral sciences* (Vol. 3). New Jersey: John Wiley & Sons Inc.

Collins, S. M. (1996). On becoming more flexible: exchange rate regimes in Latin America and the Caribbean. *Journal of Development Economics, 51(1)*, 117-138.

Cookey, A. E. (1997). Exchange rate determination in a depressed economy: The Nigerian experience. *Journal of Industrial, Business and Economic Research, 1(1)*, 16-29.

Corbo, V., Landerretche, O., & Schmidt-Hebbel, K. (2002). *Does inflation targeting make a difference?. Inflation targeting: Design, performance, challenges*. Central bank of Chile. 221-269.

Cosset, J. C., & De La Rianderie, B. D. (1985). Political risk and foreign exchange rates: An efficient-markets approach. *Journal of International Business Studies, 16(3)*, 21-55.

Cukierman, A. (1992). *Central Bank strategy, credibility, and independence: Theory and evidence*. MIT press.

Cukierman, A., Edwards, S., & Tabellini, G. (1989). *Seigniorage and political instability* (No. w3199). National Bureau of Economic Research.

Daboussi, M. O. (2014). Economic performance and inflation targeting in developing economies. *Journal of World and Research, 3(1)*, 1-7.

Dahalan, J. (2004). The uncertainty of the US and Japanese interest rates and its effect on money demand in Malaysia. *International Journal of Management Studies,11*(1), 71-89.

Danjuma, B. F., Shuaibu, U. & Said, U. Y. (2013). An assessment of exchange rate volatility and inflation in Nigeria. *Journal of Emerging Issues in Economics, Finance and Banking, 1(4)*, 321-340.

Danmola, R. A. (2013). The impact of exchange rate volatility on the macroeconomic variables in Nigeria. *European Scientific Journal, 9(7)*, 152-165.

Das, K., & Shimatani, T. (2013). Central bank intervention and exchange rate volatility: Evidence from Japan using realized volatility. *Journal of Asian Economics*, *28*, 87-98.

Dash, P. (2004). *The relationship between interest rate and exchange rate in India*. In Sixth Annual Conference on Money and Finance in the Indian Economy. March 25-27.

Davidian, M., & Carroll, R. J. (1987). Variance function estimation. *Journal of the American Statistical Association, 82(400),* 1079-1091.

Deme, M., & Fayissa, B. (1995). Inflation, money, interest rate, exchange rate, and causality: the case of Egypt, Morocco, and Tunisia. *Applied Economics*, *27(12)*, 1219-1224.

Dennis, R. (2003). Exploring the role of the real exchange rate in Australian monetary policy. *Economic Record*, *79(244)*, 20-38.

Diamandis, P. F. (2009). International stock market linkages: Evidence from Latin America. *Global Finance Journal*, *20*(1), 13-30.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74(366a)*, 427-431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*: *Journal of the Econometric Society*, *49(4),* 1057-1072.

Diebold, F. X. (1988). *Empirical modeling of exchange rate dynamics*. New York: Springer.

Diebold, F. X., Lee, J. H., & Weinbach, G. C. (1994). *Regime switching with time-varying transition probabilities*. In C. Hargreves (Ed.), Nonstationary time series analysis and cointegration. Oxford: Oxford University Press.

Dominguez, K. M. (2006). When do central bank interventions influence intra-daily and longer-term exchange rate movements?. *Journal of International Money and Finance*, *25*(7), 1051-1071.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. *The Journal of Political Economy, 84(6)*, 1161-1176.

Edwards, S. (1996). Exchange rates and the political economy of macroeconomic discipline. *The American Economic Review*, *86(2)*, 159-163.

Edwards, S. (2007). The relationship between exchange rates and inflation targeting revisited. *Central Banking, Analysis, and Economic Policies Book Series*, 11, 373-413.

Edwards, S., & Savastano, M. A. (1999). *Exchange rates in emerging economies: What do we know? What do we need to know?* (No. w7228). National bureau of economic research.

Edwards, S., & Susmel, R. (2000). *Interest rate volatility and contagion in emerging markets*: evidence from the 1990s (No. w7813). National bureau of economic research.

Edwards, S., & Susmel, R. (2001). Volatility dependence and contagion in emerging equity markets. *Journal of Development Economics*, *66(2)*, 505-532.

Efron, B. (1979). Bootstrap methods: another look at the jackknife. *The Annals of Statistics*, *7(1)*, 1-26.

Eichengreen, B., Rose, A. K., & Wyplosz, C. (1995). Exchange market mayhem: The antecedents and aftermath of speculative attacks. *Economic policy*, *10(21)*, 249-312.

Emenike, K. O. (2010). *Modelling stock returns volatility in Nigeria using GARCH models*. MPRA Paper No. 22723, posted 20. May 2010 07:03 UTC. http://mpra.ub.uni-muenchen.de/22723/.

Emmanuel, U. C. (2013). Accumulation of external reserves and effects on exchange rates and inflation in Nigeria. *International Business and Management*, *6*(2), 105-114.

Enders, W. (2004). *Applied Econometric Time Series*. NY: John Willey & Sons.

Engel, C. (1994). Can the Markov switching model forecast exchange rates?. *Journal of International Economics*, *36(1)*, 151-165.

Engel, C., & Hamilton, J. D. (1990). Long swings in the dollar: Are they in the data and do markets know it?', *American Economic Review*, 80(4), 689-713.

Engel, C., & West, K. D. (2005). Exchange rates and fundamentals. *Journal of Political Economy*, *113(3)*, 485 – 517.

Engel, C., & West, K. D. (2006). Taylor rules and the Deutschmarkdollar real exchange rate. *Journal of Money, Credit and Banking*, *38(5)*, 1175-1194.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica: Journal of the Econometric Society*, *50(4)*, 987-1007.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, *55(2)*, 251-276.

Engle, R. F., & Ng, V. K. (1993). Measuring and testing the impact of news on volatility. *The Journal of Finance*, *48(5)*, 1749-1778.

Erjavec, N., & Cota, B. (2003). Macroeconomic Granger-causal dynamics in Croatia: Evidence based on a vector error-correction modelling analysis. *Ekonomski Pregled*, *54(1-2)*, 139-156.

Eun, C. S., Resnick, B. G. & Sabherwal, S. (2012). *International finance: Global edition*. New York; McGraw Hill Irwin.

Evans, M., & Lyons, R. (2000). *The price impact of currency trades: implications for intervention*. UC Berkeley working paper. Retrived at www.haas.berkeley.edu/~lyons.

Ezirim, C. B., Amuzie, E. A. & Emenyonu, E. N. (2012). Long run equilibrium relationship between exchange rates and inflation in Nigeria. *International Journal of Business, Marketing and Decision Science*, *5*(2), 13-25.

Felipe, J. (2009). Does Pakistan need to adopt inflation targeting? Some questions. *SBP Research Bulletin, 5(1),* 113-161.

Ferrari Filho, F., & de Paula, L. F. (2008). *Exchange rate policy and capital flows in emerging economies: a proposal based on Keynes' ideas and Keynesian approach*. Encontro Nacional de Economia (36: 2008 dez: Salvador, BA). Anais. Salvador: ANPEC, 2008. 1 CD-ROM.

Fiess, N., & Shankar, R. (2009). Determinants of exchange rate regime switching. *Journal of International Money and Finance*, *28(1),* 68-98.

Fleming, J. M. (1962). Domestic financial policies under fixed and under floating exchange rates. *Staff Papers-International Monetary Fund*, *9(3),* 369-380.

Flood, R. P., & Rose, A. K. (1999). Understanding exchange rate volatility without the contrivance of macroeconomics. *The Economic Journal*, *109(459),* 660-672.

Frankel, J. A. (1979). On the mark: A theory of floating exchange rates based on real interest differentials. *The American Economic Review*, *69*(4), 610-622.

Frankel, J. A. (1999). *No single currency regime is right for all countries or at all times* (No. w7338). National bureau of economic research. Available at http://www.nber.org/papers/w7338.

Freeman, J. R., Hays, J. C., & Stix, H. (2000). Democracy and markets: The case of exchange rates. *American Journal of Political Science*, *44(3)*, 449-468.

Frenkel, J. A. (1976). A monetary approach to the exchange rate: doctrinal aspects and empirical evidence. *The Scandinavian Journal of Economics*, *78(2)*, 200-224.

Frenkel, J. A., & Johnson, H. G. (2013). *The monetary approach to the balance of payments*. In Harry G. Johnson (Eds.). Routledge, George Allen and Unwin ltd. London.

Frieden, J., Ghezzi, P. & Stein, E. (2000). *Politics and exchange rates: A cross-country approach to Latin America*. IDB Working Paper No. 137. Available at SSRN: http://ssrn.com/abstract=1814683 or http://dx.doi.org/10.2139/ssrn.1814683.

Galati, G., Melick, W., & Micu, M. (2005). Foreign exchange market intervention and expectations: The Yen/Dollar exchange rate. *Journal of International Money and Finance*, *24(6)*, 982-1011.

Gali, J., & Monacelli, T. (2005). Monetary policy and exchange rate volatility in a small open economy. *The Review of Economic Studies, 72(3)*, 707-734.

Gallant, A. R. (1977). Three-stage least-squares estimation for a system of simultaneous, nonlinear, implicit equations. *Journal of Econometrics, 5(1)*, 71-88.

Gandolfo, G. (1981). *Qualitative analysis and econometric estimation of continuous time dynamic model*, Amsterdam: North-Holland.

Glejser, H. (1969). A new test for heteroskedasticity. *Journal of the American Statistical Association, 64(325)*, 316-323.

Glynn, J., Perera, N., & Verma, R. (2007). Unit root tests and structural breaks: a survey with applications. *Journal of Quantitative Methods for Economics and Business Administration, 3(1)*, 63-79.

Gonçalves, C. E. S., & Salles, J. M. (2008). Inflation targeting in emerging economies: What do the data say?. *Journal of Development Economics*, *85(1)*, 312-318.

Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society, 37(3),* 424-438.

Granger, C. W. (1980). Testing for causality: a personal viewpoint. *Journal of Economic Dynamics and Control*, *2(1980)*, 329-352.

Granger, C. W. (1988). Some recent development in a concept of causality. *Journal of Econometrics*, *39(1)*, 199-211.

Granger, C. W., & Andersen, A. (1978). On the invertibility of time series models. *Stochastic Processes and their Applications*, *8(1)*, 87-92.

Granger, C. W., & Newbold, P. (1974). Spurious regressions in econometrics. *Journal of Econometrics*, *2(2)*, 111-120.

Gregorio, J. D., Tokman, A., & Valdés, R. (2005). *Flexible exchange rate with Inflation targeting in Chile: Experience and issues*. IDB Working Paper No. 450. Available at SSRN: http://dx.doi.org/10.2139/ssrn.1818739.

Gregory, A. W., & Hansen, B. E. (1996). Residual-based tests for cointegration in models with regime shifts. *Journal of Econometrics*, *70*(1), 99-126.

Grossmann, A., Love, I., & Orlov, A. G. (2014). The dynamics of exchange rate volatility: A panel VAR approach. *Journal of International Financial Markets, Institutions and Money*, *33*(November), 1-27.

Gupta, J. P., Chevalier, A., & Sayekt, F. (2000). *The Causality between interest rate, exchange rate and stock price in emerging markets:* The case of the Jakarta stock exchange, EFMA 2000 Athens. Available at SSRN: http://dx.doi.org/10.2139/ssrn.251253.

Gupta, R., Kabundi, A., & Modise, M. P. (2010). Has the SARB become more effective post inflation targeting?. *Economic Change and Restructuring*, *43*(3), 187-204.

Guru-Gharana, K. K. (2012). Econometric investigation of relationships among export, FDI and growth in India: An application of Toda-Yamamoto-Dolado-Lutkephol Granger causality test. *The Journal of Developing Areas*, *46*(2), 231-247.

Hacker, R. S., & Hatemi-J, A. (2006). Tests for causality between integrated variables using asymptotic and bootstrap distributions: theory and application. *Applied Economics*, *38*(13), 1489-1500.

Hacker, R. S., Karlsson, H. K., & Månsson, K. (2014). An investigation of the causal relations between exchange rates and interest rate differentials using wavelets. *International Review of Economics & Finance*, *29*(January), 321-329.

Hacker, S., & Hatemi-J, A. (2010). *HHcte: GAUSS module to apply a bootstrap test for causality with endogenous lag order*. Statistical Software Components.

Hamilton, J. D. (1988). Rational-expectations econometric analysis of changes in regime: An investigation of the term structure of interest rates. *Journal of Economic Dynamics and Control*, *12*(2), 385-423.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the Econometric Society*, *57(2)*, 357-384.

Hamilton, J. D. (1990). Analysis of time series subject to changes in regime. *Journal of Econometrics, 45(1)*, 39-70.

Hamilton, J. D., & Susmel, R. (1994). Autoregressive conditional heteroskedasticity and changes in regime. *Journal of Econometrics, 64(1)*, 307-333.

Hamrita, M. E., & Trifi, A. (2011). The relationship between interest rate, exchange rate and stock price: A wavelet analysis. *International Journal of Economics and Financial Issues, 1(4)*, 220-228.

Haniffa, R., & Hudaib, M. (2006). Corporate governance structure and performance of Malaysian listed companies. *Journal of Business Finance & Accounting*, *33*(7-8), 1034-1062.

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators. *Econometrica: Journal of the Econometric Society, 50(4)*, 1029-1054.

Hansen, L. P., & Singleton, K. J. (1982). Generalized instrumental variables estimation of nonlinear rational expectations models. *Econometrica: Journal of the Econometric Society, 50(5)*, 1269-1286.

Harberger, A. C. (2003). *Economic growth and the real exchange rate: revisiting the Balassa-Samuelson effect*. In a conference organized by the higher school of economics, Moscow. April.

Harvey, A. C., & Jaeger, A. (1993). Detrending, stylized facts and the business cycle. *Journal of Applied Econometrics, 8*(3), 231-247

Hasan, A., & Javed, M. T. (2009). An empirical investigation of the causal relationship among monetary variables and equity market returns. *The Lahore Journal of Economics. 14(1)*, 115-137.

Hatemi-J, A. (2003). A new method to choose optimal lag order in stable and unstable VAR models. *Applied Economics Letters, 10(3)*, 135-137.

Hatemi-J, A. (2012). Asymmetric causality tests with an application. *Empirical Economics*, *43*(1), 447-456.

Hatemi-J, A., & Irandoust, M. (2000). Time-series evidence for Balassa's export-led growth hypothesis. *Journal of International Trade & Economic Development*, *9*(3), 355-365.

Hatemi-J, A., & Irandoust, M. (2006). A bootstrap-corrected causality test: another look at the money–income relationship. *Empirical Economics, 31(1)*, 207-216.

Hays, J. C., Freeman, J. R., & Nesseth, H. (2003). Exchange rate volatility and democratization in emerging market countries. *International Studies Quarterly*, *47(2)*, 203-228.

Hnatkovska, V., Lahiri, A., & Vegh, C. A. (2013). Interest rate and the exchange rate: A non-monotonic tale. *European Economic Review*, *63*(October), 68-93.

Hodrick, R. J., & Prescott, E. C. (1997). Post-war US business cycles: An empirical investigation. *Journal of Money, Credit, and Banking*, *29*(1), 1-16.

Holman, J. A., & Rioja, F. K. (2001). International transmission of anticipated inflation under alternative exchange-rate regimes. *Journal of International Money and Finance, 20(4)*, 497-519.

Hooper, P., & Morton, J. (1982). Fluctuations in the dollar: A model of nominal and real exchange rate determination. *Journal of International Money and Finance*, *1*(1982), 39-56.

Ichiue, H., & Koyama, K. (2011). Regime switches in exchange rate volatility and uncovered interest parity. *Journal of International Money and Finance*, *30(7)*, 1436-1450.

Imimole, B., & Enoma, A. (2011). Exchange rate depreciation and inflation in Nigeria (1986–2008). *Business and Economics Journal*, *28*, 1-11.

Jahan-Parvar, M. R., & Mohammadi, H. (2011). Oil prices and real exchange rates in oil-exporting countries: a bounds testing approach. *The Journal of Developing Areas*, *45(1)*, 309-318.

Jarque, C. M., & Bera, A. K. (1987). A test for normality of observations and regression residuals. *International Statistical Review/Revue Internationale de Statistique, 55(2)*, 163-172.

Johansen, S., Mosconi, R., & Nielsen, B. (2000). Cointegration analysis in the presence of structural breaks in the deterministic trend. *The Econometrics Journal*, *3*(2), 216-249.

Josifidis, K., Allegret, J. P., & Pucar, E. B. (2011). Inflation targeting and exchange rate regimes in Serbia and selected transition economies. *Eastern European Economics, 49(4)*, 88-105.

Kabundi, A., & Ngwenya, N. (2011). Assessing monetary policy in South Africa in a Data-Rich Environment. *South African Journal of Economics*, 79(1), 91-107.

Kabundi, A., Schaling, E., & Some, M. (2015). Monetary policy and heterogeneous inflation expectations in South Africa. *Economic Modelling*, 45 (February), 109-117.

Kamal Uddin, K. M., Rahman, M. M., & Quaosar, G. A. A. (2014). Causality between exchange rate and economic growth in Bangladesh. *European Scientific Journal*, *10*(31). 11-21.

Kamas, L. (1995). Monetary policy and inflation under the crawling peg: Some evidence from VARs for Colombia. *Journal of Development Economics, 46*(1), 145-161.

Kamin, S. B., & Klau, M. (2003). A multi-country comparison of the linkages between inflation and exchange rate competitiveness. *International Journal of Finance & Economics*, *8*(2), 167-184.

Kan, R., & Zhang, C. (1999). GMM tests of stochastic discount factor models with useless factors. *Journal of Financial Economics*, 54(1), 103-127.

Kara, O. (2011). The effects of the U. S budget deficit and inflation on exchange rate. *Journal of the Academy of Business & Economics*, *11*(4), 80-93.

Karim, Z. A., & Zaidi, M. A. S. (2015). Monetary policy, firm size and equity returns in an emerging market: Panel evidence of Malaysia. *Asian Academy of Management Journal of Accounting and Finance*, *11*(2), 29-55.

Kayhan, S., Bayat, T., & Uğur, A. (2013). Interest rates and exchange rate relationship in BRIC-T countries. *Ege Academic Review*, *13*(2), 227-236.

Kemme, D., & Teng, W. (2000). Determinants of the real exchange rate, misalignment and implications for growth in Poland. *Economics Systems*, *24*(2), 171-205.

Kenen, P. B., & Rodrik, D. (1986). Measuring and analyzing the effects of short-term volatility in real exchange rates. *The Review of Economics and Statistics*, *68*(2), 311-315.

Kennedy, P. (2008). *A Guide to Econometrics*. Blackwell Publishing, Malden, Massachusetts.

Khan, R. E. A., Sattar, R., & Rehman, H. U. (2012). Effectiveness of exchange rate in Pakistan: Causality analysis. *Pakistan Journal of Commerce and Social Sciences*, *6*(1), 83-96.

Khodeir, A. N. (2012). Towards inflation targeting in Egypt: The relationship between exchange rate and inflation. *South African Journal of Economic and Management Sciences*, *15(3)*, 325-332.

Kilian, L., & Taylor, M. P. (2003). Why is it so difficult to beat the random walk forecast of exchange rates?. *Journal of International Economics, 60*(1), 85-107.

Kisaka, S. E., Kithitu, J. W., & Kamuti, H. M. (2014). The causal relationship between interest rates and foreign exchange rates in Kenya. *Research Journal of Finance and Accounting*, *5(14)*, 136-151.

Klein, M. W., & Marion, N. P. (1997). Explaining the duration of exchange-rate pegs. *Journal of Development Economics*, *54(2)*, 387-404.

Klein, M. W., & Shambaugh, J. C. (2010). *Exchange rate regimes in the modern era*. MIT Press. Cambridge.

Ko, H. H. (2010). *A Bootstrap Granger causality test between exchange rates and fundamentals*. Department of Applied Economics, National University of Kaohsiung, http://tea.econ.sinica.edu.tw/index.php.

Kočenda, E. (2005). Beware of breaks in exchange rates: evidence from European transition countries. *Economic Systems*, *29(3)*, 307-324.

Kočenda, E., & Valachy, J. (2006). Exchange rate volatility and regime change: A visegrad comparison. *Journal of Comparative Economics*, *34(4)*, 727-753.

Kollmann, R. (2002). Monetary policy rules in the open economy: effects on welfare and business cycles. *Journal of Monetary Economics*, *49(5)*, 989-1015.

Kroner, K. F., & Lastrapes, W. D. (1993). The impact of exchange rate volatility on international trade: reduced form estimates using the GARCH-in-mean model. *Journal of International Money and Finance*, *12(3)*, 298-318.

Kurihara, Y. (2013). Does adoption of inflation targeting reduce exchange rate volatility and enhance economic growth?. *Journal of World Economic Research*, *2(6)*, 104-109.

Lamoureux, C. G., & Lastrapes, W. D. (1990). Heteroskedasticity in stock return data: volume versus GARCH effects. *The Journal of Finance, 45(1)*, 221-229.

Leblang, D., & Bernhard, W. (2006). Parliamentary politics and foreign exchange markets: The World according to GARCH. *International Studies Quarterly, 50(1)*, 69-92.

Lee, B. J., & Lee, M. J. (1997). Generalized method of moment estimation of truncated or censored regression. *Applied Economics Letters*, 4(6), 365-368.

Lee, H. Y., & Chen, S. L. (2006). Why use Markov-switching models in exchange rate prediction? *Economic Modelling, 23(4)*, 662-668.

Lee, J., & Strazicich, M. C. (2001). Break point estimation and spurious rejections with endogenous unit root tests. *Oxford Bulletin of Economics and Statistics, 63(5)*, 535-558.

Lee, J., & Strazicich, M. C. (2003). Minimum Lagrange Multiplier unit root test with two structural breaks. *Review of Economics and Statistics, 85(4)*, 1082-1089.

Lee, J., & Strazicich, M. C. (2013). Minimum LM unit root test with one structural break. *Economics Bulletin, 33(4)*, 2483-2492.

Levy-Yeyati, E. (2011). *Exchange rate regimes* (No. 2011-02). Universidad Torcuato Di Tella.

Levy-Yeyati, E., & Sturzenegger, F. (2003). To float or to fix: evidence on the impact of exchange rate regimes on growth. *American Economic Review, 93(4)*, 1173-1193.

Levy-Yeyati, E., Sturzenegger, F., & Reggio, I. (2010). On the endogeneity of exchange rate regimes. *European Economic Review, 54(5)*, 659-677.

Lin, S., & Ye, H. (2009). Does inflation targeting make a difference in developing countries?. *Journal of Development Economics, 89(1)*, 118-123.

Lin, S., & Ye, H. (2012). What to Target? Inflation or Exchange Rate. *Southern Economic Journal*, *78(4)*, 1202-1221.

Longmore, R., & Robinson, W. (2004). *Modelling and forecasting exchange rate dynamics in Jamaica: An application of asymmetric volatility models*. Bank of Jamaica working paper No. WP2004/03, 1-32.

Lucas, R. E. (1982). Interest rates and currency prices in a two-country world. *Journal of Monetary Economics*, *10*(3), 335-359.

Lumsdaine, R. ., & Papell, D. H. (1997). Multiple trend breaks and the unit-root hypothesis. *Review of Economics and Statistics*, *79(2)*, 212-218.

Lütkepohl, H., Saikkonen, P., & Trenkler, C. (2001). Maximum eigenvalue versus trace tests for the cointegrating rank of a VAR process. *The Econometrics Journal*, *4*(2), 287-310.

MacDonald, R. (1988). Purchasing Power Parity: Some 'long run' evidence from the recent float. *De Economist*, *136(2)*, 239-252.

MacDonald, R., & Taylor, M. P. (1994). The monetary model of the exchange rate: long-run relationships, short-run dynamics and how to beat a random walk. *Journal of International Money and Finance*, *13*(3), 276-290.

MacKinnon, J. G. (1992). Model specification tests and artificial regressions. *Journal of Economic Literature, 30(1),* 102-146.

Madesha, W., Chidoko, C., & Zivanomoyo, J. (2013). Empirical test of the relationship between exchange rate and inflation in Zimbabwe. *Journal of Economics and Sustainable Development*, *4(1)*, 52-58.

Mahmoudinia, D., Soderjani, S. E., & Pourshahabi, F. (2011). Economic growth, tourism receipts and exchange rate in MENA zone: Using panel causality technique. *Iranian Economic Review*, *15(29)*, 129-146.

Maitra, B., & Mukhopadhyay, C. K. (2011). Causal relation between money supply and exchange rate in India under the basket peg and market determination regimes: A time series analysis. *The IUP Journal of Applied Economics*, *10(2)*, 40-56.

Markiewicz, A. (2012). Model uncertainty and exchange rate volatility. *International Economic Review, 53(3)*, 815-844.

Masron, T. A., & Yusop, Z. (2006). Optimum currency area criteria and volatility in ASEAN. *Asian Academy of Management Journal of Accounting and Finance, 2*(2), 1-18.

Mcgibany, J. M., & Nourzad, F. (1995). Exchange rate volatility and the demand for money in the US. *International Review of Economics & Finance*, *4(4)*, 411-425.

Meese, R. A., & Rogoff, K. (1983). Empirical exchange rate models of the seventies: Do they fit out of sample?. *Journal of International Economics, 14(1)*, 3-24.

Meese, R. A., & Rogoff, K. (1988). Was it real? The exchange rate-interest differential relation over the modern floating-rate period. *Journal of Finance*, *43*(4), 933-948.

Mendonça, H. F., Jose, G. & Souza, G. (2012). Is inflation targeting a good remedy to control inflation?. *Journal of Development Economics, 98(2)*, 178-191.

Mensi, W., Hammoudeh, S., & Yoon, S. M. (2014). Structural breaks and long memory in modeling and forecasting volatility of foreign exchange markets of oil exporters: The importance of scheduled and unscheduled news announcements. *International Review of Economics & Finance*, *30*(March), 101-119.

Miao, Y. (2009). *In search of successful inflation targeting: Evidence from an inflation targeting index (EPub)* (No. 9-148). International Monetary Fund.

Mishkin, F. S. (1999). International experiences with different monetary policy regimes. *Journal of Monetary Economics, 43(3)*, 579-605.

Mishkin, F. S. (2007). *The economics of money, banking, and financial markets*. Pearson education. New Jersey.

Mishkin, F. S., & Savastano, M. A. (2001). Monetary policy strategies for Latin America. *Journal of Development Economics, 66(2)*, 415-444.

Miyakoshi, T. (2000). The monetary approach to the exchange rate: empirical observations from Korea. *Applied Economics Letters*, *7*(12), 791-794.

Mok, H. M. (1993). Causality of interest rate, exchange rate and stock prices at stock market open and close in Hong Kong. *Asia Pacific Journal of Management*, *10*(2), 123-143.

Moore, T., & Wang, P. (2007). Volatility in stock returns for new EU member states: Markov regime switching model. *International Review of Financial Analysis*, *16*(3), 282-292.

Moya, M., & Watundu, S. (2009). Econometric analysis of real effective exchange rate on gross domestic product of Uganda. *E-Journal of Business and Economic Issues*. 4(1), 1-6.

Muktadir-al-Mukit, D. (2013). Effects of interest rate and exchange rate on volatility of market index at Dhaka stock exchange. *Journal of Business and Technology (Dhaka)*, *7*(2), 1-18.

Mundell, R. A. (1961). A theory of optimum currency areas. *The American Economic Review*, *51(4)*, 657-665.

Mundell, R. A. (1964). Exchange rate margins and economic policy. In C. Murphy. Dallas (Edt.) *Money in the International Order*: Southern Methodist Univ. Press.

Mussa, M., Masson, P., Swoboda, A., Jadresic, E., Mauro, P., & Berg, A. (2000). *Exchange rate regimes in an increasingly integrated world economy* (Vol. 193). Washington, DC: International monetary fund.

Nawaz, M. (2012). The impact of exchange rate on output level: Bounds testing approach for Pakistan. *The Pakistan Development Review, 51(4)*, 419-434.

Ndako, U. B. (2012). Financial liberalization, structural breaks and stock market volatility: evidence from South Africa. *Applied Financial Economics, 22(15)*, 1259-1273.

Nelson, C. R., & Plosser, C. R. (1982). Trends and random walks in macroeconomic time series: some evidence and implications. *Journal of Monetary Economics, 10(2)*, 139-162.

Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica*: *Journal of the Econometric Society, 59(2)*, 347-370.

Newey, W. K., & West, K. D. (1987). Hypothesis testing with efficient method of moments estimation. *International Economic Review*, 28(3), 777-787.

Newey, W. K., & West, K. D. (1994). Automatic lag selection in covariance matrix estimation. *The Review of Economic Studies*, 61(4), 631-653.

Ngerebo-A, A., & Ibe, R. C. (2014). Exchange rate and macroeconomic performance in Nigeria: A causal post structural adjustment programme investigation. *Global Journal of Management and Business Research, 13*(7), 43-48.

Nnamdi, K. C. & Ifionu, E. P. (2013). *Exchange rate volatility and exchange rate uncertainty in Nigeria: A financial econometrics analysis* (1970 - 2012). Munich Personal REPEC Archive paper 48316. http://mpra.ub.uni-muenchen.de/48316/.

Nunes, L. C., Newbold, P., & Kuan, C. M. (1997). Testing for unit roots with breaks: Evidence on the great crash and the unit root hypothesis reconsidered. *Oxford Bulletin of Economics and Statistics, 59(4)*, 435-448.

Obstfeld, M., & Rogoff, K. (2000). New directions for stochastic open economy models. *Journal of International Economics*, *50(1)*, 117-153.

Obstfeld, M., & Rogoff, K. (2001). The six major puzzles in international macroeconomics: is there a common cause?. In *NBER Macroeconomics Annual 2000, Volume 15* (pp. 339-412). MIT press.

Odusola, A. F., & Onwioduokit, E. (2005). Monetary aggregate targeting and inflation in Nigeria. *West African Monetary Journal of Economic Integration*, *5*, 67-87.

Officer, L. H. (1976). The Purchasing-Power-Parity Theory of Exchange Rates: A Review Article (Théorie de la parité des pouvoirs d'achat des taux de change: une étude) (La teoría de los tipos de cambio basados en la paridad del poder adquisitivo: Artículo de repaso). *Staff Papers-International Monetary Fund*, *23*(1), 1-60.

Ogaki, M. (1993). *Generalized method of moments: Econometric applications*. In Maddala, G. S., Rao, C. R. and Vinod, H. D. (Eds), Handbook of statistics, 11, Amsterdam, 455-488.

Ojo, M. (2013). *El Gran Papel Del Fondo Monetario Internacional (FMI) En La Reciente Crisis Financiera Mundial (The Formidable Role of the International Monetary Fund (IMF) in the Recent Global Financial Crisis)*. Available at SSRN 2227522.

Olatunji, T. M., Sunday, A. A., & Omolara, Y. J. (2012). The dynamic causality between money and macroeconomic activity: Empirical evidence from Nigeria based on VECM Approach (1960-2011). *Prosiding Perkem 7(1)*, 509-524.

Olukoshi, A. O. (2001). *West Africa's political economy in the next millennium: Retrospect and prospect* (p. 4). Codesria. 1-39.

Omotor, G. D. (2008). Exchange rate reform and its inflationary consequences: The case of Nigeria. *Ekonomski Pregled, 59(11)*, 688-716.

Orlowski, L. T. (2000). Direct inflation targeting in central Europe. *Post-Soviet Geography and Economics*, *41(2)*, 134-154.

Orphanides, A. (2004). Monetary policy rules, macroeconomic stability, and inflation: A view from the trenches. *Journal of Money, Credit and Banking, 36(2)*, 151-175.

Pagan, A. R., & Schwert, G. W. (1990). Alternative models for conditional stock volatility. *Journal of Econometrics*, *45(1)*, 267-290.

Papell, D. H., & Prodan, R. (2004). The uncertain unit root in US real GDP: evidence with restricted and unrestricted structural change. *Journal of Money, Credit and Banking*, *36(3)*, 423-427.

Paramati, S. R., & Gupta, R. (2013). An empirical analysis of stock market performance and economic growth: Evidence from India. *International Research Journal of Finance and Economics*, *73*(2011), 144-160.

Pattichis, C. (2003). Conditional exchange rate volatility, unit roots, and international trade. *The International Trade Journal*, *17(1)*, 1-17.

Pavasuthipaisit, R. (2010). Should inflation-targeting central banks respond to exchange rate movements?. *Journal of International Money and Finance*, *29(3),* 460-485.

Peguin-Feissolle, A. (1999). A comparison of the power of some tests for conditional heteroscedasticity. *Economics Letters*, *63(1)*, 5-17.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica*: *Journal of the Econometric Society*, *57(6)*, 1361-1401.

Perron, P. (1997). Further evidence on breaking trend functions in macroeconomic variables. *Journal of Econometrics, 80(2),* 355-385.

Petreski, M. (2012). Output volatility and exchange rate considerations under inflation targeting: A review. *International Journal of Economics and Financial Issues, 2(4)*, 528-537.

Petterson, K. (2000). *An introduction to applied econometrics, a time series approach*. St. Martin's Press: New York.

Pi-Anguita, J. V. (1998). Real exchange rate, interest rate and capital movements: Evidence for France. *Applied Economics Letters*, *5(5)*, 305-307.

Pokhariyal, G. P., Pundo, M., & Musyoki, D. (2012). The impact of real exchange rate volatility on economic growth: Kenyan evidence. *Business and Economic Horizons, (07)*, 59-75.

Political Risk Guide (2015). *Guide to data variables*. Accessible at https://epub.prsgroup.com/list-of-all-variable-definitions.

Psaradakis, Z., Sola, M., & Spagnolo, F. (2004). On Markov error-correction models, with an application to stock prices and dividends. *Journal of Applied Econometrics*, 19(1), 69-88.

Rapach, D. E., & Strauss, J. K. (2008). Structural breaks and GARCH models of exchange rate volatility. *Journal of Applied Econometrics, 23(1)*, 65-90.

Rapetti, M., Skott, P., & Razmi, A. (2012). The real exchange rate and economic growth: are developing countries different?. *International Review of Applied Economics*, *26*(6), 735-753.

Rodrik, D. (2008). The real exchange rate and economic growth. *Brookings Papers on Economic Activity*, *2008(2)*, 365-412.

Roger, S. (2009). *Inflation targeting at 20: achievements and challenges* (No. 9-236). International Monetary Fund.

Roger, S., & Stone, M. (2005). *On Target?: The international experience with achieving inflation targets*. IMF Working Paper. 1-68. Available at SSRN: http://ssrn.com/abstract=888032.

Røisland, Ø. & Torvik, R. (2004). Exchange rate versus inflation targeting: a theory of output fluctuations in traded and non-traded sectors. *The Journal of International Trade & Economic Development*, *13(3)*, 265-285.

Rose, A. K. (2007). A stable international monetary system emerges: Inflation targeting is Bretton Woods, reversed. *Journal of International Money and Finance, 26(5)*, 663-681.

Rose, A. K. (2011). Exchange rate regimes in the modern era: Fixed, floating, and flaky. *Journal of Economic Literature*, *49(3)*, 652-672.

Saad, W. (2012). Causality between economic growth, export, and external debt servicing: the case of Lebanon. *International Journal of Economics and Finance, 4(11)*, 134-143.

Saborowski, C. (2010). Inflation targeting as a means of achieving disinflation. *Journal of Economic Dynamics and Control*, *34(12)*, 2510-2532.

Salimibeni, Y., Zaidi, M. A. S., Karim, Z. A., Jusoh, M. (2012). Inflation and relative price variability: Further evidence from Malaysia. *Prosiding Perkem*, 7(1), 65-71.

Samuelson, P. A. (1964). Theoretical notes on trade problems. *The Review of Economics and Statistics*, 46(2), 145-154.

Sanusi, A. R. (2010). Exchange rate pass-through to consumer prices in Ghana: Evidence from structural vector auto-regression. *West African Journal of Monetary and Economic Integration, 10(1), 25-47*.

Schwert, G. W. (1987). Effects of model specification on tests for unit roots in macroeconomic data. *Journal of Monetary Economics*, *20*(1), 73-103.

Shaari, M. S., Hussain, N. E., & Abdullah, H. (2012). The effects of oil price shocks and exchange rate volatility on inflation: Evidence from Malaysia. *International Business Research*, *5*(9), 106-112.

Shabri Abd. Majid, M., Kameel Mydin Meera, A., & Azmi Omar, M. (2008). Interdependence of ASEAN-5 stock markets from the US and Japan. *Global Economic Review*, *37*(2), 201-225.

Shabri Abd. Majid, M., Kameel Mydin Meera, A., Azmi Omar, M., & Abdul Aziz, H. (2009). Dynamic linkages among ASEAN-5 emerging stock markets. *International Journal of Emerging Markets*, 4(2), 160-184.

Sherwin, M. (2000). Institutional frameworks for inflation targeting. *Reserve Bank of New Zealand Bulletin*, *63*(4), 28-34.

Sims, C. A., Stock, J. H., & Watson, M. W. (1990). Inference in linear time series models with some unit roots. *Econometrica: Journal of the Econometric Society, 58(1)*, 113-144.

Smith, S. F. (1998). *Cointegration tests when data are linearly interpolated*. Unpublished Paper, State University of New York at Albany.

Soludo, C. C. (1993). Theoretical basis for the structural adjustment programme in Nigeria: two alternative critiques. *The Nigerian Journal of Economic and Social Studies, 35(1)*, 49-63.

Sørensen, P. B., & Whitta-Jacobsen, H. J. (2010). *Introducing advanced macroeconomics: growth and business cycles* (pp. 1-2). McGraw-Hill higher education.

Srinivasan, P., & Kalaivani, M. (2013). Exchange rate volatility and export growth in India: An ARDL bounds testing approach. *Decision Science Letters*, *2*(3), 191-202.

Srinivasan, P., Kalaivani, M. & Devakumar, C. (2014). On the temporal causal relationship between macroeconomic variables. *SAGE Open*, *4(1)*, 1-14.

Stock, J. H., & Watson, M. W. (2001). Vector autoregressions. *Journal of Economic perspectives*, *15(4)*, 101-115.

Stockman, A. C. (1980). A theory of exchange rate determination. *The Journal of Political Economy*, *88*(4), 673-698.

Stone, M. & Bhundia, A. (2004). *A new taxonomy of monetary regimes*. IMF Working Paper No. 04/191. Available at SSRN: http://ssrn.com/abstract=879016.

Subair, K., & Salihu, O. M. (2004). *Exchange rate volatility and the stock market: the Nigerian experience*. Kwara State University. Retrived at http://www.aabri.com/OC2010Manuscripts/OC10113.pdf.

Sufian, F., & Habibullah, M. S. (2010). Does economic freedom fosters banks' performance? Panel evidence from Malaysia. *Journal of Contemporary Accounting & Economics*, *6*(2), 77-91.

Sufian, F., & Habibullah, M. S. (2012). Developments in the efficiency of the Malaysian banking sector: the impacts of financial disruptions and exchange rate regimes. *Progress in Development Studies*, *12*(1), 19-46.

Svensson, L. E. (1996). *Price level targeting vs. inflation targeting: A free lunch*? (No. w5719). National bureau of economic research.

Svensson, L. E. (1999). Inflation targeting as a monetary policy rule. *Journal of Monetary Economics*, *43(3)*, 607-654.

Svensson, L. E. (2000). Open-economy inflation targeting. *Journal of International Economics*, *50(1)*, 155-183.

Swift, A. L., & Janacek, G. J. (1991). Forecasting non-normal time series. *Journal of Forecasting*, *10*(5), 501-520.

Syllignakis, M. N., & Kouretas, G. P. (2011). Markov-switching regimes and the monetary model of exchange rate determination: Evidence from the Central and Eastern European markets. *Journal of International Financial Markets, Institutions and Money, 21(5)*, 707-723.

Tabachnik, B. G., & Fidell, S. L. (2007). *Discriminant analysis. Using multivariate statistics.* Boston: Pearson Education Inc.

Taiwo, A. & Adesola, O. A. (2013). Exchange rate volatility and bank performance in Nigeria. *Asian Economic and Financial Review, 3(2)*, 178-185.

Tang, C. F. (2008). A re-examination of the relationship between electricity consumption and economic growth in Malaysia. *Energy Policy, 36*(8), 3077-3085.

Tang, C. F. (2013). Temporal Granger causality and the dynamics relationship between real tourism receipts, real income and real exchange rates in Malaysia. *International Journal of Tourism Research, 15(3)*, 272-284.

Taylor, J. B. (1993). *Discretion versus policy rules in practice*. In Carnegie-Rochester conference series on public policy 39, 195-214. North-Holland.

Taylor, M. P., & Peel, D. A. (2000). Nonlinear adjustment, long-run equilibrium and exchange rate fundamentals. *Journal of International Money and Finance,* 19(1), 33-53.

Taylor, M. P., Peel, D. A., & Sarno, L. (2001). Nonlinear mean-reversion in real exchange rates: toward a solution to the purchasing power parity puzzles. *International Economic Review*, 42(4), 1015-1042.

Toda, H. Y., & Phillips, P. C. (1993). Vector autoregressions and causality. *Econometrica: Journal of the Econometric Society, 61(6)*, 1367-1393.

Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, *66(1)*, 225-250.

Tolulope, A. O., & Ajilore, T. (2013). Inflation targeting monetary policy rule in Nigeria: Estimates of the policy reaction function. *International Journal of Economics and Finance*, *5(7)*, 139-144.

Tornell, A., & Velasco, A. (2000). Fixed versus flexible exchange rates: Which provides more fiscal discipline?. *Journal of Monetary Economics*, *45(2)*, 399-436.

Torres, A. (2003). Monetary policy and interest rate: evidence from Mexico. *The North American Journal of Economics and Finance*, *14*(3), 357-379.

Udoh, E., & Egwaikhide, F. O. (2008). Exchange rate volatility, inflation uncertainty and foreign direct investment in Nigeria. *Botswana Journal of Economics*, *5(7)*, 14-31.

Walid, C., Chaker, A., Masood, O., & Fry, J. (2011). Stock market volatility and exchange rates in emerging countries: A Markov-state switching approach. *Emerging Markets Review*, *12(3)*, 272-292.

Wang, P., & Moore, T. (2009). Sudden changes in volatility: The case of five central European stock markets. *Journal of International Financial Markets, Institutions and Money*, *19(1)*, 33-46.

Woodford, M. (2001). The Taylor rule and optimal monetary policy. *American Economic Review*, *91(2)*, 232-237.

World Bank (2015). *World development indicators*. http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators.

Worswick, G. D. N. (1981). The money supply and the exchange rate. *Oxford Economic Papers*, 33(*Supplement*), 9-22.

Yagci, F. (2001). Choice of exchange rate regimes for developing countries. *World Bank-African Region Working Paper Series, 16.*

Yamada, H. (2013). Does the exchange rate regime makes a difference in inflation performance in developing and emerging countries?: the role of inflation targeting. *Journal of International Money and Finance*, *32*(February), 968-989.

Yartey, C. A. (2007). Well-developed financial intermediary sector promotes stock market development evidence from Africa. *Journal of Emerging Market Finance, 6*(3), 269-289.

Yoon, S., & Lee, K. S. (2008). The volatility and asymmetry of Won/Dollar exchange rate. *Journal of Social Sciences, 4(1),* 7-9.

Yuan, C. (2011). The exchange rate and macroeconomic determinants: Time-varying transitional dynamics. *The North American Journal of Economics and Finance, 22(2),* 197-220.

Zakoian, J. M. (1994). Threshold heteroscedastic models. *Journal of Economic Dynamics and Control, 18(5),* 931-955.

Zamanian, G., Pahlavani, M. & Ranjbarnouri, F. (2013). Causal relation between money stock and exchange rate under the fixed and floating regimes. *International Journal of Academic Research in Progressive Education and Development, 2(1),* 75-82.

Zellner, A. (1978). Estimation of functions of population means and regression coefficients including structural coefficients: A minimum expected loss (MELO) approach. *Journal of Econometrics, 8(2),* 127-158.

Zivot, E., & Andrews, D. W. K. (1992). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business & Economic Statistics, 20(1),* 25-44.