

UNIVERSITY OF GHANA

COLLEGE OF HUMANITIES AND SOCIAL SCIENCES

**BUDGET DEFICIT AND ITS FINANCING: EXCHANGE RATE,
INTEREST RATE, AND INFLATION TRILEMMA IN GHANA,
A CO-INTEGRATION APPROACH**

The background of the page features a large, light-colored watermark of the University of Ghana crest. The crest is a shield-shaped emblem with a blue background and gold elements. It contains three stylized trees at the top, a central gold cross with four arms, and a banner at the bottom with the Latin motto 'INTEGRI PROCEDAMUS'.

BY

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**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF
GHANA, LEGON**

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THE AWARD OF MPhil FINANCE DEGREE.**

JULY, 2018

DECLARATION

I, ATSYOR PROSPER, hereby declare that I have personally, under the guidance of my supervisors, undertaken the study herein submitted, and that this thesis is the original research and it contains neither in whole nor in part, material previously published by me or another person or has been presented for another degree elsewhere except where due acknowledgement has been made in the text

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CERTIFICATION

Having supervised the student in accordance with the University of Ghana's laid down guidelines on supervision of the thesis, the thesis to the best of our knowledge was prepared from the candidate's own work and hereby certify same.

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DEDICATION

This work is dedicated to the God Almighty, the Atsyor family for their love and immense support, and also to the memory of my late brother Emmanuel Korsi Aglobi

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My greatest thanks go to the Almighty God for His abundant grace, love and mercies throughout my academic life and more especially in the preparation of this thesis. My profound gratitude goes to my supervisors' Dr Lord Mensah and Prof. Anthony Q. Aboagye for their scholarly guidance, constructive criticism, suggestions and corrections throughout the preparation of this thesis. They have been patient with my progress in completing this thesis and I am most grateful. I will look forward to working with them on other projects in the future.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
BD	Budget Deficit
CUSUM	Cumulative Sum Control Chart
CUSUM	Cumulative Sum of Recursive Residuals
DPQR	Dynamic Panel Quartile Regression
DRC	Democratic Republic of the Congo
ECM	Error correction model
ECOWAS	Economic Community of West African States
ERP	Economic Recovery Programme
FMOLS	Fully Modified Ordinary Least Squares
GDP	Gross Domestic Product
IEA	Institute of Economic Affairs
IFE	International Fisher Effect
IMF ECF	International Monetary Fund Extended Credit Facility
IMF	International Monetary Fund
IRF	Impulse Response Function
LINF	Lin Inflation Rate
LM	Lagrange Multiplier
LNEXR	Lin of Exchange Rate
OLS	Ordinary Least Squares

PPP	Purchasing Power Parity
PWC	Price Waterhouse Coopers
SBC	Schwarz Bayesian criterion
SIC	Schwarz Information Criterion
SVAR	Structural Vector Autoregression
UECM	Unrestricted Error Correction Model
VAR	Vector Autoregression
VECM	Vector Error-Correction Model

ABSTRACT

The study employed annual data from the year 1982 to 2017 to investigate the relationship exchange rate, interest and inflation, have with the budget deficit in Ghana. It also used monthly data from the year 1990 to 2017 to establish the long run distribution of inflation and the exchange rate in Ghana. The Autoregressive Distributed Lag (ARDL) co-integration technique, the Error correction parameterization of the ARDL model, impulse response function of the Vector Autoregressive model, and Markov transition probabilities were used in unveiling these dynamics. The study established co-integration between budget deficit and exchange rate as well as with the inflation. It, however, suggests no co-integration between the budget deficit and the interest rate. The result showed that there exists statistically significant negative long-run relationship between the budget deficit and the exchange rate. The speed of adjustment estimated by the error correction model for exchange rate, and inflation in relation to the budget deficit shows that changes in the budget deficit cause the inflation to adjust faster than the exchange rate. Furthermore, upon the establishment of these long-run relations, Markov transition probabilities was used in estimating the long-run stationary distributions of inflation and exchange rate. It was realized that in the long run there is a 56.45 % chance that inflation rate will lie between 10% and 20%, inclusive in Ghana whereas the Cedi in the long run has a 87.76 % chance of depreciating against the US dollar. The study predicts the long run distribution of the exchange rate to occur in 20 months' time whiles the inflation rate will have 316 months' time-horizon

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Developing economies are driven by economic plans that specify social and economic objectives to be achieved in the short-run and long-run (Budlender, 2009). According to Eli (2010), the role of budgeting in a developing country is much different from that of developed countries. He adds that budgets are used in developing countries as an integral part of development planning owing to the un-cyclical and chronic nature of unemployment in developing countries that reflect structural bottlenecks of those economies. This has gathered substantial attention in macroeconomic theory from both academia and industry players given the impact it has on macroeconomic performance and its follow-up debt dynamics. The subject of budget deficit had been topical over the last three decades. This is evidently shown in the extensive debates, it amassed in academic and policy arenas coupled with its financing issues which had always posed serious challenges, particularly to developing countries like Ghana (Appiah, 2015).

Both in the past and present, the budget deficit policy has remained a popular instrument of fiscal tool available to state authorities for steering the economy and increasing its growth rate.

Government finances this instrument when created by increasing taxes, external and domestic borrowing, or by the use of central bank accumulated cash balances among others (Fatima, Ahmed, & Rehman, 2012). As Kustepeli and Onel (2005) put it, the amount of the budget deficit and the financial channel defines the fiscal constraints a country is likely to face in the future. To this end, the budget deficit of Ghana and how it should be sustained becomes an important factor that occupies the attention of policy. Alagidede, Baah-Boateng, and Nketiah-Amponsah, (2013) opine that, in practice, a government which incurs fiscal deficits can finance it by borrowing either from

domestic or external sources, issuing bonds on the domestic financial markets and finally by resorting to the “printing of money”.

Borrowing; one of the most popular models of deficit finance, which is done through the issuance of government bonds reduces the real value of money and makes the long run uncertain for economic players. Budget financing through borrowing has created uncertainty about the real debt situations of states. In the need to secure better economic conditions, governments are forced to implement expansive fiscal policies with the aim of stimulating economic growth (Moraa, 2014). Another option available for financing government deficit is money financing. With money financing, an increase in government expenditure needs a proportionate increase in revenue for it to be financed. The assumption here is that, the treasury department of the central bank print money without any liability of the government paying back. The aggregate demand is fuelled up as the government spends this money, which increases the amount of currency that circulates in the economy. The effect is that growth is experienced on both the private sector’s financial wealth and the broad money supply. Like tax financing, private consumption, broad money demand, and private investments are all affected by time lags (Friedman, 1978).

Acknowledging that deficit financing as a fiscal weapon is very instrumental in stimulating economic development, it is however only beneficial if it is prudently used. While the usage affords the economy a means of mobilizing additional resources for its development and the optimal usage of resources, it equally has the tendency of accumulating both economic and social overheads; as it ensures that the country attains higher levels of productivity through the full employment of economic resources (Kuncoro, 2011). Despite the positives, each of these sources of financing triggers its own macroeconomic effects and costs. Domestic borrowing shoves credit

through higher interest rates and further to the squeezing out of private investment and consumption. Borrowing externally is usually accompanied by a current account deficit and strengthen the real exchange rate. It could also lead to difficulties with either the balance of payments or debt crisis in the event of a decrease in the foreign reserves or where the debt becomes too large. Finally, money printing by the central bank leads to inflation (Easterly & Schmidt-Hebbel, 1993).

The impact budget deficit financing has on the economy can be felt through many channels. Most notable is the direct effect large supply of bonds exerts on the interest rates. Baumol and Blinder (2005) note that the price of bonds intended for sale tends to fall as its supply increase, which increases the market interest rates; except for the timeless elasticity of credit offer, the private borrowing will eventually have decreased. They further explain that interest rate increases can be limited in the short run from the inflows of capital and this can increase the proportion of the public expenditure accounted for by the interest rate. As a result, future fiscal deficits impact the investment and expenditure in the economic performance front.

Government competes with private businesses for funds through domestic borrowing. Extra demand for funds by government results to interest rate hikes in the money market. This curtails the private investment which is described as the crowding out effect (Blanchard, 2008). Where the deficit financing is done through the printing of new notes by the central bank, it creates inflationary pressure on the economy, which only do not make foreign investment unattractive, but compounds the problem by reducing exports, increasing imports, increasing inequality in the distribution of income, lowering savings rate and encouraging wasteful expenditures. Hudson

(2011) notes that deficit financing builds up inflationary pressure on the economy and if the period between which the printed money is injected into the economy and the execution time of development projects for which the money is created is long such that the extra demand for goods is mismatched with additional output, then inflationary pressure is bound to be greater in the economy. Where the time lag is short, one is sure of lesser inflationary impacts on the economy.

With the view of the above, examining budget financing effect on the exchange rate, interest rate as well as inflation is not an end in itself. It is equally important to evaluate empirically, the interdependencies and the significance of the nexus between these variables and their long term sustainability.

1.2 Problem Statement

Africa countries just as any developing nations are faced with high fiscal deficits resulting from increased recurrent expenditures, unbudgeted spending and financing election activities through budget provisions (Zuze, 2016). The budget deficit in Ghana is crucial in achieving socioeconomic objectives such as macroeconomic stability, poverty eradication, and sustainable growth. Bank of Ghana, 2005 annual report at the time thought the deficit position of Ghana's budget and for that matter, other countries with similar status as Ghana has worsened. This draws attention to the long-term sustainability of the deficit. It is therefore not surprising that many still hold the same view even in recent times as the budget deficit trend seems to be persistence. For most fiscal years, revenue generated in Ghana is not enough to meet the government expenditures leading to a negative balance of the budget. The steady rise in expenditure is due to high-interest payment on government debt and increase demand for infrastructure to meet the growing population. It is worth

noting that, total expenditure as a percentage of GDP has risen from 31.62 percent in 2005 fiscal year to 33.71 percent in 2006 and went up further by 2.19 percentage points in 2007 (Bank of Ghana, 2008). Notwithstanding this, Straub and Tchakarov (2007) argued that, as Ghana incurs a large budget deficit in the form of public expenditure, it serves as an engine of growth that propels the economy on the path of development. For instance, irrespective of the size of Ghana's budget deficit, expenditure on infrastructure in the area of communication, education, research, and development provide input to stimulate the growth of the private sector. Xiomara and Greenidge, (2003) corroborated this and opined that it is prudent for the government of Ghana to run some fiscal deficits with the view of stimulating growth by accumulating enough capital stock. They believed running a budget deficit would paddle the economy on its long-run distribution growth path so that short term issued debts can be repaid in the future.

Despite the above arguments, there has been a call on the reduction of the budget deficit. The main fiscal objective of the inception of the Economic Recovery Programme (ERP) has been the reduction of fiscal deficits in order to help control inflation and prevent crowding-out of the private sector (Aryeetey, Harrigan, & Nissanke, 2000). This objective was partly achieved until the 1992 election year where fiscal indiscipline emerged and the large deficit of 4.3% of GDP was recorded. Between 1986 and 1991, the government experienced consistent surpluses on its accounts. Large foreign inflows coupled with more efficient public spending accounted for these surpluses achieved throughout the period. Since 1992, the country has recorded fiscal deficits with the exception of 1994 and 1995 fiscal years, where surpluses of 2.3% and 0.9% of GDP respectively were registered (Amoah & Loloh, 2008).

As Ghana consistently operates budget deficit, government debt is being swelled up as past deficit influences current borrowings, thereby creating higher debt service payments. This underscores the need for further borrowing to meet the interest payment and also the increasing primary deficit, which eventually affects the future borrowing rate. In case the interest payment on a debt is even met, the debt must be rolled over indefinitely because tax revenue is not enough to pay for other expenditure. Meanwhile, except for money printing, there is a ceiling on the extent to which the budget deficit financing options that are available to the government can be pursued. According to section 30 (2) of Bank of Ghana Act, 2002 (Act 612), “the total of the loans, advances, purchases of treasury bills and securities together with money borrowed by the Government from other banking institutions and the public at the close of a financial year under subsection (1) shall not exceed 10 percent of the total revenue of the fiscal year in which the advances were made” (Fitch report, 2014).

In accordance with the IMF Extended Credit Facility Program to Ghana, the government originally targets a deficit of 3.0% for a medium-term period ending in the year 2018 which was expected to be achieved progressively. However, the deficit of 10.3% and 8.7% of GDP recorded on commitment and cash basis in the 2016 fiscal year, which was mainly caused by large fiscal slippage and poor revenue mobilization, coupled with the developmental programme line-up for the 2017 statistical year, has forced the government to revise the target to 6.5% in 2017. Although this budget deficit target seems reasonable, its attainment depends largely on whether or not government revenue targets for the year will be met. (pwc, 2017)

Ghana registered high inflationary episodes between the 1970s and early 1980s. The yearly inflation rates recorded exceeded 100% on four occasions between July 1977 and March 1983. Inflation averaged about 50%, with 1977 and 1981 recording 116.5% respectively. Inflation continued to surge upwards, reaching approximately 123% in 1983. Coincidentally, the government budget was also in deficits between 1972 and 1983. For instance, the fiscal deficit measured in terms of GDP was 6% in 1972 and 11% in 1976. This “skyrocketing” inflation rates of the period were attributed to the monetization of the fiscal deficits, which caused an excess growth in the money supply. The government was, however, compelled to monetize existing deficits due to the financial environment of that time (Sowa & Kwakye, 1993).

Ghana has been battling with high inflationary rates over the past three decades until June 2010, when it recorded a single-digit inflation rate of 9.5%. Although the rates have seen a further decline to about 8.8% by January 2012, it went up hitting 13.5% by December 2013 and has exhibited an increasing trend afterward registering 17% of GDP by December 2014 (Ghana Statistical Service, 2014). One major prerequisite to joining the Economic Community of West African States (ECOWAS) common currency zone is the attainment of a single digit rate of inflation (Adu & Marbuah, 2011). Despite the current downward trend being experienced, achieving yet another single digit inflation and its sustainability is of great concern to government and policymakers.

It is no doubt the country Ghana has had challenges in the prudent management of its exchange rates. Ghana’s exchange rate policy before the coming into being of the economic recovery programme mainly involves the maintenance of a fixed exchange rate regime while occasionally

engages in devaluation, and exchange rationing. The year 1988, saw Ghana adopt the flexible exchange rate regime, however, for the most part, the national currency, the Cedi (¢), was characterized by instability. According to Aboagye (2018), two of the most topical macroeconomic issues in Ghana today included the depreciation of the domestic currency. Owing to this, Ghana's policy circle over decades has concerned itself with issues of exchange rate stabilization. This has been demonstrated by successive governments through their policy documents and budget statements. Nevertheless, it is trivial to say maintaining a stable value for the Cedi against its major international currencies continuously poses a lot of challenges to policymakers (Bank of Ghana **WP/BOG-2004/06**)

The fall in the value of the Ghanaian currency is now a common phenomenon. The Cedi's value was weakened by 93.67%, 48.86%, 36.76% and by 33.00% in the years 1983, 1987, 1993 and 1999 respectively vis a vis the US dollar (Bawumia & Abradu-Otoo, 2003). It went down further against the US Dollar by 25.1% in 2008 and by 17.7% in 2009 (Immurana, Iddrisu & Kyei-Brobbe, 2013). In the year 2009, the Cedi depreciates by some 15.3%, and by 3.0% in the following year. It further depreciated by 31.3%, 17.2%, and 9.0% in the year 2014, 2015, and 2016 respectively (Aboagye, 2018). This depreciating nature of the Cedi and its adverse effect on the economy raises much concern.

Inflows from the US\$750 million Eurobond, the COCOBOD syndicated loan of US\$1,800 million as well as the IMF Extended Credit Facility programme which brought in about US\$116.2 million in the third quarter of 2016 are responsible for the stabilized exchange rates chocked through the second half of 2016. However, the local currency value stabilization was short-lived as the first quarter of 2017 experienced further weakening of the Cedi against the major foreign currencies,

like the US Dollar. The depreciation of the Cedi in the first quarter, according to Price Waterhouse Coopers 2017 report is a reflection of the undulating impact of expenditure overruns in the last quarter of 2016 and the uncertainties surrounding the general elections at the time. This they claimed caused an increase in demand for foreign currencies.

In another vein, Price Waterhouse Coopers, reported 2016 year-on-year growth rate of 14.4% in Ghana's private sector credit facility, against 24.5% as recorded in the year 2015. Among the factors, they attributed to this decline is the excessive borrowings by the Government from the domestic front. This lead to higher average lending rates, accompanied by general low economic activities in the year. They alluded to the fact that the central bank actually decreased the Monetary Policy Rate by 50 basis points between 2015 December to December 2016, yet, the average lending rate rather increased from 27.5% in December 2015 to 31.2% by December 2016. The 2016 deficit of 7.8% was financed mostly from domestic sources, amounting to GH¢10,184.7 million (77.5%), while foreign financing accounted for 22.5 percent. The Government; acknowledging the upward trend communicated its intentions to minimize borrowings, especially from the domestic front, as evident from its policy document. It believes the crowding out of the private sector through increased lending rates can be averted. It is, however, difficult to reconcile this position as the Government's decision to borrow over GH¢13 billion in the domestic market to finance the 2017 budget do not support the realization of that objective.

The aggregated effect of the current state of these economic measures could have dire consequences on the economic growth in general. With the government flagship interventions like the free SHS, a factory in each district, one million per constituency, and the reduction of taxes, future pressure on the budget is inevitable. This makes it imperative for economic analysts, policy

makers and academia to question the effects of the revenue-expenditure-gap on price stability, cost of capital, and the price of foreign currency.

The issues surrounding the favourable as well as unfavourable impacts of budget deficits on the growth of the economy has been long-standing in the Ghanaian context, particularly among political elites and policymakers. Since the adoption of the socialist agenda in the first republic, Ghana's economic management was characterized by budget deficits as a common feature of economic policy (Larbi, 2012). Present happenings, including the phenomenal increase in the government's 2012 budget deficit rekindled this debate intensely. Ghana's deficit increased from 4.3 percent of the country's GDP in 2011 to 11.8 percent in 2012 (Bank of Ghana, 2012 & 2013). Although this was reduced by 5.5 percentage points in 2015, previous figures make it considerably high. The country's continuous budget deficit run accounted for the increase in the gross public debt. A debt of 40 percent in 2011 rose by 3260 basis points at the end of November 2015 (ADB, OECD & UNDP, 2015). Meanwhile, the debt itself is at a cost and the question about its sustainability is sure the popular opinion. As put forward by Arestis and Sawyer (2006), Ghana can run a primary deficit occasionally, but not permanent interest-exclusive deficits because optimizing individuals will not continuously lend to a defaulting government. Also, going by the neoclassical proposition, one needs to be careful with policies that support budget deficit just for the sake of it without taking into account its effects on other economic variables as high budget deficits in itself may not necessarily guarantee economic growth in the long term.

The beaconing question in this regard is; whether achieving stability in exchange rates, sustaining single digit inflation and low-interest rate whiles running a budget deficit is possible? Or whether

the government can rely on fiscal prudence alone to curtail the woes of the high exchange rate, high-interest rate, and inflation impacts on the economy? This thesis sets out to achieve empirical answers to these questions and also to determine the long run distribution of inflation and the exchange rate.

1.3 Objectives of the Study

The study seeks to determine whether persistent depreciation of the Cedi, double-digit inflation and high-interest rate in Ghana tend to have some considerable fiscal roots. Specifically, it seeks to:

1. Investigate the relationship exchange rate, interest rate, and the inflation has with the budget deficit in Ghana and Test for possible co-integration
2. Determine the long-run distribution of inflation and the exchange rate, using Markov transition probabilities

1.4 Hypotheses

The following hypotheses will be tested using appropriate quantitative and statistical techniques.

To achieve the specific objectives of this study, two hypotheses are set:

1. **H0:** Budget deficits does not granger-causes exchange rate, interest rate, and inflation in Ghana.
H1: Budget deficits granger-causes exchange rate, interest rate, and inflation in Ghana.
2. **H0:** There are no long-run inflation, and exchange rate distributions in Ghana.
H1: There are long-run inflation, and exchange rate distributions in Ghana

1.5 Significance of the Study.

The relevance of potential negative spill-over effects of running large budget deficits on economic variables and how they impact on the economic growth, in general, is paramount both for policymakers, academia, financial intermediaries, and capital market participants. As put forward by Aworinde (2013), Fiscal deficits and its financing means are at the centre of political discussions and policy documents in Africa. Fiscal deficits, especially when large have negative implications on the economy and may breed large current account deficit. Over dependent on commodities whose prices are not even guaranteed exposes these African economies to greater vulnerabilities emanating from external shocks and the consequences of economic disruption.

Antwi and Atta-Mills (2013) also think that Ghana's continues deficit run implied that the growth rate of the debt and its accompanying service charge will persist without limit if not contained. They believe a major adjustment is required in the future to curtail government excess spending and the exploded debt-GDP ratio resulting from higher interest payment in Ghana.

As pointed out by Risti, Nicolaescu, and Tagaduan (2013), whiles the budget deficit impacts all the macroeconomic variables, the reverse is true for macroeconomic indicators on the budget balance. With the ECOWAS zone currency requirement to be met, coupled with the government's desire to promote the private sector and as such making cost of capital accessible and affordable to the private sector, and considering the efforts being made by successive governments to arrest the depreciating Cedi, the impetus is given for one to conclude that Ghanaians are gradually voting for stable prices, low-interest rate, and a stronger currency. This study will therefore not only be adding to the store of knowledge but also helping financial analyst, policy makers and academia to see or otherwise the interrelationship between the aforementioned variables and how a sound

balance can be achieved between them through the use of the budget deficit in Ghana. The study is also expected to help explore the policy implications for managing the budget deficit in Ghana. Finally, the findings of the study will provide developing countries that are benchmarked with Ghana some insights on the budget deficit and macroeconomic variable relationships which is expected to help them formulate timely and appropriate interventions to spur their economies.

1.6 Organization of the Study

The study consists of five chapters. The first; segmented into background, statement of the problem, research objectives, hypotheses, significance, and organization of the study all representing the introduction. Chapter two presents the literature review of the work of other authors. It deals with both the theoretical and empirical literature. This covers the impact government budget deficit, inflation, exchange rate, and interest rate have on the economy. The third chapter is concerned with the method of study. It includes the variables of the study, the model specification, data sources, and data analysis. Chapter four discusses the estimation, analysis, and interpretation of the results. This includes the presentation of test results of unit root, Granger causality, and co-integration between government budget, inflation, exchange rate, and interest rate series. Also, the stability test is conducted to check for structural breaks. Finally, the fifth chapter outlines a summary of the findings and conclusion of the study. Recommendation for policy making is also highlighted together with the limitation of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Focus on the budget deficit has drawn substantial attention in the area of macroeconomic theory as evident by the literature. The role of the budget deficit on the performance of macroeconomic indicators is overwhelming. In Ghana, for instance, changes in both the interest and inflation rates have all exhibited negative reactions to changes in the budget deficit (Islam & Wetzels, 1991). The big question is what effect does deficit have on the economy? At the root of modelling how the budget deficit relates to exchange rate, interest rate and inflation and the interdependency amongst these indicators are long-standing underpinning theories and postulates explaining changes in their periodic value. This chapter focused on the definition of relevant terms, Review of theories such as Keynesian theory, Neo-Classical Growth Theories, Ricardian Equivalence Theory, Purchasing Power Parity (PPP) Theory, and the Interest Rate Parity Theory. The literature on the nexus between budget deficit, exchange rate, interest rate, and the inflation was examined and finally, empirical review of studies on the various objectives of this study was carried out.

2.1 Definitions of Variables

2.1.1 Budget Deficit

When government appetite for expenditure far outweighs its revenue, the result is a revenue-expenditure gap. This gap which needs financing is described as a Budget deficit. Since the late 1950's the Ghanaian economy has a persistent inclination towards budget deficit due to the government's ever-growing expenditure envelope, insufficient revenue mobilization capacity and rising debt levels (Pomeyie, 2001). For the purpose of this study, the Budget deficit is considered

as the overall balance; minus divestiture receipts and liabilities measured in percentage terms of nominal GDP

2.1.2 Exchange rate (LNEXR)

The exchange rate can be described as the price for which a foreign currency can be acquired in domestic currency. The Budget deficit can cause the domestic currency to appreciate by beefing up the foreign reserves and foreign currency-stock or give rise to a weaker exchange rate by decreasing the demand for loanable funds which will cause the interest rate to shrink. As the domestic interest rate declines, it is prudent for domestic investors to prefer foreign securities instead resulting in the exchange rate weakening. The relationship between exchange rate and the budget deficit is expected to either be positive or negative.

2.1.3 Interest Rate (INR)

The treasury bill rate generally regarded as a gauge for the interest rate policy a government pursues, and also considered as the yardstick for rates charged by banks is used as a proxy for the interest rate. Literature has it that, running continuous budget deficits triggers wrong public perception about the economy, causes the demand for government bonds to fall and possibly increases the interest rates. Although other studies state an opposite causality between budget deficits and interest rates. The main feature is that, for the government to meet the deficit financing need, it must offer higher interest for its issued debt to make it attractive. Hence it is expected that interest rates will be positively related to the Budget deficit.

2.1.4 Inflation Rate (LINF)

Inflation refers to the persistent rise in the general price level. It is a situation where the supply of money exceeds its demand. Hudson (2011) notes that financing the deficit creates inflationary pressure in the economy such that the delay between the time of injection printed money into the economy and the completion of projects if prolong creates mismatches between the extra demand for goods and the additional output causing greater inflationary impacts on the economy. Where the time lag is short, the impact on the economy is lesser. The study of monetary expansions situations draws a link between money printing and government deficit financing. It is therefore expected that; the printing of money leads to an excess supply of money over demand thereby causing inflation. We, therefore, expect the inflation rate and the budget deficit to be positively related.

2.2 Theoretical reviews

2.2.1 Keynesian theory

The Keynesian theory was first postulated in the 1930s. John Maynard Keynes recognized the possibility of the budget deficit crowding out effect. He is however of the view that since the economy is generally not at full capacity, it cannot experience full crowding out. Instead, partial crowding out would be witnessed with no crowding out effect at all during a deep recession. Eisner (1989) also suggested that increased aggregate demand brings to the fore higher levels of investment at any given rate of interest by changing the profitability of the private investment. Hence, deficits may be used to invigorate aggregate saving and influence investment, although it may raise the interest rate. He concluded that increased consumption is fuel through unutilized resources.

Traditional Keynesians does not believe that deficits can swarm out private investment. In their view, expanding the budget deficit influences output to extend by influencing negatively the extra desire to save. Where the deficit is bond financed, interest rates must rise and private investment falls. This then decreases output and partly offset the Keynesian multiplier effect (Hicks, 1980). This argument has several dimensions: firstly, the choice to save or to invest are not only dependent on the rate of interest, but also on primary expectations of future profit, which in itself a function of other factors, including what Keynes called "animal spirits" (emotional psychology of the investor). This contradicts how investors would react if their concern is only with the cost of borrowing and disregards future expectations. Also, business seasonality (boom and recession) and its dynamics implied that, although government spending can increase interest rates, there is no guarantee that this would automatically decrease the investment; especially when businesses are certain of the economic prospects.

The multiplier effect is highlighted in the second argument. On a slack economy, it's supposed that if slacks exist in an economy and the government spending has positive multiplier effects, then government spending can increase total output, and also creates more investment, to crowd in the private sector by proportionally compensating for in multiples any investment eroded by higher interest rates caused by the spending. Keynes insisted that the possibility of the economy being entrapped in a perpetual low-level equilibrium should not be disregarded, as both individuals and banks have the option to hoard money or simply by not investing it with an adjustment mechanism. This underscored the need for government to operate deficits and spend money to keep the economy on the growth path until investor and consumer confidence returned.

Krugman (1994) however, objected the Keynesian view on two major grounds. First, the viewpoint on budget deficits, which assumes that the government is able to "fine tune" fiscal policy may not

always hold as under certain conditions, stimulation of the economy may be detrimental to growth. Eisner for example, calls for policies that would keep the real deficit from rising when the economy is at full capacity. The inflationary implication of this policy makes proponents of the strategy to embrace the purist view that Inflation is costless. Meanwhile, Inflation, if combined with the tax system, can give rise to distortions and also redistributes resources in an undesirable manner. It follows that inflation brings fluctuations and uncertainty to the economic circles. Hence the proper management of fiscal policy is crucial.

The second critique of the Keynesian school of thought on deficit financing was its view on the effects of deficits in the short run. By lumping both the temporary and permanent deficits together, it is argued that Keynesians provide inaccurate advice to policymakers (Hollander, 1987).

As postulated in the Keynesian school of thought, with fiscal policies, there is the possibility of the existence of unemployed resources in the economy and also the crowding out of the private investment. This view is relevant in a study on economic measures as it highlights the downside on the use of fiscal policies as the catalyst for economic growth.

2.2.2 Neo-Classical Growth Theories

The Neoclassicals believe that fiscal deficit affects investment and growth by crowding out private investment. They assume taxes, finances government expenditures, as such; deferring taxes to future generations only influences current consumption to increase and creates fiscal deficits (Bernheim, 1989). This school of thought sees budget deficits as a means of increasing current consumption by the government or consumers, thereby causing investment to fall. They assert that at full employment of resources, increased consumption results in savings decrease. A fall in

savings raises real interest rates to the point of achieving equilibrium in the capital markets, which then reduces investment. Assuming the government borrows money to finance the budget deficit, the demand curve for loanable funds will be shifted to the right; this will increase the interest rate and make investment more expensive. Marshall (1890) has a problem with governments obstructing the economy. He argued that the market for loanable funds would balance out savings and investment if left to itself. This they believe will help keep the economy at or close to full employment. They argue that market free from government interference is the best way of inducing rapid and successful development, as such, they see no need for government deficit spending since that would only be counterproductive. In any case, the effect is only to shift funds from investment to government consumption. They added that competitive markets that are free from too much of government regulation are able to ensure that the distribution of resources to productive sectors occur with the greatest efficiency possible. Classically-oriented economists generally ascribe these reasons for opposing government deficit spending

2.2.3 Ricardian Equivalence Theory

Ricardo (1817) contends that family units are indifferent in the choice of facing present taxes, or buying debt now and getting rent. The only thing relevant to the economy is the quantity the government purchases as revealed in Barro (1974). Harvard's Robert Barro contends that inflation, unemployment, real GNP, and real national savings ought not to be influenced by whether the government expenditure is funded by high taxes or high deficits. Since individuals are rational and will accurately perceive that low taxes and high deficits now should mean higher future taxes for them and their beneficiaries. This theory is based on the presumptions that people are foresighted, individual discount rates on spending are precisely equivalent to those of government and finally, individuals have extremely long-term periods for assessing the present value of future taxes. The

theorem recommends that fiscal deficit and tax assessment affects the economy in a like manner. It is accepted that a household spreads consumption as indicated by the permanent income hypothesis, which states that consumers will choose their spending pattern not only in the light of current income but rather on all future income streams which presupposes that the household consumption behaviour does not change just as its net wealth.

In basic economics, a deviation from tax to bond financing increases consumption, as it makes available more disposable income. This implies that by reducing taxes and financing expenditures by issuing bonds, a country can increase consumption, except that the increase in government consumption and decrease in savings in the form of a current fiscal deficit results in offsetting the desired growth of private saving and hence no change is achieved for the desired national saving. Feldstein (1974) argues that there is no need for the real interest rate to rise in a closed economy to balance off national saving and investment demand since desired national saving remains unchanged. David Ricardo further contends that a related issue is the desirability of purposely using deficits to impact the path of the economy by making individuals think they all of a sudden have turned out to be wealthier (and alternately for surpluses) and along these lines question the rationale for an approach that is effective simply because it intentionally misleads the public.

Ricardo (1951) admitted that the turnover of population and the limitations of the permanent-income hypothesis are some reasons why the Ricardian equivalence would not hold. However, the review of this theory is important as it analyses the trade-off between the uses of government bonds and taxation to raise money to close the budget deficit, provides options by comparing the most productive way for governments to raise money to balance their budgets and gives insight into income theories of consumers and households which is one of the factors used in the measurement of economic growth in the GDP approach.

In summary, the three mainstream analytical perspectives concerning the economic effects of budget deficits were identified as the Neoclassical, Keynesians and Ricardian: the neoclassical view fiscal deficits to be having a negative influence on investment and growth, while the Keynesians consider it as a key policy instrument (Rahman, 2012). Theorists championed by Ricardian equivalence contend that fiscal deficits have neutral effects on economic growth and are inconsequential, except for steering the economy after an expenditure or revenue shocks. Finally, the Keynesian view emphasizes the short-run effects. On the other hand, Neoclassical and Ricardian schools emphasize on the long run, (Van & Sudhipongpracha, 2015).

2.3 Other Theories

Numerous theories have also been propounded for the determination of the interdependency of economic measures such as the exchange rate, interest rate, and inflation and the effect of those on long term growth; Purchasing Power Parity (PPP) theory, and the Interest Rate Parity theory, are some examples of theories used to model this phenomenon

2.3.1 Purchasing Power Parity (PPP) Theory

This theory is based on the assumption that “the normal convergence rate of exchange established for two inconvertible currencies will be ascertained by their purchasing power ratios as such, the rate of exchange tends to exist at the point where the purchasing powers of the two currencies reach equality” (Kuttner & Posen, 2004). The theory sought to quantify the relationship between inflation and the exchange rate by insisting that the inflation rate differentials are what necessitate the changes in the exchange rate (Kara & Nelson, 2003). Simply put, the PPP contends that in the long run, differences in exchange rate among countries will be a reflection of how their respective price level changes. It, therefore, means that a unit increase in a country’s rate of inflation relative

to its counterpart decreases exports and causes imports to increase thereby exerting pressure on the domestic currency.

Ndung'u (1997) statement that the rate at which two countries' currencies are being exchanged for is the same as the price ratio of goods between those countries supposed that "exchange rate must adjust to reflect the change in the prices of goods in the two countries". Meanwhile, the expected difference in their inflation rates as accorded by Kamin (1997) should be the same as the differences between the current spot rate and the expected spot rate.

Despite the acceptability of the PPP theory due to its sound theoretical foundation and reasonable explanation, Grigorianm (2004) thinks its application in real situations might be very difficult, particularly over the long run. In any case, PPP theory is, for the most part, a key ingredient in the exchange rate determination literature and it is still very essential among the economies of the world (Nucu, 2011).

2.3.2 Interest Rate Parity Theory

This theory takes into consideration the exchange rate and interest rate nexus between any two countries. In its wisdom, interest rate differentials between the two countries remain the determinant of their exchange rate. It attempts to define the rate of interest in one country in relation to the exchange rate value of its trading counterpart. Put differently, interest rate change in a country will be influenced by the value at which that country's currency can be exchanged for her trading partners(s). Alum (2012) corroborated this by agreeing that, the change in the interest rate of two countries should be able to meaningfully reflect the exchange value of their currencies such that, when interest rates fall in one country, the exchange value of that country's currency with respect to foreign currencies will equally fall and if interest rates are high, the reverse is experienced. The traditional flow model put forward that, increasing the home country's interest

rate in relation to the foreign interest rate appreciates the exchange rate by arousing capital inflow (Obi, Nurudeen, & Wafure, 2009). Bergen (2010) accorded that, where similar interest rates levels exist between two countries, an increase the interest rates of one will lead to a depreciation of that country's currency

2.4 Nexus between Variables

2.4.1 Fiscal Deficits and the Inflation Debate

The way government fiscal deficits relate to inflation has been highly discussed and debated over the years. Notable among them include; Patinkin (1965), Sargent and Wallace (1981), Miller (1983), and Barro (1978, 1979). However, the effect of fiscal deficit and inflation, on each other, and related macroeconomic variables, remains an unsettled issue. Mundle, Bhanumurthy, and Das (2011). Patinkin (1965) and later, Friedman (1968) postulate a direct relationship between fiscal deficit and inflation through the aggregate demand approach where inflation is the result of an increase in aggregate demand causes prices to increase in order for a new equilibrium to be established. Patinkin (1965) suggests that where the real value of the bond stock increases, there is a rise in perceived private wealth, which influences spending, leading to inflation. On the other hand, Friedman (1968) argues that increases in the general price level are a reflection of an increase in aggregate demand on the condition that the economy is in its steady state.

An immediate effect through the money supply, where the vast fiscal deficit prompts increment in the money supply to swell up the general level of prices was proposed by Sargent and Wallace (1981). They modelled a phenomenon where higher government deficits do not result in higher taxes; instead, higher deficits or debt leads to higher money growth in the current period or in the

future; leading to inflation. They contend that seigniorage, is vital to deficit finance; the obligation of the central bank to monetize the deficit created by the government leads to an expansion in the money supply and induces the rate of inflation. They trust that fiscal deficit first causes money supply; then inflation. The third linkage is the argument by Miller (1983). In his view, the means of financing government deficits, whether monetized or not is inconsequential because budget deficits are just inflationary. He contends that even if the Central Bank fails to monetize the deficit through the printing of money, the non-monetized deficits would still affect private investment and reduce aggregate supply through higher interest rates. The shortfall in the growth rate of real output, therefore, leads to a price increase.

Barro (1978, 1979) proclaimed the fourth link and suggests reverse causation, where expectations for higher inflation induces real interest rates and debt-service charges to go up causing an increase in fiscal deficits. According to him, deficits are the consequence of inflation. The deficit is the difference in the nominal value of outstanding government bonds. Conditioning on the anticipated inflation rate increase, the nominal value of the bonds must also increase. This means that the government will run a deficit in order to maintain the same anticipated real amount of bonds.

Concluding on these four arguments, it is evidently clear that the budget deficit has an inflationary impact which is dependent on the deficit financing choice and the effect it has on total demand. Where government issued bonds in an attempt to finance the budget deficits at the blind side of tight monetary policy, it may be “calling” for inflation. On the other hand, if seigniorage revenue is the channel through which the deficit was financed; fiscal deficits will still lead to inflation. At the theoretical level, these major channels of interaction between fiscal deficits and inflation have

a close link between deficits and monetary growth on one hand and fiscal deficit and inflation on the other.

2.4.2 Fiscal Deficits and the Interest rate Debate

The debate on the budget deficit and the interest rate relationship was as old as the Mundell-Flemming model. The underlining assumption of the model is that a large budget deficit uses the interest rate as a conduit to cause the exchange rate to appreciate by attracting capital inflows. The belief that the budget deficit attracts higher interest was justified by the standard Keynesian and Neoclassical models through the crowding out effect. The emergence of the Ricardian equivalence hypothesis in the 1980s which has been most popularly upheld by Barro (1989) and has been receiving increasing attention since; brought in a new twist to the already existing budget deficit and interest rate nexus. No wonder empirical and theoretical works over the years were focused on explaining their relationship. While Keynesian is of the view that the budget deficit crowds out the private sector through higher interest rates, Ricardo, is of the opinion that budget deficits do not really matter. He argues that any increase in the budget deficit of government is effectively neutralized by an increase in future tax liabilities, and assuming lower tax levels in the present is in equal proportion, balanced off by higher taxes in the future, budget deficits need not have any influence on the macroeconomic variables.

In response to these controversies, empirical work both past and present attempt to put into perspective the link between budget deficit and the rate of interest, however, there seems to be no general consensus. Authors such as: Barro (1974, 1987), Hoelscher (1983), Aschauer (1985), Evans (1987), Darrat (1989, 1990), and Kormendi and Protopapadakis (2004) have all found no

significant relationship between government budget deficit and the interest rate and therefore endorse the Ricardo view of government deficits having no impact on key macroeconomic variables. Other authors who found positive and significant link existing between budget deficits and interest rates include Makin (1983), Zahid (1988), Laumas (1989), Bovenberg (1998), and Dai and Philippon (2004). Conversely, they support the Keynesian theory.

Till date, many theoretical and empirical examination of this crucial relationship between Budget deficit and the interest rate has been carried out, yet, the conclusion, from all their findings, remains heterogeneous

2.4.3 Fiscal Deficits and the Exchange Rate Debate

The influence government spending has on the exchange rate has been argued by economists from many fronts. Some participants of the August 1995 session of the Jackson Hole symposium on “Budget Deficits and Debt: Issues and Options” put forward that, reduction in budget deficit brings about the stronger exchange rate, others, however, contend that it would lead to currency depreciation. (Hakkio, 1996)

Similarly, as many economic commentators attributed the rising U.S. deficit to the strength the U.S. dollar gained in the early 1980s, the rising deficits recorded in Finland, Italy, and Sweden in the 1990s were associated with a weak exchange rate. Feldstein (1986) and Sachs (1986) also argued that the strength of the dollar was due to anticipated future budget deficits

Turnovsky (1986) and Dornbusch (1976) in this debate put forward the view that; assuming capital is mobile to the extent that interest rate parity exists, financial market participants would have anticipated capital inflows with respect to higher domestic interest rates and immediately offer higher prices for domestic currency. By so doing, budget deficit effects do not change the interest

rates but are rather reflected in exchange rates causing Exports to be crowded out instead of real investment.

In the view of Persson (1985) and Frenkel and Razin (1987), budget deficits operate fundamentally through wealth effects on aggregate demand. They accorded that budget deficit involves an increase in government dis-saving which is less than fully compensated for by a rise in private sector saving. In effect, causing the interest rates to rise in a closed economy while in an open economy, the result would be a combination of trade deficits and a real exchange rate appreciation. Barro (1974) corroborated this view and put forward the argument that increases in government expenditure raise interest rates to induce intertemporal resource reallocations. The anticipated rise in the interest rate raises the domestic currency price in open economies.

Likewise, Bernheim (1989), Abell (1990), and Zietz and Pemberton, (1990) has demonstrated that increase in government spending accompanied by lower savings has a tendency to strengthen the domestic currency through induce capital inflows. Evans (1987), contends that a higher budget deficit tends to fuel consumption of both domestic and foreign goods, which translate to a higher interest rate in the home country relative to their foreign partners. The increase in the rate of exchange prevents the induced capital inflows to the point where traders are adequately motivated to hold the existing stock of assets. In the event that the budget deficit contributes to aggregate demand, this might lead to weaker domestic currency through higher price levels.

2.4.4 Exchange Rates, Interest rate, and Inflation Linkages

Literature acknowledges budget deficit financing of having a direct effect on the exchange rate, inflation and interest rate. There has also been renewed enthusiasm from economists about the link between these three variables in recent years both in advanced and developing countries. Economic

and finance literature is flooded with both theoretical and empirical works connecting exchange rate, interest rate, and inflation. The reasons, for the linkage, are not far fetching considering the importance of these variables in advancing developments in both the nominal and real sides of the economy. Among developing economies, this interest is further prodded as many economies are now moving towards inflation targeting which is structured to operate under flexible exchange rate regimes. Variations in the exchange rate and interest rate have all risen in recent years compared to previous periods distinguished by far more fixed exchange rate regimes. While the extent of such variation is still a matter of debate (Bergen, 2010). Pattnaik and Mitra (2001) argue that central banks are able to exert control over both inflation and exchange rates by just focusing on interest rates. It is their contention that exchange rates, interest rate, and inflation are all highly correlated, to the extent that changing interest rates impact inflation and currency values. Asari, Baharuddin, Shamsudin, Jusoh, Mohamad, and Jusoff (2011), added that Inflation and interest rates are highly correlated such that, the interest rate can be employed as a policy variable in managing future expectations regarding inflation and also to control exchange rate volatility. Bove and Saltvedt, (2004) also pointed out that by manipulating the interest rates, the central bank can contain the exchange rate under a defined range. In the Mundell-Fleming model, an increase in interest rate is essential to stabilize the exchange rate and to curb the inflationary pressure and by that helps to prevent any adverse economic consequences (Calvo, & Reinhart, 2000). High-Interest rate raises the appetite of investors for domestic financial assets. This is expected to result in capital inflow and thereby limiting the rate at which the domestic currency can depreciate (Devereux, & Engel, 2003). In Duarte and Stockman (2002) view, lower inflation levels exhibit a stronger exchange rate, as the purchasing power of the domestic currency will appreciate against other currencies.

Eichengreen (2004) argues that the way in which the exchange rate impacts the inflation in itself is dependent on the exchange rate regime choice of the country. In his opinion, the negative influence exchange rates, volatility has on the economy can be resolved by the exchange rate system in that country. Engle (2002) believes that exchange rate fluctuations in the system of floating exchange rates can have a strong effect on the level of prices through the aggregate demand and aggregate supply (i.e. Demand-pull and Cost-push inflation). Some economic analysts conclude that the increase in exchange rate volatility is one of the consequences of adopting inflation targeting considering the relationship existing between inflation targeting regime and the exchange rate regime.

2.5 EMPIRICAL LITERATURE

The literature is awash with empirical works explaining the basis for budget deficit impacts on inflation, exchange rate, and interest rate. All angles there are, to these relationships were critically examined by literature and different results appeared. Generally, studies done for low and middle economies show that inflationary pressures, currency depreciation, and interest rate hikes are victims of government budget deficits. Whiles evidence from the developed nations on the role of budget deficit appeared to be less significant in determining those.

Auerbach, Gale, and Orszag (2002) reviewed the interest rate – fiscal deficit nexus by examining the positive links of fiscal deficit and interest rates. It is their conclusion that continuous fiscal imbalances may distort capital stock accumulation which will then cause interest rates to remain high in any economy. Earlier, Ford and Laxton (1999) contend that factors that impacts the rate of interest in an economy still remain cloudy, however, an increase in government expenditure is a

major contributing factor to the interest rate hikes in most economies. Sheriff and Amoako (2014) corroborated this and presented inflation and fiscal deficit as fundamental macroeconomic indicators responsible for the high spread in the lending-deposit rates in Ghana. Similarly, Adu and Marbuah (2011) utilized the Autoregressive Distributed Lag (ARDL) model and employed data from 1960 to 2009 to affirm the inflation-interest rates nexus and how they impact other macroeconomic determinants in Ghana. The paper provided an empirical investigation of factors that accounted for inflation dynamics in the country and identified real output as the major cause of inflation in the long-run whilst monetary expansion was the most significant driver of inflation in the short-run followed by nominal interest rate and then, fiscal deficit. They attributed the positive relationship between the two variables to the short-term interest rate used by the central bank as the principal policy anchor in targeting inflation.

Agha and Khan (2006) employed Vector Autoregression (VAR) and a Vector Error Correction Model (VECM) models to investigate the long run relationship budget deficits have with inflation in Pakistan. Deficit financing was used as their main economic framework and found out that budget deficits had a positive relationship with inflation. Whilst market borrowings were the most inflationary financing source in Pakistan. Similarly, Devapriya and Ichihashi (2012), examining the relationship and causality between government deficit financing sources, the budget deficits itself, and inflation in Sri Lanka. Vector Autoregressive (VAR) model was employed on a time series data from 1950 to 2010. Their result also found a positive relationship between budget deficits and inflation. The Granger causality test indicated a bi-causal relationship between budget deficits and inflation. They concluded that budget deficits, growth of money supply, interest rates, and the real exchange rate were the main determinants of inflation in Sri Lanka.

Hsin-Yi and Hao-Pang (2013) applied a branch of the Autoregressive Distributed Lag (ARDL) specification; particularly the Dynamic Panel Quartile Regression (DPQR) model and analyzed the deficits-inflation nexus in 91 countries. Time series data from 1960 to 2006 was used to estimate the effect of fiscal deficits on inflation. The study allowed for a dynamic adjustment with the ARDL specification to demonstrate the impact at various inflation levels. The results established that in high-inflation episodes, the strong impact of a budget deficit is exerted on inflation, while a weak impact is being experienced in low-inflation episodes. Erkam and Çetinkaya (2014) established a similar result. They re-examined a well-known causal relationship between budget deficits and inflation for Turkey in two different sub-periods, namely; 1987-2003 and 2005-2013 with the use of Vector Autoregression (VAR) and Granger non-causality procedures. The Granger test confirmed a positive and significant causality emanating from budget deficits to inflation for the first sub-period in which the average inflation was relatively high. This causal link disappeared when the second sub-period with low average inflation was analyzed. According to the study, the findings may be a result of the strong fiscal policies pursued in stabilizing the Turkish economy in the aftermath of the 2001 crisis.

Ferrando and Vicente (2007) give experimental proof to the negative impact budget deficit experience from inflation in Uruguay between 1970– 2006. They found an increased rate of inflation to have a significant and negative association with real budget expenditure (i.e. Strong Patinkin effect), they also found that tax receipts have no significant impact from the inflation movement (weak Olivera– Tanzi effect). Finally, they establish a cross-country prove for the dominance of the Patinkin effect.

Chibber (1991) infers that the degree to which a weak currency value impact interest rate movement in African economies, to a great extent depends upon the revenue and expenditure trends of the government at the same time on the monetary policy pursued by the central bank. Consequently, Saysombath and Kyophilavong (2013) investigated the dynamic links between budget deficit and the real exchange rate in the Lao People Democratic Republic from the year 1980 to 2010. The study employed ARDL Co-integration methodology in collaboration with the VAR and the structure VAR (SVAR) analysis to provide for both the long and short run evidential dynamics between the variables. The result shows no long-run relationship and Granger causality between budget deficit and real exchange rate on account of Laos.

Utami and Inanga (2009) examined the effect of inflation rate on interest rate differentials and also the impact interest rate differentials have on exchange rate changes in view of the IFE theory, in the context of Indonesia. They used both quarterly and annual data for the interest rate, inflation differentials and changes in the exchange rate over a five-year time span; 2003-2008. The study used the USA, UK, Japan, and Singapore as the counterpart foreign countries. It was discovered that interest rate differentials have positive yet no significant impact, on the changes in Indonesians exchange rate relative to the USA, Singapore, and the UK. However, between Indonesia and Japan, changes in the exchange rate are to a very large extent negatively impacted by interest rate differentials. The result equally shows that inflation rate differentials have significant positive effects on interest rate differentials.

Asari et al. (2011) explained the collaborative effect of interest rate and inflation towards exchange rate volatility in Malaysia. The study adopted the time-series Vector Error Correction Model

(VECM) approach. The paper tested for stationarity, co-integration, stability and Granger non-causality. Response to shock amongst the variables was explained using the Impulse Response Function (IRF). The Granger causality test shows that the inflation rate impacts the interest rate while the interest rate subsequently influences the exchange rate. The study found opposite directional movement for, interest rate and inflation towards exchange rate volatility in Malaysia in the long run. While the interest rate movement is positive, that of the inflation rate is negative. The result established that exchange rate determinants include inflation rate and its own lag, while the role of interest rate in determining the exchange rate is insignificant although negatively related. In another study Ali, Mahmood, and Bashir, (2015) examine the relationship interest rate have with investment in Pakistan over a 10-year horizon (2000 - 2009). The study found that an increase in the interest rate causes output and investment to increase, which in turn increases the inflation rate. They believe by controlling interest rate, inflation can be manipulated to decrease volatility in the exchange rate.

Khan and Zaman (2012) investigated how the exchange rate effectively impacts macroeconomic variables in Pakistan. They sought to test for causality between the exchange rate, trade, inflation, FDI and GDP. The unit root test, Johansen's co-integration test, and the Granger Causality test was applied to the annual time series data for the years 1980-2009 in order to check for: stationarity, long-run equilibrium relationship between the variables and causality respectively. The result found no long-run equilibrium relationship between exchange rate and inflation.

Nachege (2005) investigated a long-run indirect relationship, between fiscal deficits and inflation through the money supply channel for the Democratic Republic of Congo (DRC) from the year

1981 to 2003 using the multivariate co-integration analysis. The Vector Error Correction Model (VECM) was also employed. The results revealed the existence of a strong and statistically significant long-run relationship between budget deficits and seignories, and also between money creation and inflation. Policy recommendations suggested by the study included curtailing fiscal deficits so as to achieve and maintain long-term price stability in the DRC.

Ezirim, Amuzie, and Muoghalu, (2012) also examined the interdependencies of the behavioural patterns of exchange rates and inflation rates in Nigeria. The study used the autoregressive distributed lag technique and found that exchange rate movements and inflation spiral are co-integrated. The paper concludes that exchange rates and inflation rates having an association in the short run as well as the long run indicates inflation targeting regime and the most appropriate monetary policy action is the one targeted at exchange rate manipulation, and vice versa.

Oladipo and Akinbobola (2011), investigated the causality between budget deficits and inflation and also the economic implication of deficit financing in Nigeria from 1970 to 2005. The study adopted a four variable single equation model in which the budget deficits, GDP and the exchange rate were treated as exogenous variables. The Granger Causality Pairwise test results indicated that budget deficits, GDP and the exchange rate have a causal effect with inflation. The main variables of interest have a strong unidirectional causality; with the causality running from budget deficits to inflation at a 95% confidence interval.

Bawumia and Otoo (2003) using the error correction mechanism examined monetary growth, exchange rates and inflation relationships in Ghana. The result empirically confirms the existence of a long-run equilibrium relationship between inflation, money supply, the exchange rate, and

real income and show that inflation adjusts to its equilibrium value fairly rapidly. The impact of the exchange rate, on inflation, is transmitted with a one-month lag, while the effect of real income and money on inflation takes 2 and 4- month lags, respectively. The findings established that in line with theory, the long-run inflation in Ghana has a positive relationship with the money supply and the exchange rate, but negatively related to real income.

Ahiakpor (2013) examined the factors that influence inflation in Ghana over the sample period of 1965-2012. The results of the study indicated that real output, population growth rate, broad money, exchange rate, lending rate, and budget deficits are the key factors in explaining the inflation movement in Ghana. The paper established that output levels had an inverse relationship with inflation whilst population growth, broad money, exchange rate, lending rate, and budget deficits had a positive relationship with inflation. On the other hand, a similar study by Atta-Mensah and Bawumia (2003) using a vector error correction model concluded that inflation was basically a monetary phenomenon in Ghana. Their study, however, neglected structural factors in the inflationary process.

2.6 Conclusion

In conclusion, Budget deficit and its financing theories are at the core of the macroeconomic literature due to its impact on the economic performance indicators. Despite the substantial attention drawn, economists have different perspectives regarding the economic effects of budget deficits: while the neoclassical consider it to be detrimental to investment and growth, the Keynesians consider it as a key policy prescription. What was certain is that the impact of budget deficits on any economy obviously depends on the choice of financing and the impact of such a choice on aggregate demand.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

The chapter covers the description of the dataset and the statistical models used in analyzing the co-integration, long run distribution, and causality between the government Budget Deficit (BD), the exchange rate (Ghana Cedi per the US dollar), the Inflation rate and interest rate in Ghana. The study employs rigorous econometric processes and methods, including the Vector Autoregressive (VAR) Model, Autoregressive Distributed Lag (ARDL) Model, and the Markov transition probabilities to unveil the dynamics between the variables.

3.1 Data Collection and Source

The study made use of secondary data collected from the period, 1982 to 2017 for annual observations for each variable and 1990:01 to 2017:12 for monthly observations of the variables except budget deficit. The variables were sourced from IMF, International Financial Statistics, the Ministry of Finance and Economic Planning, Ghana and the Bank of Ghana monetary time series data. Other sources include Aryeetey and Baah-Boateng (2007), Amoah and Loloh (2008) and Nkrumah, Orkoh, and Owusu, (2016).

3.2 Description and transformation of data

In carrying out the VAR and ARDL methodologies, we used government budget expressed as a percentage of nominal GDP, exchange rates expressed as one unit price of the US dollar in Ghana Cedi, interest rates expressed as the government treasury bill rate, and finally the inflation as computed by Ghana Statistical Service. Before applying the statistical models, each data set was

checked for stationarity (to ensure that the mean and variance is constant over time). We check the stationarity, by using the Augmented Dickey-Fuller (ADF) test for stationarity. Any dataset that is not stationary was differenced using the formula $\Delta Y_t = Y_t - Y_{t-1}$. Ranges were provided and given to each inflation and interest rates data points, whereas the exchange rate data were also labelled based on the immediate past value in building the Markov transition probability matrix. The procedure for testing for stationarity and the statistical models used are discussed below.

3.4 Unit root test (Test for stationarity)

Both financial and macroeconomic data sets are, generally, found to be non-stationary. Time series data is stationary (has no unit root/ not a random walk) if its statistical characteristics (i.e. mean and variance) are constant over time and the value of its covariance between two timelines depending not on the actual time for which it is considered but only on the gap between the periods. If one or both of these conditions are not satisfied, then the process is said to be non-stationary (Charemza & Deadman, 1992). Stationarity of a time series data can be investigated using the Augmented Dickey-Fuller Test (ADF), Phillips-Perron test or the KPSS test, which can be applied as a counterpart of ADF and Phillips and Perron test. The purpose of performing unit root test is to ensure that the integration of the variables of interest is not in a higher order to cause spurious results. While the ARDL approach or the Bound test for co-integration does not necessarily require the pre-testing, this process is imperative, as the computed F-statistics provided by Pesaran, Shin, and Smith, (2001) are not valid in the presences of $I(2)$ variables. To apply the ARDL methodology on the time series of this study, we foremost carried out the unit root test on the data set to establish the existence or otherwise of a unit root. For the purpose of this study, the

Augmented Dickey-Fuller (ADF) stationarity test was employed. In the application of the ADF test, a regression of the form:

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \beta_0 Y_{t-1} + \sum_{j=1}^p \gamma_j \Delta Y_{t-j} + \varepsilon_t \dots \dots \dots (1)$$

Has been generated. Where Δ represent the first difference operator; t denotes the time trend; p is the highest lag order used while ε is the white noise error term; α s and β s are parameters of the regression. The ADF test is based on the hypothesis below:

H_0 : $Y_t \neq I(0)$ or Y_t is non-stationary

H_1 : $Y_t = I(0)$ or Y_t is stationary

To conclude on the test, the calculated ADF statistics were compared to the critical values from Fuller’s table. Having the test statistic lesser than the critical value would mean that the null hypothesis (H_0) cannot be rejected and the conclusion drawn as the series being non-stationary or not integrated of order zero. The test’s p-value can also be compared to the level of significance for drawing this conclusion. If a variable is stationary without differencing, we say it is integrated of order zero and if it is stationary only after the first difference we say it is integrated of order one.

The Vector Autoregressive (VAR) model was used due to its advantage over simultaneity bias and also the easy solution, it offers in capturing all the dynamics of economic variables at any point in time. The VAR model is able to test for partial exogeneity and parameter restrictions with no assumption of priory direction of causality among the variables. Another good attribute of the model is its ability to overcome the difficulty of identifying those contemporaneous variables that

are exogenous by simply lagging variables on the right-hand and considering all variables as endogenous.

Following the literature, the dynamic relationship between budget deficits, exchange rate, interest, and inflation rates is specified in a general form as:

$$y_t = a_i + \beta_i \sum_{j=1}^p Y_{t-1} + \partial_i \sum_{j=1}^p x_{t-1} + \varepsilon_t \dots \dots \dots (2)$$

Where y_t is the endogenous variables (ie. $y_t = BD_t, EXR_t, INR_t,$ and INF_t) in a 4 x 1 vector form
 $a_i = 4 \times 1$ vector of constant terms. $\beta_i = 4 \times 4$ coefficient matrix of the autoregressive terms
 $\partial_i = 4 \times 4$ coefficient matrix of the explanatory variables (vector of coefficients). $\varepsilon_t =$ vector of random disturbances.

Transforming equation (2) into VAR models we have

$$BD_t = a_0 + \beta_1 \sum_{j=1}^p BD_{t-1} + \beta_2 \sum_{j=1}^p EXR_{t-1} + \beta_3 \sum_{j=1}^p INR_{t-1} + \beta_4 \sum_{j=1}^p INF_{t-1} + \varepsilon_{1t} \dots \dots \dots (3)$$

$$EXR_t = \beta_0 + \beta_1 \sum_{j=1}^p EXR_{t-1} + \beta_2 \sum_{j=1}^p BD_{t-1} + \beta_3 \sum_{j=1}^p INR_{t-1} + \beta_4 \sum_{j=1}^p INF_{t-1} + \varepsilon_{2t} \dots \dots \dots (4)$$

$$INR_t = \gamma_0 + \beta_1 \sum_{j=1}^p INR_{t-1} + \beta_2 \sum_{j=1}^p BD_{t-1} + \beta_3 \sum_{j=1}^p EXR_{t-1} + \beta_4 \sum_{j=1}^p INF_{t-1} + \varepsilon_{3t} \dots \dots \dots (5)$$

$$INF_t = \varphi_0 + \beta_1 \sum_{j=1}^p INF_{t-1} + \beta_2 \sum_{j=1}^p BD_{t-1} + \beta_3 \sum_{j=1}^p EXR_{t-1} + \beta_4 \sum_{j=1}^p INR_{t-1} + \varepsilon_{4t} \dots \dots \dots (6)$$

Where j and P are the lag length and the maximum distributed lag length respectively, $\alpha_0, \beta_0, \gamma_0, \varphi_0$, represent the constant terms while the \mathcal{E}_t is independent and identically distributed error term.

Specifying the above equation in compact matrix form, we have:

$$\begin{bmatrix} BD_t \\ EXR_t \\ INR_t \\ INF_t \end{bmatrix} = \begin{bmatrix} \alpha_0 \\ \beta_0 \\ \gamma_0 \\ \varphi_0 \end{bmatrix} + \sum_{j=1}^p \begin{bmatrix} BD_{t-1} & EXR_{t-1} & INR_{t-1} & INF_{t-1} \\ EXR_{t-1} & BD_{t-1} & INR_{t-1} & INF_{t-1} \\ INR_{t-1} & BD_{t-1} & EXR_{t-1} & INF_{t-1} \\ INF_{t-1} & BD_{t-1} & EXR_{t-1} & INR_{t-1} \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} + \begin{bmatrix} \mathcal{E}_{1t} \\ \mathcal{E}_{2t} \\ \mathcal{E}_{3t} \\ \mathcal{E}_{4t} \end{bmatrix} \dots\dots\dots (7)$$

3.5. Co-integration

Economic time series variables are mostly in practice non-stationary and thus renders OLS regression ineffective. The co-integration analysis is often resorted to in an attempt to avoid, spurious regression problem associated with nonstationary variables. Two or more variables are said to be co-integrated if the linear combination yield stationarity. This implies that co-integration exists between nonstationary variables if the residuals of the co-integrating regression are stationary (Granger, 1986; Hendry, 1986). Thus, establishing a stationary co-integrating relationship between the variables is the only means to avoid spuriousness.

Econometric literature documented a plethora of econometric techniques for investigating co-integration relationships among macroeconomic variables for both univariate and multivariate analysis. Mention can be made of, Engle-Granger (1987) and the Fully Modified Ordinary Least Squares (FMOLS) procedures of Phillips and Hansen (1990) as some examples of the univariate co-integration techniques while Johansen (1988); Johansen and Juselius (1990); and Johansen's (1995) co-integration technique that has provided full information for the maximum likelihood approach to co-integration Pesaran and Shin (1995) and Pesaran *et al.* (2001) proposed

autoregressive distributed lag (ARDL) approach which is the technique adopted by this study are some examples of the multivariate co-integration techniques.

The choice of the ARDL approach to co-integration in examining between budget deficit, and exchange rate; interest rate; and inflation relationships in Ghana is informed by its suitability for the underlying data for the study. In particular, the choice is based on the following reasons. First, the bounds test is not only more robust but also performs better for small sample size (which is applicable for this study with only 35 observations) Most conventional multivariate co-integration procedures are only valid for large sample size. Secondly, the ARDL required, not all its regressors to be integrated of the same order which is a condition for the other co-integration techniques. This means that the ARDL is applicable irrespective of whether the underlying regressors are purely $I(1)$, and $I(0)$. Thus, whether the regressors are all stationary, non-stationary or fractionally integrated. But for the F-statistics provided by Pesaran *et al.* (2001) which are not valid in the presences of $I(2)$ variables using bound test econometric technique avoids the burden of pre-testing of variables for unit roots.

Thirdly, while the other standard techniques have to make choices including decisions regarding what number of endogenous and exogenous variables the model should contain, how to treat the non-random elements, as well as what order of Vector Auto Regression (VAR) or optimal number of lags to be specified, the ARDL avoid those. According to Pesaran *et al.* (2001), the empirical results are generally as good as the method and various alternative choices made in their estimation.

Finally, the ARDL is able to accommodate with ease the problem Johansen-type model has with a different optimal number of lags for variables, the Engle-Granger problem of endogeneity as

$$H_0 : a_1 = a_2 = a_3 = a_4 = 0$$

$$H_1 : a_1 \neq a_2 \neq a_3 \neq a_4 \neq 0$$

After establishing co-integration between the variables, we estimate the ARDL model as below to obtain the long run and short run coefficients.

$$EXR_t = \beta_0 + \beta_1 \sum_{j=1}^p EXR_{t-i} + \beta_2 \sum_{j=1}^p BD_{t-i} + \beta_3 \sum_{j=1}^p INR_{t-i} + \beta_4 \sum_{j=1}^p INF_{t-i} + v_{2t} \dots \dots \dots (11)$$

$$INR_t = \gamma_0 + \beta_1 \sum_{j=1}^p INR_{t-i} + \beta_2 \sum_{j=1}^p BD_{t-i} + \beta_3 \sum_{j=1}^p EXR_{t-i} + \beta_4 \sum_{j=1}^p INF_{t-i} + v_{3t} \dots \dots \dots (12)$$

$$INF_t = \varphi_0 + \beta_1 \sum_{j=1}^p INF_{t-i} + \beta_2 \sum_{j=1}^p BD_{t-i} + \beta_3 \sum_{j=1}^p EXR_{t-i} + \beta_4 \sum_{j=1}^p INR_{t-i} + v_{4t} \dots \dots \dots (13)$$

The error correction estimation of the ARDL model is specified as:

$$\Delta EXR_t = \beta_0 + \beta_1 \sum_{j=1}^p EXR_{t-i} + \beta_2 \sum_{j=1}^p \Delta BD_{t-i} + \beta_3 \sum_{j=1}^p \Delta INR_{t-i} + \beta_4 \sum_{j=1}^p \Delta INF_{t-i} + \Pi ECT_{t-1} + \varepsilon_{2t} \dots \dots \dots (14)$$

$$\Delta INR_t = \gamma_0 + \beta_1 \sum_{j=1}^p INR_{t-i} + \beta_2 \sum_{j=1}^p \Delta BD_{t-i} + \beta_3 \sum_{j=1}^p \Delta EXR_{t-i} + \beta_4 \sum_{j=1}^p \Delta INF_{t-i} + \lambda ECT_{t-1} + \varepsilon_{3t} \dots \dots \dots (15)$$

$$\Delta INF_t = \varphi_0 + \beta_1 \sum_{j=1}^p INF_{t-j} + \beta_2 \sum_{j=1}^p \Delta BD_{t-j} + \beta_3 \sum_{j=1}^p \Delta EXR_{t-j} + \beta_4 \sum_{j=1}^p \Delta INR_{t-j} + \psi ECT_{t-1} + \varepsilon_{4t} \dots \dots \dots (16)$$

The, $\Pi, \lambda,$ and ψ are the coefficient of how quickly the long-run equilibrium will adjust to normalcy after a shock to the system while the error correction term(ECT_{t-1}), is the residuals from one period lagged co-integration equation. In order to further confirm the existence of a co-integrating relationship among the variables in the model, the coefficient of the lagged error correction term is expected to be negative and statistically significant

3.6 Model Selection Criteria

Several criteria have been proposed to aid in the selection of the most appropriate model with regards to the lag order of the models. Some of these selection criteria include the Akaike Information Criteria (AIC), Schwarz Bayesian criterion (SBC) and Hannan-Quinn (HQ). The competing models in the study based on the appropriate lags are ranked according to the values of the AIC, SBC or HQ. The selected model is the one with the lowest information criterion. Where competing models have the same or similar AIC, SBC or HQ values, then the principle of parsimony is applied to select the most appropriate model. The principle prefers a model with fewer parameters to a complex one.

3.6.1 Akaike Information Criterion (AIC)

The Akaike Information Criterion (AIC) is the model selection criterion to have first gained widespread acceptance. Akaike (1973) introduced this criterion as an add-on to the maximum

likelihood approach to parameter estimation in a specified model. By definition, it is given as; $AIC = 2(N) - 2(\log\text{likelihood})$, where N represents the number of parameters in the model. The maximum likelihood estimation is employed to fit two or more competing models of various structures, and the AIC is then computed based on each of the fitted model. The model with the minimum AIC is deemed as the most appropriate model for selection. The $2(N)$ of the AIC equation above measures the model goodness of fit whereas the second term is called the penalty function as it penalizes a competing model by the number of parameters it contains.

3.6.2 Schwarz Bayesian Information Criterion

The Schwarz Bayesian criterion (SBC) is a modified version of the AIC and relates to the Bayes factor. By replacing the $2(N)$ in the AIC equation with $N\ln(n)$ the BIC is obtained. This criterion is also defined as $BIC = k\ln(n) - 2(\log\text{likelihood})$ with the k denoting the number of parameters in the model, while the n represents the length of the time series or the sample size. The BIC is another useful criterion for choosing the most appropriate model out of a hopeful group of models. Just like the AIC, the maximum likelihood estimation is again used to fit the model and the BIC computation for each of the competing models is based on the fitted model where the model with the least BIC is deemed the most appropriate model.

3.6.3 Model Diagnostic Checks

Diagnostic checks of the model were performed on the residuals to assess the adequacy (goodness of fit) of a chosen model. For the ARDL model, residuals are assumed to be independently and identically distributed with non-constant variance and serially uncorrelated errors. The diagnostic tests conducted were the serial correlation test of residuals, normality and heteroscedasticity test

in relation to the residuals. The Cumulative Sum of recursive residuals (CUSUM) was the stability test conducted to determine if there were significant breaks with the sampled period.

3.6.4 Lagrange Multiplier (LM) Test

We adopted Lagrange multiplier to test for serial correlation. The choice was based on its usefulness in identifying serial correlation, even for higher orders. In carrying out the test we first estimate the regression model (i.e. the ARDL model) using the ordinary least squares and compute its estimates residuals (e_t). After we regress the errors (e_t) against the independent variable x_{1t}, \dots, x_{tk} and e_{t-1} . The test statistic is

$$LM = (n - 1) R_e^2 \dots\dots\dots (17)$$

Where R_e^2 is the R-square from the regression model. We reject the null hypothesis of no serial correlation ($\rho=0$) in favour of the alternative that ($\rho \neq 0$) if $(n - 1) R_e^2 > \chi^2_{1,(1-a)}$. If the test shows that there is a serial correlation in the residuals, then we would expect e_t to be related to e_{t-1} .

3.6. 5 Testing for Heteroscedasticity

To test the null hypothesis of homoscedasticity against the alternative hypothesis of heteroscedasticity we apply the Lagrange Multiplier test for homoscedasticity. The test either uses the F-statistic which is dependent on the goodness of fit measure from the entire model or the Lagrange multiplier statistic which is an easier approach. The test statistic for the Lagrange Multiplier test is given by:

$$LM = n X R_e^2 \dots\dots\dots (18)$$

The LM statistic is distributed as χ^2_k , with the number of regressors being denoted by k. The test makes use of the residuals of the ordinary least square regression of the variables in question.

3.7 Stochastic Processes

The evolutionary process of collecting some random values over time is described as a stochastic process. Given random variables $\{x(t), t \geq 0\}$ indexed by the time parameter t , the process $x(t)$ is called a stochastic process. The value assumed by the collection process is called the states, and all the possible values that can be assumed within the state is called the state space. Also, all the possible values of the indexing parameter which can either be discrete or continuous is known as the parameter space. The study uses the Markov stochastic properties on the inflation and exchange rate time series by converting the variables into a three-state transition probability matrix with discrete parameter and state spaces.

3.7.1 Markov's Process

First-order dependence is the simplest type of dependence in an underlying stochastic process and is called the Markov-dependence. The dependence exhibited by the process $\{x(t), t \in T\}$ is said to be a Markov-dependence if the conditional distribution of $x(t)$ for given values of $x(t_1), x(t_2), \dots, x(t_n)$ depends only on $x(t_n)$ which is the immediate known past value of the process. That is if;

$$P [X(t) \leq x \mid X(t_n) = x_n, X(t_{n-1}) = x_{n-1}, \dots, X(t_0) = x_0] = [X(t) \leq x \mid X(t_n) = x_n] \dots\dots\dots (19)$$

Therefore, a discrete stochastic process is said to exhibit Markov Dependence if

$$P (X_n=j \mid X_{n1}=i_1, X_{n1}=i_2 \dots, X_{nk}=i_k) = (X_n=j \mid X_{n1}=i_1) \dots\dots\dots (20)$$

$$\forall n > n_1 > n_2 > \dots > n_k, t_1, t_2, \dots, t_m \in T \text{ and } i_1, i_2, \dots, j \in S$$

Any stochastic process satisfying equation (20) is called a Markov process. One characteristic of the Markov process is that knowing a state space for any specified value of the time parameter t , provides sufficient information to predict the behaviour of the process beyond it. This is the

Markov property. The process is considered a chain (i.e. Markov chain) if the parameter and state spaces are discrete. The study seeks to compute the n-step transition probabilities which is defined as; $P_{ij}^{(n)} = P(X_n = j \mid X_0 = i)$. Where the “n-step” refers to the time interval between observations. When $n=1$ we write $P_{ij}^{(1)} = P_{ij}$. The one-step transition probability (P_{ij}) is computed to form the transition (stochastic) matrix for the determination of the long run stationary (steady state or limiting) distribution of the variables under study.

3.7.2 Transition stochastic matrix

Given that S is a finite discrete state space containing two states i and j with a process X in a first state (i) at discrete time t , then the probability of the process moving, to the second state (j) in the next step at time $t+1$ is called the first transition probability and is denoted by P_{ij}

This can be stated mathematically, as: $P_{ij} = P(X_{t+1} = j \mid X_t = i)$. In time-homogeneous Markov chain P_{ij} is true for all $t \in T$. Hence, in a time-homogeneous process, the probability of moving from state i to state j in n time steps is $P_{ij}^{(n)} = P(X_n = j \mid X_0 = i) = P(X_{t+n} = j \mid X_t = i)$.

Let $P = P_{ij} = \begin{bmatrix} P_{00} & P_{01} & \dots & P_{0k} \\ P_{10} & P_{11} & \dots & P_{1k} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ P_{k0} & P_{k1} & \dots & P_{kk} \end{bmatrix}$ be the matrix of all possible first step transitions from state i to

$$j \quad \forall i, j \in S = \{0, 1, 2, \dots, k\}$$

We can then show by induction through the use of the Chapman-Kolmogorov equation

$$P_{ij}^{(n)} = \sum_{r \in S} P_{ij}^{(k)} P_{rj}^{(n-k)}$$

$$\text{that } P^n = P^{(n)} \text{ i.e. } = \begin{bmatrix} P_{00} & P_{01} & \dots & P_{0k} \\ P_{10} & P_{11} & \dots & P_{1k} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ P_{k0} & P_{k1} & \dots & P_{kk} \end{bmatrix}^n = \begin{bmatrix} P_{00}^{(n)} & P_{01}^{(n)} & \dots & P_{0k}^{(n)} \\ P_{10}^{(n)} & P_{11}^{(n)} & \dots & P_{1k}^{(n)} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ P_{k0}^{(n)} & P_{k1}^{(n)} & \dots & P_{kk}^{(n)} \end{bmatrix}$$

From the above matrix, we get one-step transition probability if the value of n is one (n = 1).

Computing the one step probabilities, the long run distribution can be determined provided it can

be shown that the states are irreducible and aperiodic. (i.e. Communicate)

3.7.3 Communication, reducibility and periodicity of Markov chains

Given that State *i* and state *j* are accessible to each other, then the two states are said to communicate. A *j* state is said to be **accessible** from an *i* state provided state *j* can be reached from the state *i* in a finite number of steps. Thus, a non-zero probability of a process in state *j* transition into state *i*.

By definition:

$i \rightarrow j$ (*j* is accessible from *i*) if for some $n \geq 0$, $P_{ij}^{(n)} > 0$

$j \rightarrow i$ (*i* is accessible from *j*) if for some $n \geq 0$, $P_{ji}^{(n)} > 0$

$i \leftrightarrow j$ (*i* and *j* communicate) if for some $n \geq 0$, $P_{ij}^{(n)} > 0$ and for some $m \geq 0$, $P_{ji}^{(m)} > 0$

If every pair of states contained in a set of states says “S” communicates with each other, that set is called a **communicating class**. Communication in itself is an equivalence relation, as such, all Markov chain states that communicates with each other can be categorized into a single

equivalence class or different equivalence classes. While it is possible for Markov chain to have communicating states in one class that are accessible from another class, it is not possible to have communicating states in the different equivalent classes. A Markov chain is **irreducible** if; all its states belong to only one equivalence class (its state space has a single communicating class)

An i state is said to have a **period k** if any return to state i must occur in multiples of k time steps and **aperiodic** if the value of k is one ($k = 1$). Formally, the period of a state is defined as $k = \gcd\{n: P(X_n = i | X_0 = i) > 0\}$

3.7.4 Ergodicity Long-Run Stationary Distribution

A state is described as **ergodic** if it is aperiodic and positive recurrent. A state is recurrent if and only if beginning from that state, the eventual return to that particular state is certain. Given that all the states in an irreducible Markov chain are aperiodic or that, there exists a finite number m such that any state can be reached from any other state in exactly n steps then it is said to be ergodic. Also, if an n -state time-homogeneous Markov chain is ergodic then it has a long-run stationary distribution $\lim_{n \rightarrow \infty} p^n = \pi$ where π is the stationary matrix with same row probability vectors. A finite irreducible Markov chain can be shown to be ergodic if is aperiodic.

3.7.5 Classification of Exchange Rate and Inflation as a Three State Markov Process

To model the exchange rate and inflation rates; continuous variables as a discrete Markov chain, the study classifies them into three mutually exclusive and exhaustive states. For the exchange rate, we have appreciated, stable and depreciated states while for inflation, we have Low, Medium and High states.

Grouping of exchange rates into states will be as follows:

Appreciated (**state 0**)

Stable (**state 1**)

Depreciate (**state 2**)

Also, to model the Markov chain for inflation rates in Ghana, the states grouping would be based on what most economists view as:

Low (state 0) single digit inflation (less than 10%)

Medium (state 1) moderate inflation (10% - 20%) acceptable for economic development and

High (state 2) inflation values that distort economic stability (inflation above 20%).

The monthly exchange rate and inflation rate data from January 1990 to December 2017 would be assigned to a state according to its grouping and the number of first step transitions computed for each $i \rightarrow j, i \neq j \in S = \{0, 1, 2\}$

The stochastic matrix $P = P_{ij}$ is estimated using the sample estimates of the first passage probabilities given by;

$$P_{ij} = \frac{\text{Frequency of first step transitions from state } i \text{ to state } j}{\text{Total number of first step transitions from state } i}$$

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

4.0 Introduction

This fourth chapter presents a thorough analysis and discussion of the results obtained from the study. The chapter commences by checking the time series properties of the data; covering the summary statistics and diagnostic analysis of the stationarity of the data used in the study. This is then followed by the Autoregressive Distributed Lag (ARDL) and Error correction model (ECM) methodology; used in determining the short and long run relationships between the variables. The VAR model was employed for the interdependency between the endogenous variables and lastly the estimation of the long run (steady state or limiting) distribution of exchange rate and inflation rate using Markov transition probabilities. Eviews 10 (student version) was used for the ARDL methodology while the transition matrices were developed using excel. Annual data for all the variables from 1982 -2017 was used for the Bound test while monthly inflation rates, and exchange rate data from 1990 – 2017 was used for the Markov transition probabilities.

4.1 Descriptive Statistics

Table 4.1. 1 Descriptive statistics

DESCRIPTIVE STATISTICS							
VARIABLES	Mean	Max	Min	Std. Dev.	Jarque-Bera	Prob	Observations
BD	-4.29778	2.8	-11.8	4.06897	1.587882	0.45206	36
EXR	0.886299	4.350633	0.000275	1.171572	21.74531	0.000019	36
INF	24.38056	122.8	8.58	21.14249	261.4697	0.0000	36
INR	23.51002	47.88	9.6	10.54489	4.188082	0.123188	36

The average budget balance with respect to GDP over the 36-year span is approximately, -4.3 and that of the exchange rate is about 0.89. The implication is that the Ghanaian economy on average runs a budget deficit to about 4.3% of the gross domestic product while the Cedi depreciates about 89% annually to the US dollar. This is however expected as the Ghanaian economy is still a developing one and the demand for public goods, infrastructures and others are high. Maybe the high unemployment, the nation is bedevilled with, put more pressure on government expenditure as the private sector is not fully developed. The range between the minimum and the maximum exchange rates is very large, 4.350358 highlighting the weak nature of the Cedi against the US dollar. The exchange rate is positively skewed to the right tail of the distribution and the Jarque-Bera statistics of 21.745 reject normality in the distribution at the 1% level of significance.

The mean rate is quite high for both inflation and the interest rate. This means that, while the inflation rate on average is about 24.38% annually, the interest rate is about 23.51% per annum. The general information provided by the high range between the minimum and maximum values of inflation and interest rate is that the two variables for the period recorded high volatility clustering. The standard deviation is also large, which confirms the range values of the high volatility of the variables. Normality on the interest rate distribution is not so clear. The series of inflation seems not to follow a normal distribution. This is confirmed by the Jarque-Bera (J.B) statistics of 261.4697 which rejects normality of the series at the 1% level. The Figures below show the trend of the time series of the four variables of interest to the study.

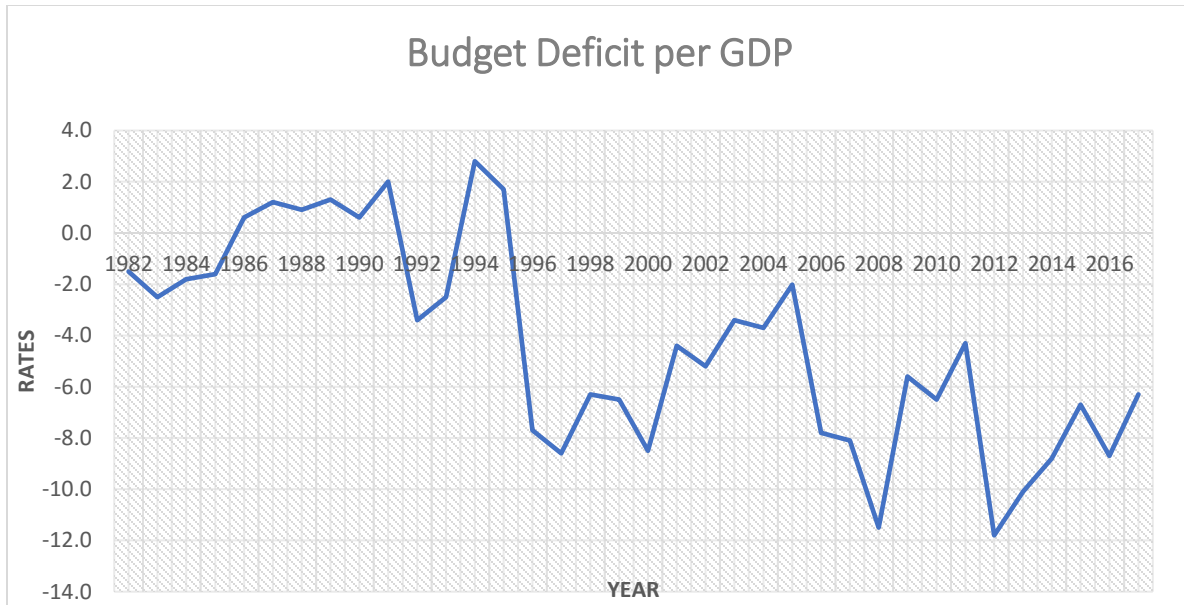


Figure 4.1. 1 Budget Deficit Trend from 1982 to 2017

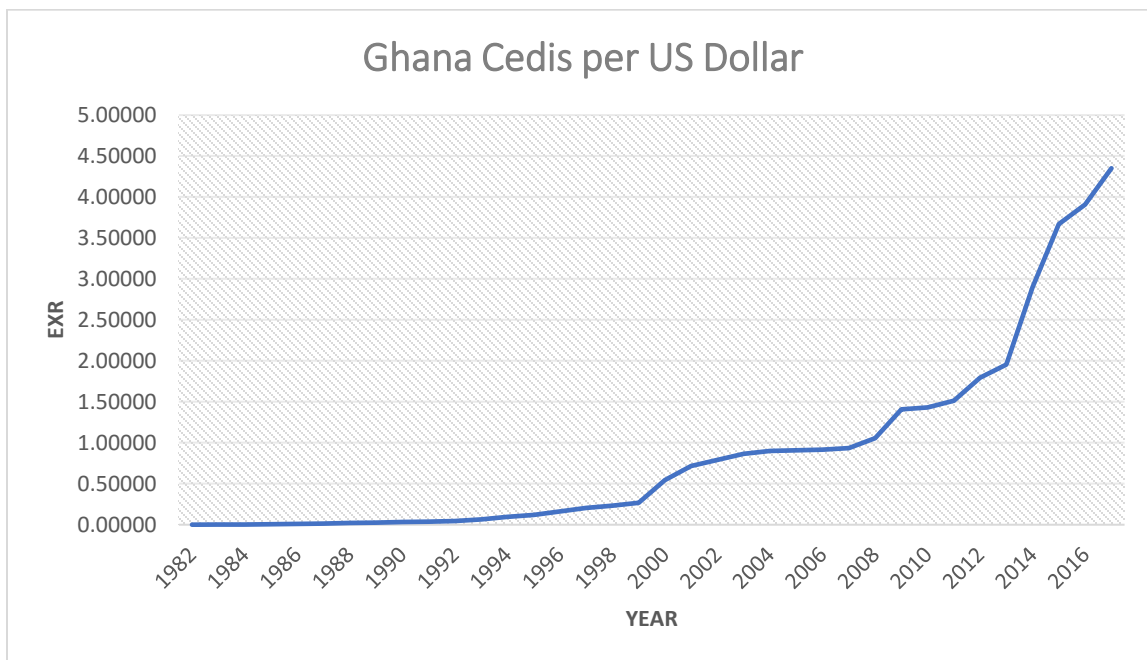


Figure 4.1. **Error! Bookmark not defined.** Cedi per US Dollar Trend from 1982 to 2017

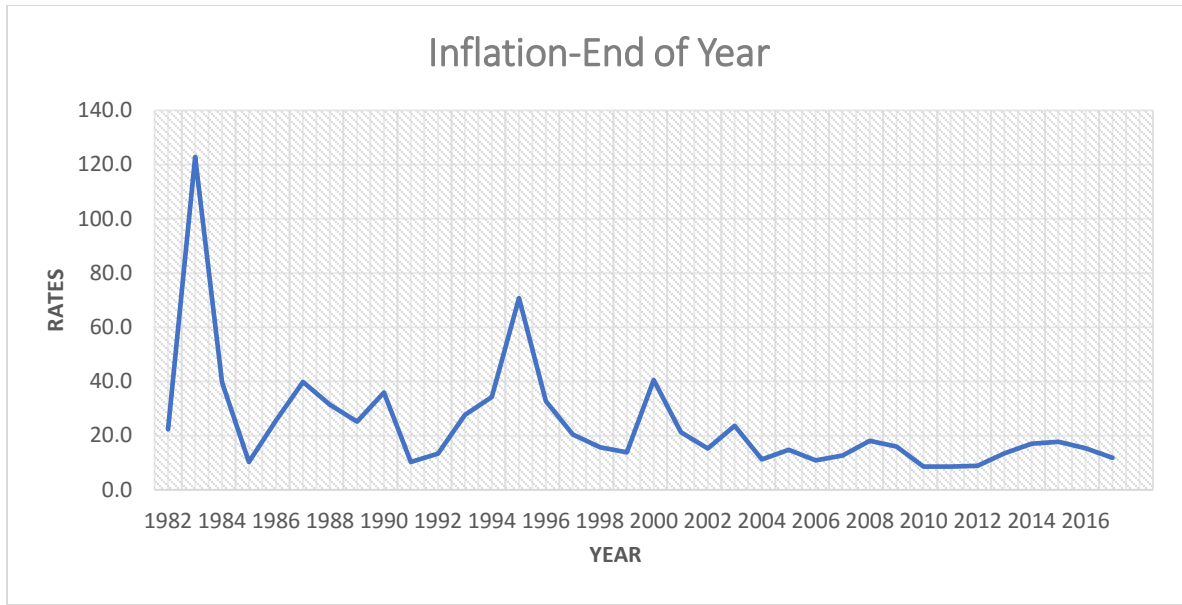


Figure 4.1. 2 Inflation Trend from 1982 to 2017

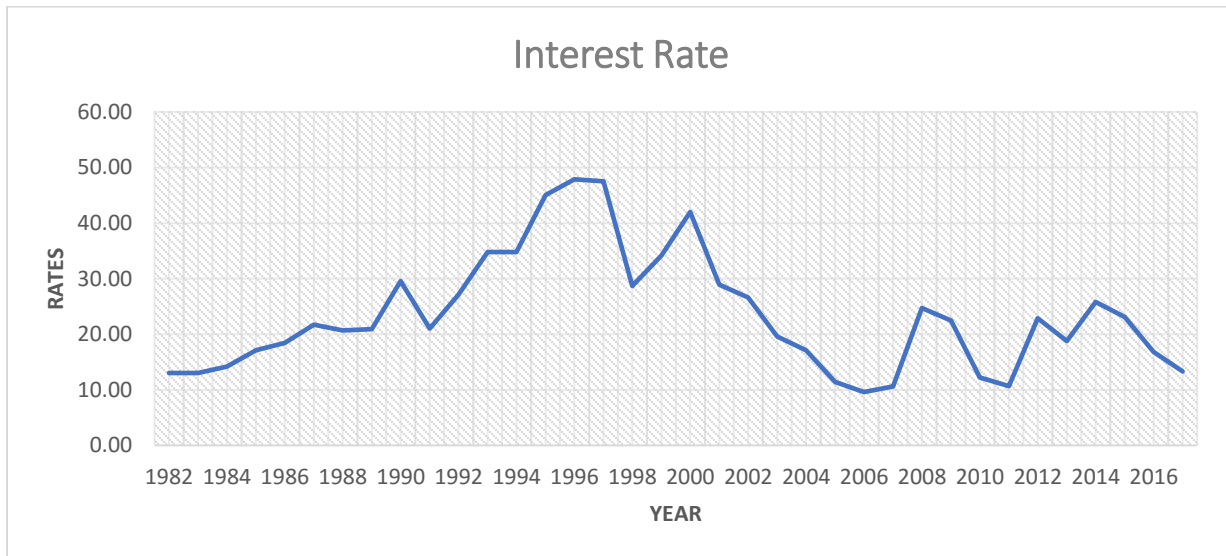


Figure 4.1. 3 Interest Rate Trend from 1982 to 2017

Figures 4.1.1 to 4.1.4 are the annual time series plot of the variables for the period 1982 to 2017. From the figures, the mean and variance of all the variables appeared not to be constant over time, which is an indication of non-stationarity. The exchange rate and the inflation were logged to check for the effect of the skewness and the outlier in them respectively. To confirm the presence of non-

stationarity, the Augmented Dickey-Fuller (ADF) test was performed. The p-value of the test for the budget deficit was less than 0.05 at trend and intercept while the test for exchange rate (logged) was less than 0.05 at intercept and None. The test's p-value for interest rate and inflation (logged) rate were more than 0.05 at intercept; at trend and intercept; and also at None. Hence, we fail to reject the null hypothesis of a unit root (non-stationarity) at the 1 % level of significance for the budget deficit and at the 5 % level of significance for Interest rate and inflation. We conclude that, at the 5 % level of significance budget deficit, and the exchange rate is stationary at level while interest rate and inflation are non-stationary over the period 1982 to 2017. Table 4.1.2 below shows the result of the Augmented Dickey-Fuller (ADF) test.

Table 4.1. 2 Augmented Dickey-Fuller (ADF) test at levels

Variables	Test	Level/First Difference	Including in test Equation	Statistics	Critical Values		
					1%	5%	10%
Budget Deficit	ADF	Level	Intercept	-2.46785	-3.6329	-2.9484	-2.61287
			Trend and Intercept	-3.8736**	-4.2436	-3.5443	-3.20470
			None	-1.44942	-2.6327	-1.9507	-1.61106
Exchange Rate(logged)	ADF	Level	Intercept	-3.27627**	-3.6329	-2.9648	-2.61287
			Trend and Intercept	-1.367581	-4.2436	-3.5443	-3.20469
			None	-2.62110**	-2.6347	-1.9510	-1.61091
Inflation Rate(logged)	ADF	Level	Intercept	-1.326306	-3.6617	-2.9604	-2.61916
			Trend and Intercept	-2.774453	-4.2845	-3.5629	-3.21527
			None	-0.855721	-2.6417	-1.9521	-1.6104
Interest Rate	ADF	Level	Intercept	-2.03866	-3.6329	-2.9484	-2.61287
			Trend and Intercept	-2.16199	-4.2436	-3.5443	-3.20469
			None	-0.78044	-2.6327	-1.9507	-1.61106

*** Indicates Null Hypothesis of a Unit Root is Rejected at 1% Significant Level

** Indicates Null Hypothesis of a Unit Root is Rejected at 5% Significant Level

The result from the ADF test means that the budget deficit fails at the 1% significance level. It is only integrated of order I (0) at 5% with the presence of trend and intercept. The interest rate, on the other hand, is not integrated of order zero (I (0)) and therefore called for the transformation of

their data. There are several means by which time series data can be transformed to achieve stationarity. Examples of such transformations include ordinary differencing, taking of natural logarithms, taking square roots, etc. The study used ordinary differencing. Hence, the exchange rate and interest rate values were differenced.

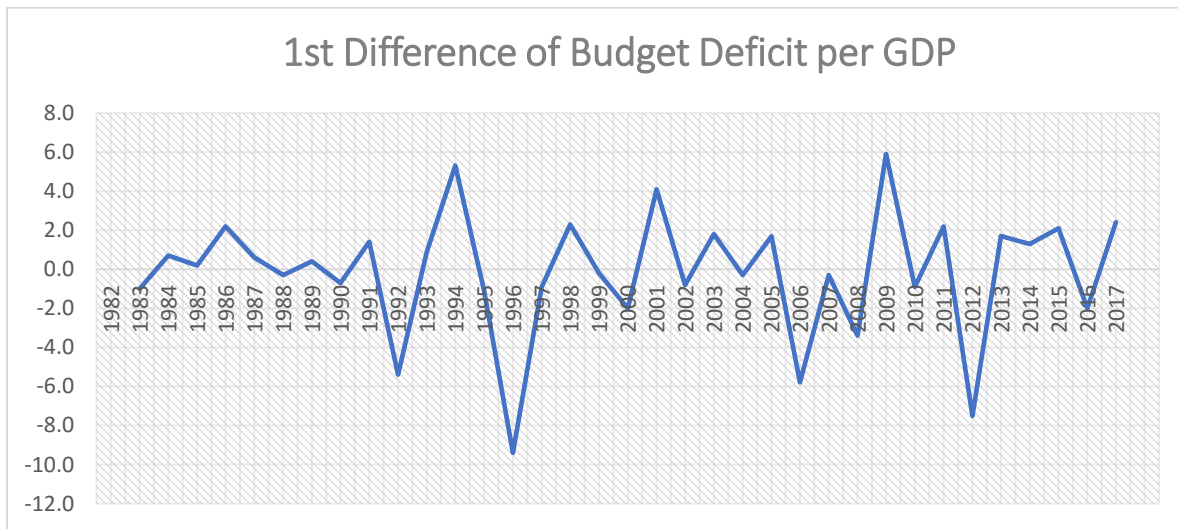


Figure 4.1. 4 Budget Deficit first Difference Trend from 1982 to 2017

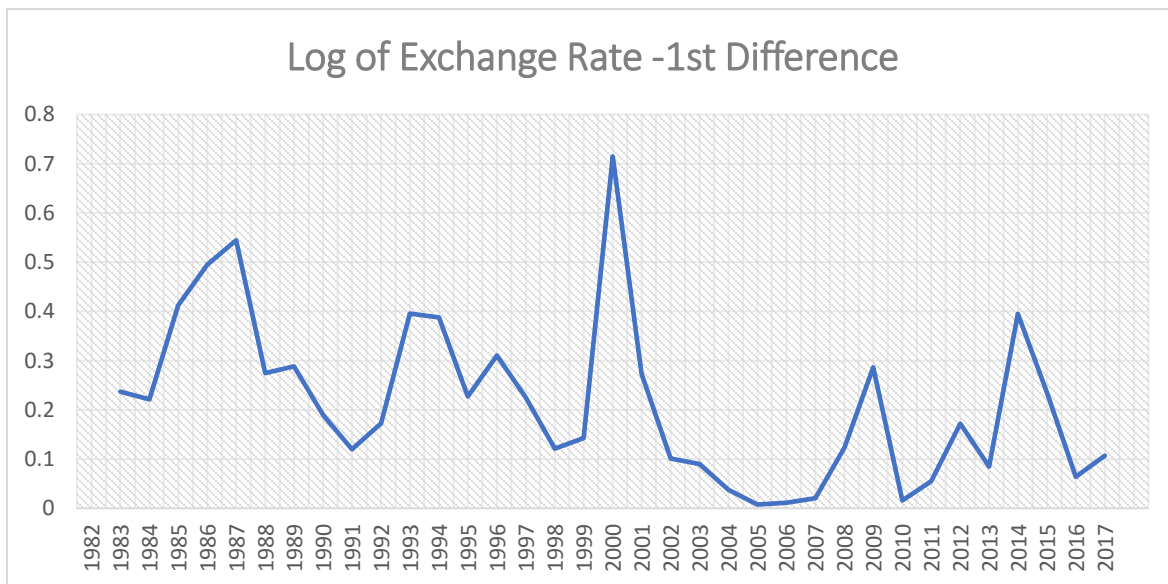


Figure 4.1. 5 Exchange Rate first Difference Trend from 1982 to 2017

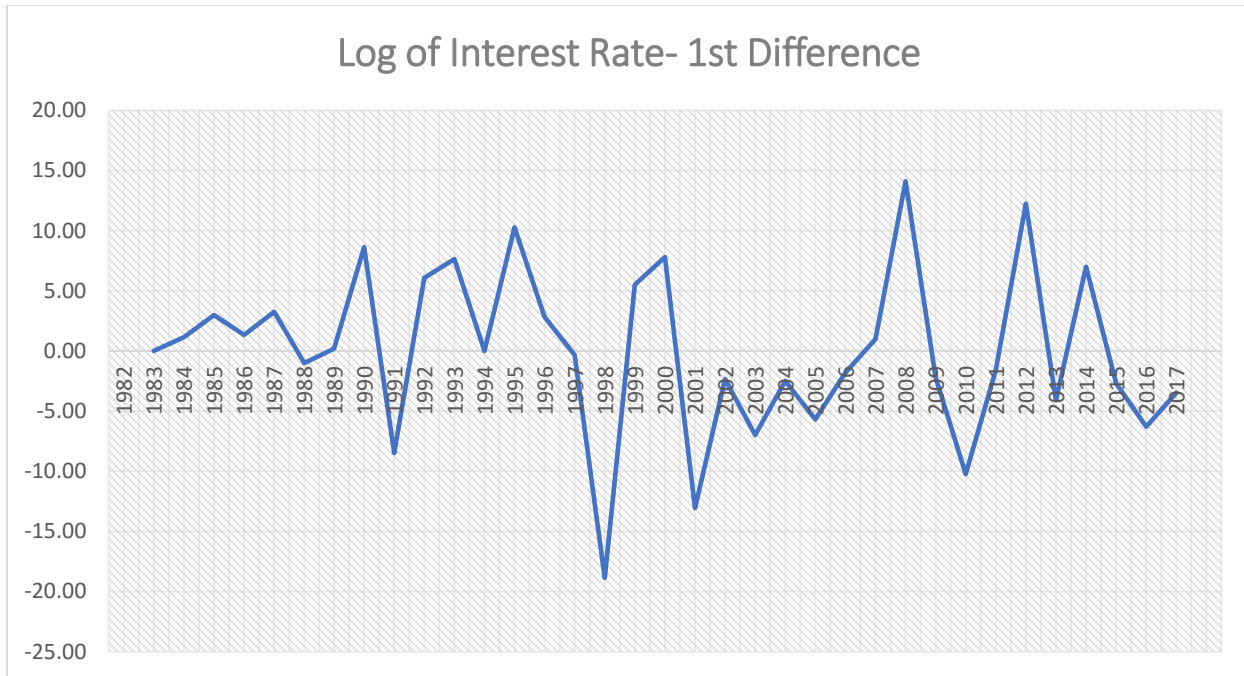


Figure 4.1. 6 Interest Rate first Difference Trend from 1982 to 2017

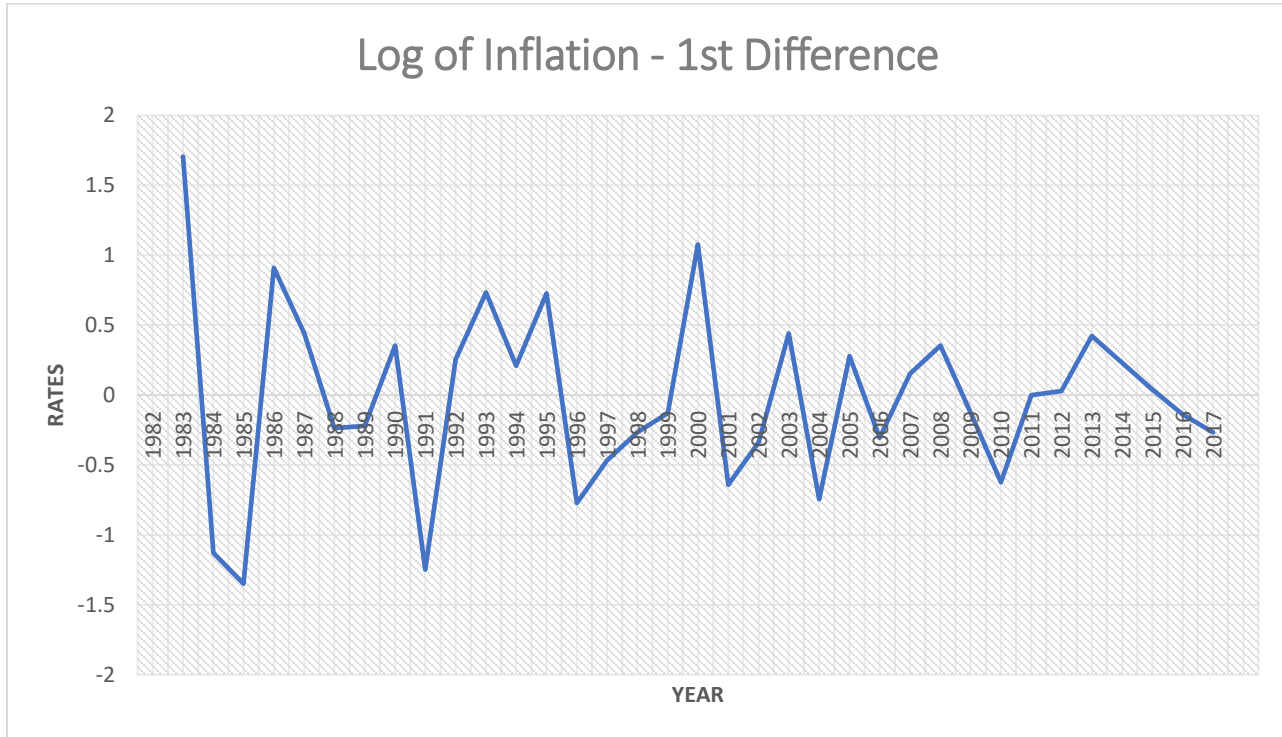


Figure 4.1. 7 Inflation Rate first difference trend from 1982 to 2017

Figures 4.1.5 to 4.1.7 above also shows a plot of the differenced values. The plot shows that the mean and variance of the first difference of the variables appears to be constant over time. This is confirmed by the ADF test of stationarity with p-values from Table 4.3 for at least the trend and intercept for the differenced variables each being less than 0.05. We conclude that the variables are stationary. Hence this shows that after first difference, stationarity was achieved for the budget deficit at Intercept and also at None, for the exchange rate at trend and intercept and for interest rate and inflation at all the categories. This means that those variables are integrated of order one I (1).

Table 4.1. 3Augmented Dickey-Fuller (ADF) test at first difference

Variables	Test	Level/First Difference	Including in test Equation	Statistics	Critical Values		
					1%	5%	10%
D(BD/GDP)	ADF	First Difference	Intercept	-4.012842***	-3.670170	-2.96397	-2.62101
			Trend and Intercept	-3.844396**	-4.296729	-3.56838	-3.21838
			None	-3.806801***	-2.644302	-1.95247	-1.61021
D(LNEXR)	ADF	First Difference	Intercept	-3.583126**	-3.639407	-2.95113	-2.61430
			Trend and Intercept	-4.312498***	-4.252879	-3.54849	-3.20709
			None	-2.62110**	-2.6347	-1.9510	-1.61091
D(INR)	ADF	First Difference	Intercept	-6.225832***	-3.639407	-2.95113	-2.61430
			Trend and Intercept	-6.299291***	-4.252879	-3.54849	-3.20709
			None	-6.322871***	-2.634731	-1.95100	-1.61091
D(LNINF)	ADF	First Difference	Intercept	-5.565886***	-3.661661	-2.96041	-2.61916
			Trend and Intercept	-5.453275***	-4.284580	-3.56288	-3.215267
			None	-5.574645***	-2.641672	-1.95206	-1.610400

*** Indicates Null Hypothesis of a Unit Root is Rejected at 1% Significant Level

** Indicates Null Hypothesis of a Unit Root is Rejected at 5% Significant Level

4.2. Co-integration

The ADF test proves that we have a mixed order of integration of both the $I(0)$ and $I(1)$ however, stationarity was achieved for the series after first difference thereby justifying the use of the ARDL technique of co-integration. Having established with proof that the underlying series are coordinated of either order one or zero, the study adopted the bound test of co-integration as proposed by Pesaran et al. (2001) to test for the existence of level relationship. Two sets of critical values were given by Pesaran, Shin, and Smith (1996), and Pesaran et al. (2001) for the bound test. One of the sets treats every one of the variables as $I(0)$ and the second, considered them to be $I(1)$.

The null hypothesis of no co-integration among the variables of interest is set for the lower critical bound (i.e. $I(0)$ variables) while the alternative of co-integration among the underlying variables set for the upper critical bound which assumes all the variables are $I(1)$. They provide a band covering all the possible classifications of the variables into either, $I(0)$ and $I(1)$ for each of the applications. However, Narayan (2005) put forward that, the critical values of Pesaran et al. (2001) are computed based on large samples, hence not applicable for small sample sizes. He went further and provided a set of critical values that can be applied to small sample sizes (30 to 80 observations) which we believe is suitable for this study. The critical values are 2.496 - 3.346, 2.962 - 3.910, and 4.068 - 5.250 at 90%, 95%, and 99%, confidence intervals respectively.

A separate ARDL model was used for exchange rate; interest rate; and inflation. For each of the three models, the budget deficit was used as the dynamic regressor and the rest of the other two variables used as fixed regressors in order to ascertain how the regressors could affect the dependent variable jointly. The computed F-statistic of each model is compared with the lower and upper critical bound values provided by Narayan (2005). The F-statistic was used to test jointly

the coefficients of the lagged level variables to ascertain their significance. The null hypothesis of non-cointegration is tested against the alternative hypothesis that there is co-integration among the variables

4.2. 1 ARDL Model for Exchange rate and Budget Deficit

The ADRL model describing the relationship between the exchange rate and the budget deficit was estimated and the effects of both their short and long-run relationships were equally investigated. After estimating the conditional ARDL specification for the exchange rate model, results from the estimation of the long run coefficients and the bound test are represented in the table below:

4. 2.2 Estimation of Long-run Coefficients and Discussions of Exchange Rate Model

Table 4.2. 1 Long-run coefficient Estimate and bound test - exchange rate

Levels Equation				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Budget Deficit per GDP	-0.485732	0.062477	-7.7746	0.0000
F-Bounds Test				
Null Hypothesis: No levels relationship				
Test Statistic	Value	Significance	1(0)	1(1)
Finite Sample: n=35				
F-statistic	13.93933	10%	4.225	5.05
		5%	5.29	6.175
		1%	7.87	8.96
Actual Sample Size = 33		Finite Sample: n=30		
		10%	4.29	5.08
		5%	5.395	6.35
		1%	8.17	9.285

Author's computation using Eviews 10

It can be observed from table 4.2.1 that, the long-run coefficient of the budget deficit is significant at 1%. The result exhibits a negative long-run relationship between the budget deficit and the exchange rate. The coefficient of the budget deficit (-0.485732) implies that a unit change in the budget deficit causes the exchange rate to change by -48 percent. Intuitively, when the deficit is created and government source external fund in financing it, the inflows of those funds normally come in a foreign currency which will help strengthen the domestic currency. The result lends support to the argument of Aboagye (2018). He argues that without foreign borrowings, the domestic currency would have depreciated even more in Ghana. The result, therefore implied that an increase in the budget deficit leads to the appreciation of the Ghana Cedi. The result also supports the attribution of the rising US deficit in the '80s by many economic commentators as the major cause of the strength gained by the US dollar at the time. Similarly, Feldstein (1986) and Sachs (1986) all found anticipated future budget deficit as the cause of US dollar appreciation.

The bound test results above suggest that the null hypothesis of no co-integration relationship between the exchange rate and its co-variate be rejected as the F-statistic of 13.93933 computed from the model is greater than the 3.910 and 4.35 critical values provided by Narayan (2005) and that of Pesaran et al. (2001) for the upper bounds at 5% level of significance respectively. The result, therefore, established the existence of a stable equilibrium relationship between the variables in the long run.

Next, we estimated the error correction model which represents the speed of adjustment to restore the dynamic model to equilibrium following any shock. As expected, the ECM term, here represented as $CointEq(-1)$, is negative with an associated coefficient estimate of -0.096695. This implies that about 9.67% of any development into disequilibrium are adjusted for within one period

(i.e. the speed of adjustment to long-run equilibrium is approximately 9.67 percent per annum). Additionally, given the vast t-statistic, to be -5.384590, we can also conclude that the coefficient is highly significant. This establishes the existence of a co-integrating relationship among the variables in the model. The size of the coefficient in this study is an indication that the rate of adjusting to long-run changes is slow. The short-run result confirms the negative relationship found by the long run estimate except that it is insignificant. Also, although the first and second lags of budget deficit confirm a significant relationship with the exchange rate at 1% and 10% respectively they are positively related. This result, therefore, fails to suggest the immediate effect of budget deficit changes on the price of the US dollar in Cedis.

Table 4.2. Error correction Regression and short-run estimate - Exchange rate

ARDL Error Correction Regression				
Dependent Variable: LN Exchange Rate - 1st Difference				
Selected Model: ARDL (1, 3)				
Sample: 1982 - 2017		Included Observation: 33		
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	-0.599717	0.123659	-4.849747	0.0001
D(BD GDP)	-0.011371	0.007142	-1.592133	0.1239
D(BD GDP(-1))	0.021539	0.007362	2.925685	0.0072
D(BD GDP(-2))	0.013361	0.006791	1.967661	0.0603
INR	0.001869	0.002635	0.709186	0.4848
LNINF	0.149322	0.05107	2.923868	0.0072
CointEq(-1)	-0.096695	0.017958	-5.38459	0.0000
R-squared	0.716655		F-statistic	10.96014
Adjusted R-squared	0.651267		Prob.(F-statistic)	0.000004

4.2.3 Diagnostic Tests for Budget Deficit on the Exchange Rate

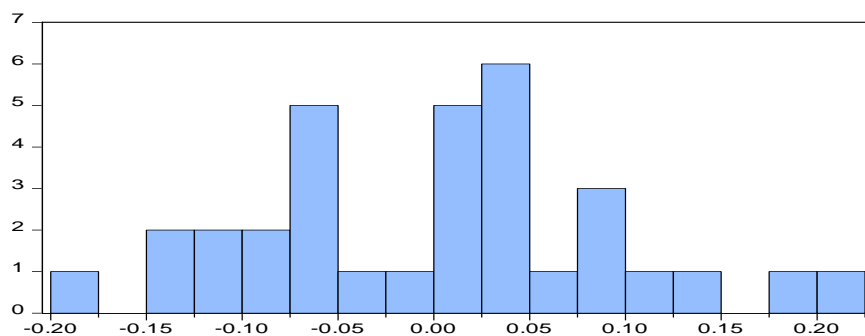
The R-square shows a good fit of the model. It indicates that about 71.67% of the variability in the exchange rate has been explained by the variations in the explanatory variables. The table below shows the normality, serial correlation, and the heteroscedastic tests for the model. The null hypotheses testing, normality, serial correlation and heteroscedasticity includes: no normally distributed residuals, no serial correlation, and homoscedasticity respectively.

From Table 4.2.4, the null hypotheses cannot be rejected at the 5% significance level for the given probability values of 0.864173 (the Jarque-Bera), 0.6692 (chi-square) and 0.2605 (chi-square) respectively. Thus, the exchange rate function passes all the diagnostic tests. This implies that the exchange rate function does not suffer from any problem related to normality, serious serial correlation, and heteroscedasticity.

Table 4.2. 3Diagnostic Test - Exchange Rate

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 3 lags

F-statistic	0.525645	Prob. F(3,22)	0.6692
Obs*R-squared	2.207192	Prob. Chi-Square(3)	0.5305



Series: Residuals	
Sample 1985 2017	
Observations 33	
Mean	-6.22e-17
Median	0.008151
Maximum	0.201016
Minimum	-0.190609
Std. Dev.	0.090900
Skewness	0.204377
Kurtosis	2.787261
Jarque-Bera	0.291965
Probability	0.864173

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	1.628997	Prob. F(27,7)	0.2605
Obs*R-squared	30.19447	Prob. Chi-Square(27)	0.3055
Scaled explained SS	28.37549	Prob. Chi-Square(27)	0.3918

Equally important for any standard econometric analysis, is the stability of coefficients in the Regression. This requirement for the co-integration analysis is depicted using the Cumulative Sum (CUSUM) of plot, based on the recursive residuals. In Figure 4.2.1 the plot does not show evidence of statistically significant breaks. We can, therefore, conclude that the parameters of the estimated ARDL model for the budget deficit on the prices of the Cedi per the US dollar are stable over the sampled period.

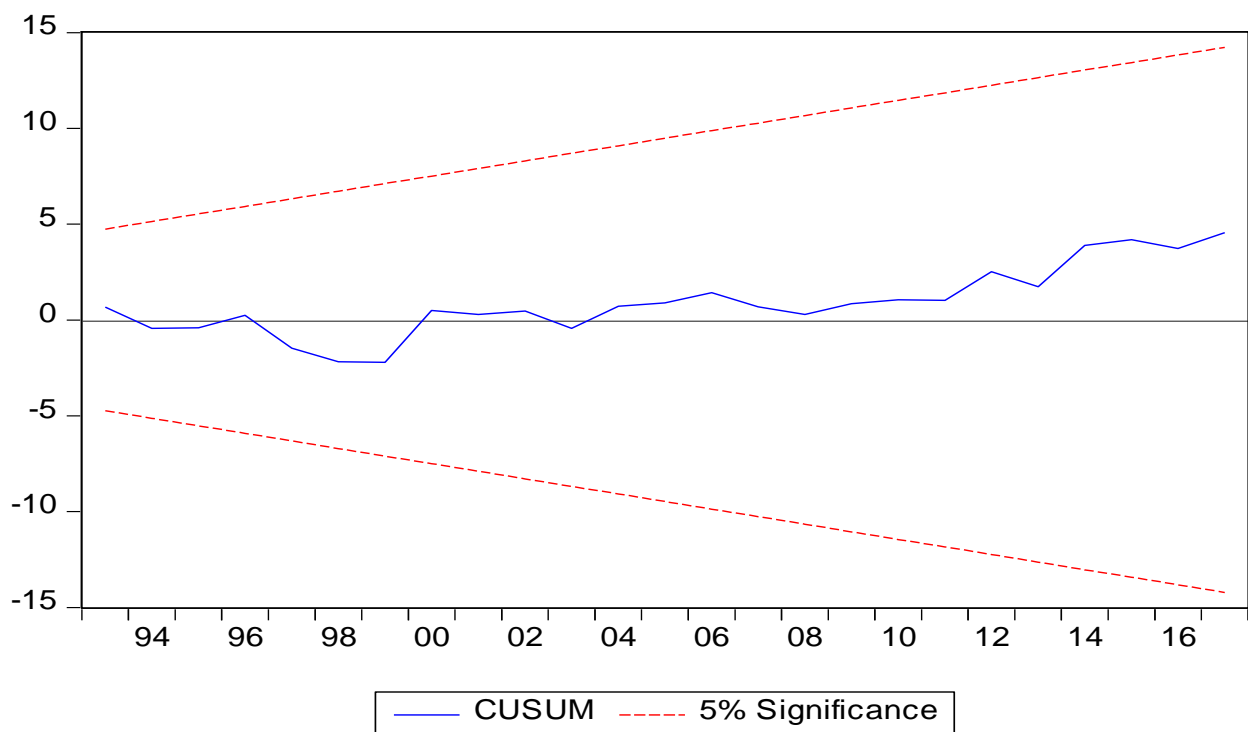


Figure 4.2. 1 Recursive Residuals plot - Exchange Rate

4.3.1 ARDL model for Interest rate and budget deficit

The results in Table 4.3.1 show the estimates of the ADRL model describing the interest rate relationship with the budget deficit. Here the error correction model was not estimated as co-integration was not achieved.

Intuitively, one expects that if government budget deficits were financed through domestic borrowing, the demand for loanable funds increases and the effect of that will lead to an increase in the interest rate, hence the priori expectation of a government figurative expenditure increase translating into a high-interest rate, especially in the long-run. Also, the budget deficits itself have the effect of increasing current consumption by the government or consumers. The increase in consumption causes savings to fall and consequently raises interest rates. From the bound test result, however, the F-statistic of 3.256592 computed from the model is less than the Narayan (2005) critical values of 3.910 and 4.350 which are the upper bounds at the 5 % level of significance respectively. As a decision rule, the computed F-statistic is compared with the upper bound critical value before any inference could be drawn.

The result suggests that the null hypothesis of no co-integration relationship between the interest rate and the budget deficit could not be rejected. We, therefore, conclude that there is no stable, long-run equilibrium relationship between the variables. This means that the result lends credence to the Ricardian Equivalence Theory especially the argument from Feldstein (1974). He argued that an increase in government consumption and decrease in savings in the form of a current fiscal deficit results in offsetting the desired growth of private saving and hence no change is achieved for the desired national saving. Since desired national savings have remained constant, the real interest rate does not have to rise to balance off national saving and investment demand.

Table 4.3. 1 ARDL model for Interest rate

Levels Equation				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Budget Deficit per GDP	-0.339164	1.628708	-0.20824	0.8365
F-Bounds Test	Null Hypothesis: No levels relationship			
Test Statistic	Value	Significance	1(0)	1(1)
F-statistic	3.256592	Finite Sample: n=35		
		10%	4.225	5.05
		5%	5.29	6.175
Actual Sample Size = 35		1%	7.87	8.96

Author's computation using Eviews 10

4.3.2 Estimation of Interest Rate Short-run model and Discussions

With the existence of no long-run relationship between the interest rate and the budget deficit as indicated by the results of the bound test, the study only went further to estimate the short-run model of the variables on the interest rate. The short-run dynamics show no significant impact of the regressors on the dependent variable. The budget deficit has its first lag positively relating to the interest rate and alternates its sign afterwards.

The result deviates from the IEA (2010) interest rate analysis on Ghana; suggesting the government borrowing to finance budget deficits as one of the major factors that have sustained, the high level of interest rates in Ghana. However, the result confirms the findings of Darrat (1989, 1990) and Kormendi and Protopapadakis (2004) who have all found no significant relationship between government budget deficit and the interest rate and therefore endorse the Ricardo view of government deficits having no impact on key macroeconomic variables.

Table 4.3. 2 Short run model Estimate – Interest Rate

ARDL Error Correction Regression				
Dependent Variable: Interest Rate - 1st Difference				
Selected Model: ARDL (1, 3)				
Sample (adjusted) : 1986 - 2017		Included Observation: 32 after adjustments		
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	-19.36002	9.654159	-2.005355	0.0568
D(INR(-1))	-0.301375	0.232955	-1.293702	0.2086
D(INR(-2))	-0.269115	0.213921	-1.258010	0.2210
D(INR(-3))	-0.021213	0.219868	-0.096481	0.9240
D(BD GDP(-1))	0.057015	0.483029	0.118036	0.9071
D(BD GDP(-2))	-0.108983	0.472689	-0.230559	0.8197
D(BD GDP(-3))	0.277770	0.470255	0.590681	0.5605
LNEXR	-0.032345	0.906600	-0.035677	0.9718
LNINF	6.639213	3.432321	1.934322	0.0655
R-squared	0.249198		F-statistic	0.954240
Adjusted R-squared	-0.011950		Prob.(F-statistic)	0.493759

4.3.3 Diagnostic and Stability Tests

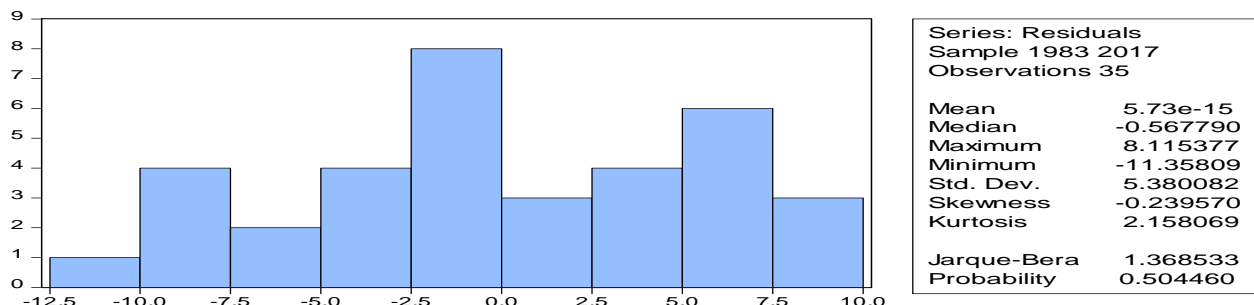
To detect any possible spurious results and correct such defects, if any, in time series econometric analysis and to avoid the possibility of spurious results and conclusions, it is always imperative to carry out diagnostic tests to ensure that the results meet the standard classical linear regression assumptions. These tests are illustrated in table 4.3.4.

Table 4.3. 1 Diagnostic Test – Interest Rate

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 4 lags

F-statistic	0.192071	Prob. F(4,25)	0.9403
Obs*R-squared	1.043531	Prob. Chi-Square(4)	0.9031



Heteroskedasticity Test: White

Null hypothesis: Homoskedasticity

F-statistic	1.342623	Prob. F(5,29)	0.2746
Obs*R-squared	6.579068	Prob. Chi-Square(5)	0.2539
Scaled explained SS	2.615343	Prob. Chi-Square(5)	0.7590

The results for the Breusch-Godfrey test for serial correlation has a P-values more than 5% indicates the presence of no serial correlation. Also, the white test for heteroskedasticity suggests that we cannot reject the null hypothesis of homoskedasticity. Based on the null hypothesis that the sample population follows a Gaussian (normal) distribution, judging by the Jarque-Bera output of 1.368533 and a high probability level of 0.504460 which is greater than the significance level of 0.05, therefore we do not reject the null hypothesis. We conclude that the interest rate function does not suffer from any problem related to normality, serious serial correlation, and heteroscedasticity.

The CUSUM method tests the null hypothesis that the parameters do not change or the model is stable. The depicted graph in figure 4.3.1 shows no sign of a structural break. We can, therefore, conclude that the parameters of the estimated ARDL model for the budget deficit on the interest rate are stable over the period 1983 to 2017.

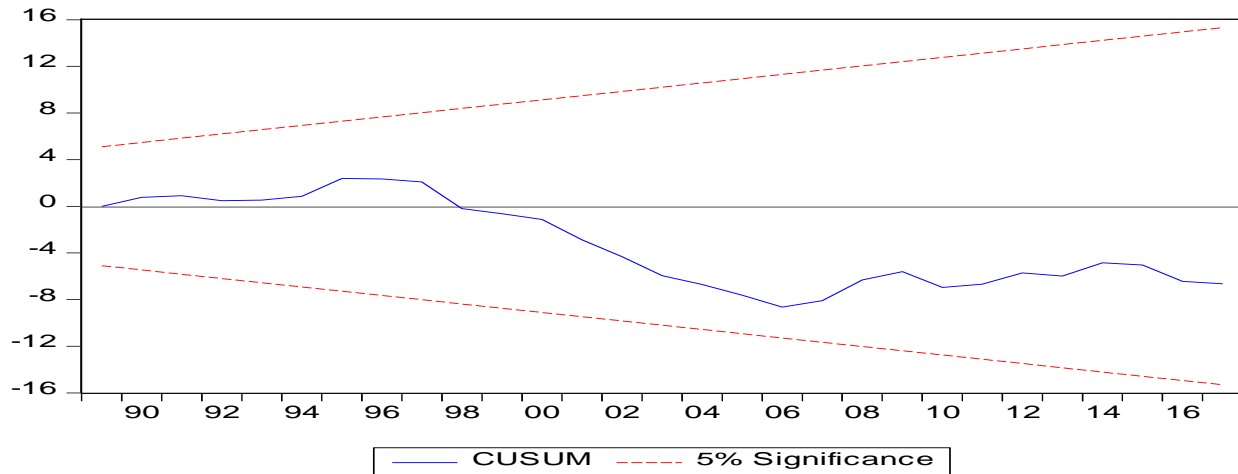


Figure 4.3. 1 Recursive Residuals plot - Interest Rate

4.4. 1: ARDL Model for Inflation and Budget Deficit

The result shows the estimates of the ADRL model describing the relationship between the inflation rate and budget deficit. The short and long-run relationships and their effects were both investigated.

4.4.2 Estimation of Long-run Coefficients and Discussions of Inflation Rate Model

Table 4.4. 1 Long-run Coefficients Estimate and bound test - Inflation

Levels Equation				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Budget Deficit per GDP	0.036876	0.018811	1.960329	0.0600
F-Bounds Test	Null Hypothesis: No levels relationship			
Test Statistic	Value	Significance	1(0)	1(1)
Finite Sample: n=35				
F-statistic	28.31147	10%	4.225	5.05
		5%	5.29	6.175
		1%	7.87	8.96
Actual Sample Size = 34		Finite Sample: n=30		
		10%	4.29	5.08
		5%	5.395	6.35
		1%	8.17	9.285

Author's computation using Eviews 10

The results of the bound test above suggest the rejection of the null hypothesis of no co-integration relationship between the inflation rate and its co-variate as the F-statistic of 28.31147 computed from the ARDL model is greater than the critical values provided by Narayan (2005) and that of Pesaran et al. (2001) for the upper bounds at both 5% and 1% levels respectively. This suggests the existence of a stable, long-run equilibrium relationship between the inflation, and the budget deficit.

Excess government spending is expected to translate into a high inflation rate, particularly over the long run. Increase in budget deficit requires financing; when governments print money for that purpose, it is essentially increasing seigniorage revenue without any obligation on its part to repay. The aggregate demand is then increased as there is more money in circulation. This leads to the growth of the financial wealth of the private sector and on the broad money supply. Both real and the expectation of more money chasing fewer goods brings about an increase in the inflation rate of the country. (i.e. positive budget deficit and the inflation rate relationship).

Although the result shows the priori expectation of the relationship between the budget deficit and inflation rate, this relationship is significant only at the 10 % significance level. This finding confirms the assertion by Sargent and Wallace (1981), that public sector deficits are inflationary. This implies that high and prolonged government deficit statistically explains the upsurge in inflation in the long-run. Findings by Agha and Khan (2006) and Appiah (2015), affirms this positive relationship that exists between budget deficits and inflation in Sri Lanka and Ghana respectively.

Table 4.4. 2 Error Correction Regression and short-run estimate – Inflation

ARDL Error Correction Regression				
Dependent Variable: LN Inflation - 1st Difference				
Selected Model: ARDL (2, 0)				
Sample : 1982 - 2017		Included Observation: 34		
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	2.782296	0.434449	6.404190	0.0000
D(LNINF(-1))	0.315487	0.112563	2.802755	0.0091
LNEXR	-0.061006	0.032581	-1.872429	0.0716
INR	0.028005	0.005858	4.780637	0.0001
CointEq(-1)	-1.141201	0.149020	-7.658014	0.0000
R-squared	0.715916		F-statistic	18.27065
Adjusted R-squared	0.676732		Prob(F-statistic)	0.000000

Also, Table 4.4.3 shows a correctly signed (negative) error correction terms which are statistically significant at the 1% level, thereby ensuring that long-run equilibrium is attained following a system disturbance. However, the adjustment speed adjustment to equilibrium exceeds unity. It has a coefficient of -1.141201 suggesting oscillatory convergence. The value of the ECM implied that instead of monotonically converging to the equilibrium path directly, the error correction process vacillates around the long-run value in a dampening manner. Be that as it may, once this process is complete, convergence to the equilibrium path is rapid. Narayan and Smyth (2006) state that an error correction term that lies between -1 and -2 means that the equilibrium is achieved in a decreasingly fluctuating form. The system corrects its previous period disequilibrium at a speed of 114.12%. In another study, Nchor and Darkwah (2015) find similar oscillatory convergence for the error correcting term for the inflation model in the Ghanaian context. Their result also shows an insignificant negative relationship between the exchange rate and the inflation rate. The short-run dynamics lend credence to their findings. The first lag of inflation impacts itself positively in the short-run. The coefficient of interest rate shows a significant relationship with the inflation rate (sig=0.0001) and a one unit increase in interest rate, results in a 0.03 percent increase in inflation.

The Cumulative Sum (CUSUM) of plot based on the recursive residuals is again used to test for a structural break in the parameters. It shows whether the ARDL model has shifted over time. In Figure 4.4.1, the plot does not show evidence of statistically significant breaks. We, therefore, conclude that the parameters of the estimated ARDL model for the budget deficits on the inflation rates in Ghana over the period 1982 to 2017 were stable as the plot is contained in the bound

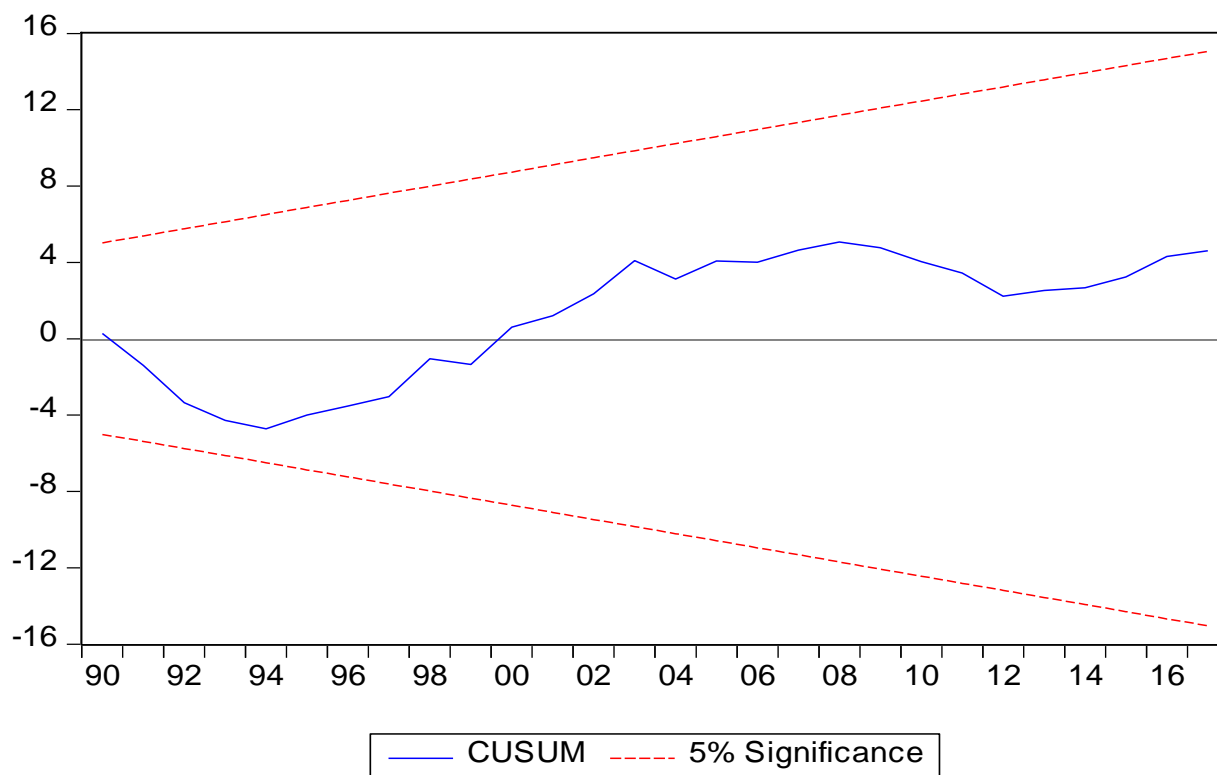


Figure 4.4. 1 Recursive Residuals plot - Interest Rate

4.4.3 Diagnostic tests for the budget deficit on the inflation rate

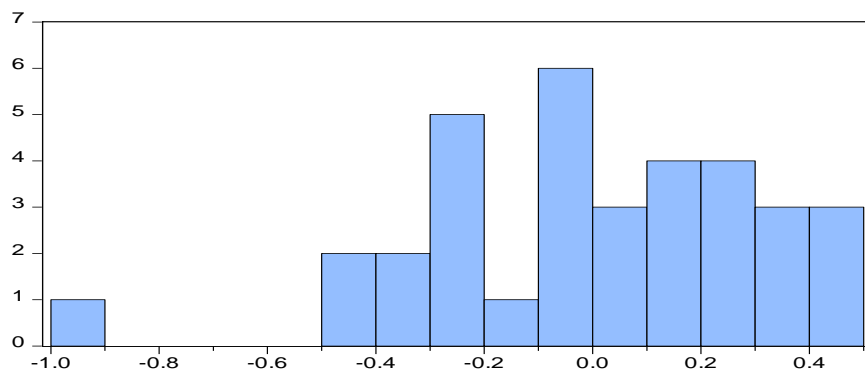
The R-square shows a good fit of the model. It indicates that about 78.43% of the variability in the inflation rate has been explained by the variations in its covariates. Table 4.15 shows the normality, serial correlation, and the heteroscedastic tests for the model. The null hypothesis testing, just like the previous ones includes: no normally distributed residuals, no serial correlation, and

homoscedasticity respectively. From the table, it is clear that the null hypotheses cannot be rejected at the 5% significance level for the given probability values of 0.259741 (the Jarque-Bera), 0.6647 (chi-square) and 0.8787 (chi-square) respectively. Thus, the interest rate function passes all the diagnostic tests. This means the exchange rate function does not suffer from any problem related to normality, serious serial correlation, and heteroscedasticity.

Table 4.4. 3 Diagnostic tests - inflation rate

Breusch-Godfrey Serial Correlation LM Test:
 Null hypothesis: No serial correlation at up to 3 lags

F-statistic	0.531717	Prob. F(3,25)	0.6647
Obs*R-squared	2.039288	Prob. Chi-Square(3)	0.5643



Series: Residuals	
Sample 1984 2017	
Observations 34	
Mean	-1.38e-16
Median	0.015611
Maximum	0.475064
Minimum	-0.931379
Std. Dev.	0.312037
Skewness	-0.634417
Kurtosis	3.541495
Jarque-Bera	2.696138
Probability	0.259741

Heteroskedasticity Test: White
 Null hypothesis: Homoskedasticity

F-statistic	0.564541	Prob. F(20,13)	0.8787
Obs*R-squared	15.80382	Prob. Chi-Square(20)	0.7287
Scaled explained SS	13.62008	Prob. Chi-Square(20)	0.8492

4.5 Vector Autoregressive Model

Table 4.5. 1 VAR Lag Order Selection

VAR Lag Order Selection Criteria						
Endogenous Variables: BD_GDP LNXR INR LNINF						
Sample: 1982 - 2017			Included Observations: 31			
Lag	LogL	LR	FPE	AIC	SC	HQ
1	-160.9990	N/A	1.076341*	11.41929	12.15941*	11.66055*
2	-147.8385	19.5285	1.348141	11.60248	13.08273	12.08500
3	-133.8298	17.17185	1.732767	11.73096	13.95132	12.45474
4	-113.6231	19.5549	1.728761	11.45956	14.42005	12.42460
5	-95.5353	12.83654	2.579972	11.32486*	15.02547	12.53116
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quann information criterion						

The SIC criterion was used in the study for the lag selection. In order to check whether the lag length selected give residuals that are free, from the first-order autocorrelation, homoscedastic and are normally distributed we performed specification tests in that regards. Where the test indicates autocorrelation, the lag order is increase compared to the one selected by the SIC criterion until the autocorrelation test does not reject the null hypothesis of no serial correlation. However, where the test shows non-normal residuals distribution, the SIC criterion is not dismissed as the asymptotic properties of the VAR parameter estimators do not depend on the normality assumption. (Lutkepohl, 1991).

Table 4.5. 2 VAR Residual Serial Correlation Test

VAR Residual Serial Correlation LM Tests						
Sample: 1982 - 2017			Included observations: 35			
Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	15.02123	16	0.5231	0.942376	(16.74.0)	0.5263

From table 4.5.2, the lag order selected by the SIC criterion is lag order one. This is also confirmed by the autocorrelation test as it indicates that the residuals are not autocorrelated at lag one with a p-value of 0.5263 for no serial correlation for the null hypothesis. The stability condition of the VAR model is also satisfied as all the roots are within a unit circle.

Table 4.5. 3 Unit Root Test

Roots of Characteristic Polynomial	
Endogenous variables: BD_GDP LNEXR INR LNINF	
Root	Modulus
0.954741 - 0.050603i	0.956081
0.954741 + 0.050603i	0.956081
0.830251	0.830251
0.298106	0.298106
No root lies outside the unit circle.	
VAR satisfies the stability condition.	

Blanchard (1987) and Gujarati (1995), argue that less concentration should be given to explaining the individual coefficients; signs and significance for VAR results as their interpretations may not be accurate. Rather, Blanchard (1987) pointed out that the whole model should be looked at using Impulse Response and Variance Decomposition functions to draw econometric inferences about the system of equations and to give a comprehensive description of the dynamic properties of that system. The study therefore proceeded and used the Impulse Response and Variance Decompositions functions.

4.5.1 Impulse response

The impulse responses of all the endogenous variables to one standard deviation shock were reported in Appendix B. The impulse response functions presented in the Appendix show the direction, magnitude, time-path and the dynamic response of budget deficits, exchange rate, interest rate, and the inflation to a one-period standard deviation shock to the innovations of the

system. It also shows the directions and the persistence of the response to each of the shocks over a 10-year period. The functions have the expected pattern and shocks. The variables are significant, since all lies within the dotted lines which denotes the 95 percent, confidence bands.

The budget deficit responded positively to its own shocks, while it responded negatively to the exchange rate shocks, as well as to the shocks in the interest rate and inflation. The response to the inflation rate shocks has a higher incidence than the response to the exchange rate and interest rate shocks. A one-period standard deviation shock to the budget deficit cumulatively causes the inflation rate to take a negative dive exerting almost the same magnitude and directional impact on the exchange rate and the interest rate in the first ten-year period.

The exchange rate cumulatively responds positively to its own shock and the shock of the interest rate with a marginal positive response to inflation. It also responded negatively to the shocks of the budget deficit. With an exception of budget deficit itself, a unit shock in the budget deficit is being cumulatively responded to negatively by all the variables while the budget deficit also cumulatively responded negatively to a one unit shock of all the other variables. From the impulse response function, the exchange rate, interest rate, and inflation reinforce each other and exhibits interdependency by cumulatively responding positively to a unit shock of each other. These results are in line with economic theory.

4.5.2 Variance Decomposition

Aworinde (2013) contends that notwithstanding the usefulness of the impulse response analysis on how specific shocks are being responded to; it is better to assess the impact of those shocks within the context of their variance decompositions.

Table 4.5.4 presented in the Appendix gives variance decomposition of the budget deficit, exchange rate, interest rate, and the inflation shocks. The variance decomposition of the budget deficit indicates that 100 percent of the forecast error of the deficit is explained by its own shocks in the first year of estimation. This is expected as Ghana's economy is in the transition stage of infrastructural development and its growth path just like any other African country requires the provision of power, good roads, hospitals and schools. These infrastructures call for increased government spending and as such, Fiscal policy decisions are most likely to be affected by that factor rather than changes in the exchange, inflation or interest rates. The influence from its own shock fell gradually to 98.18 percent after the tenth year while the fluctuations in the exchange rate, interest rate, and the inflation around that time explained about 0.004 to 1.27 percent, 0.14 to 0.47 percent, and 0.03 to 0.08 percent respectively, after a 10-year horizon.

The exchange rate variance decomposition indicates that about 99.85 percent of the forecast error exchange rate is explained by its own innovation in the first year of estimation. This, however, fell gradually below 81.15 percent after the fifth year and went further to about 75.90 by the tenth year. In the first year, shocks to the budget deficit remain the second major factor that explains the variations in the exchange rate while interest rate and the inflation play no role in determining fluctuations of the exchange rate at that period.

The variance decomposition of interest rate indicates that about 57.50 percent of the forecast error of interest rate is influenced by its own innovation in the first year, while about 17.70 percent was as a result of innovations in the budget deficit and 24.80 was impacted by the forecast error of the exchange rate. Although inflation does not affect the fluctuations of the interest rate in the first year it explained between 1.92 to 3.60 percent over the 10-year horizon. While the influence from

the budget deficit and exchange rate fell gradually to about 8.49 percent and 23.05 percent respectively in the tenth year, the influence of its own shock increased to about 64.90 percent

Table 4.5.4 shows that the innovations of the inflations accounted for about 84.31 of its variations in the first year. By the sixth year, the role of inflation in explaining its own variations sharply decrease to about 80.89 percent and then decreased further to 80.36 in the tenth year.

A cross-sectional check of the variance decomposition establishes the budget deficit variance to exchange rate to be greater than the exchange rate variance to the budget deficit; by implication, this means that the budget deficit shocks impact significantly on the exchange rate and the direction of causality emanates from the budget deficit to the exchange rate. On the other hand, exchange rate shocks impact significantly on the interest rate and the direction of causality emanates from the exchange rate to the interest rate. But for interest rate, the impact of the variables in explaining their own shocks has a decreasing trend over the 10-year horizon.

4.6. Three-state stochastic Markov chain of inflation

Table 4.6.1 gives the categorical groups and the frequencies of the three-state inflation. Starting from January 1990 through to December 2017, for monthly inflation values tagged as 0, 1 or 2 in line with the classification in the table. From the data set, the number of inflation rates below 10%, from 10% to 20% inclusive and above 20% was counted. After, the various states to state one step transitions were then tracked and also counted manually.

Table 4.6. 1 Categorization of inflation into three states

State of inflation	Representation of state	Classification of state	Frequency
Low	0	Below 10%	39
Medium	1	From 10% to 20%	179
High	2	Above 20%	117

Table 4.6.2 shows the frequencies that were observed by counting the number of times of moving from one state to the other throughout the data from January 1990 to December 2017.

Table 4.6. 2 Inflation Transition Frequencies

One step transition from state 0	Frequency
0 =====> 0	36
0 =====> 1	3
0 =====> 2	0
<u>Total transition from state 0</u>	<u>39</u>
One step transition from state 1	Frequency
1 =====> 0	3
1 =====> 1	170
1 =====> 2	5
<u>Total transition from state 1</u>	<u>178</u>
One step transition from state 2	Frequency
2 =====> 0	0
2 =====> 1	6
2 =====> 2	112
<u>Total transition from state 2</u>	<u>118</u>

Table 4.6.2 shows that the number of times low inflation were consecutively recorded in Ghana after a previous month's low record within the sampled period was 36 while for a total number of 39 times Ghana has recorded low monthly inflation within the period. The table also shows that there was no time within the sampled period in which high inflation was recorded when that of the previous month was low. Similarly, there was no time within the sampled period in which low inflation was recorded when that of the previous month was high. (i.e. no transition from state two to state zero). The highest state to state transition was from state one, to state one with a frequency of 170. This suggests a high probability of Ghana recording a-medium inflation given the previous month's state to be medium. It can be observed that the future monthly inflation depends largely on the immediate past monthly inflation rates thereby exhibiting Markov dependence.

The frequencies above were used to calculate sample estimates of the first transition probabilities p_{ij} 's using the formula:

$$P_{ij} = \frac{\text{Frequency of first step transitions from state } i \text{ to state } j}{\text{Total number of first step transitions from state } i}$$

Where p_{ij} is the probability of moving from state i to state j in the next month

Using the frequencies from the above table, the transition probabilities are given by:

$$P_{00} = \frac{36}{39} \quad P_{01} = \frac{3}{39} \quad P_{02} = 0$$

$$P_{10} = \frac{3}{178} \quad P_{11} = \frac{170}{178} \quad P_{12} = \frac{5}{178}$$

$$P_{20} = 0 \quad P_{21} = \frac{6}{118} \quad P_{22} = \frac{112}{118}$$

The first step transition probability matrix is computed as:

$$P = \begin{pmatrix} P_{00} & P_{01} & P_{02} \\ P_{10} & P_{11} & P_{12} \\ P_{20} & P_{21} & P_{22} \end{pmatrix} = \begin{pmatrix} \frac{36}{178} & \frac{3}{178} & 0 \\ \frac{3}{178} & \frac{170}{178} & \frac{5}{178} \\ 0 & \frac{6}{118} & \frac{112}{118} \end{pmatrix} = \begin{pmatrix} 0.923 & 0.077 & 0.000 \\ 0.017 & 0.955 & 0.028 \\ 0.000 & 0.051 & 0.949 \end{pmatrix}$$

The second step transition matrix $P_{ij}^{(2)}$ through to the n -steps transition matrices $P_{ij}^{(n)}$ were obtained recursively according to the Chapman Kolmogorov equations. The same step transition for each matrix was used to plot the graph below. The figure shows a plot of n -step transition probabilities for inflation rates for state zero to zero $P_{00}^{(n)}$, one to one $P_{11}^{(n)}$, and two to two $P_{22}^{(n)}$ for fifteen months ($n=1, 2, \dots, 15$) to give a trend of the behaviour as n increases. It depicts the various transition probabilities from a given state to the same state for fifteen months.

Figure 4.6.1 shows that the probabilities keep decreasing as n increases. It suggests that the long run distribution cannot be obtained in a few transitions. What is not so clear is how the line will keep moving as n increase further. This underscores the need for the long run distribution to be determined. The line for state one marginally exudes superiority over the other two states showing a relatively high probability of the long run distribution being in state one. We, therefore, expect the inflation rate to be in state one in the long-run.

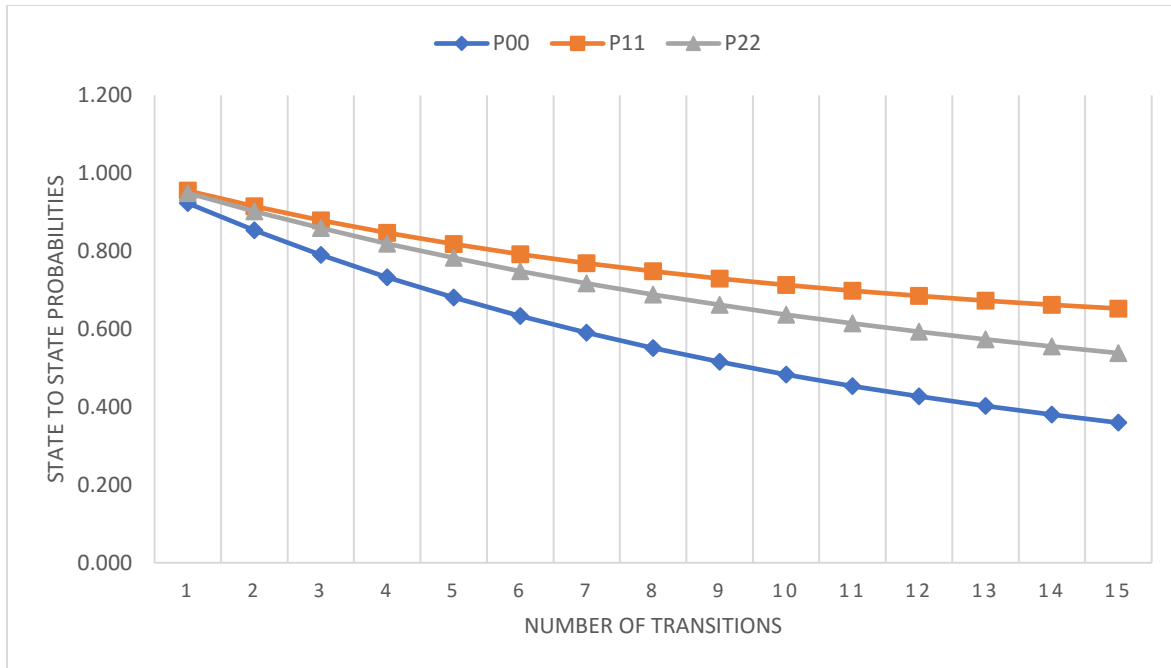


Figure 4.6. 1 *n*-step transition probabilities for inflation rates in Ghana

To determine the long run distribution (stationary distribution) of inflation, the three-state transition probability matrix P of the variable needs to meet the geometrically ergodic condition. We therefore show that the process is irreducible and aperiodic by theorems on ergodicity. A Markov graph was employed to show if the process is irreducible by showing that all the states communicate.

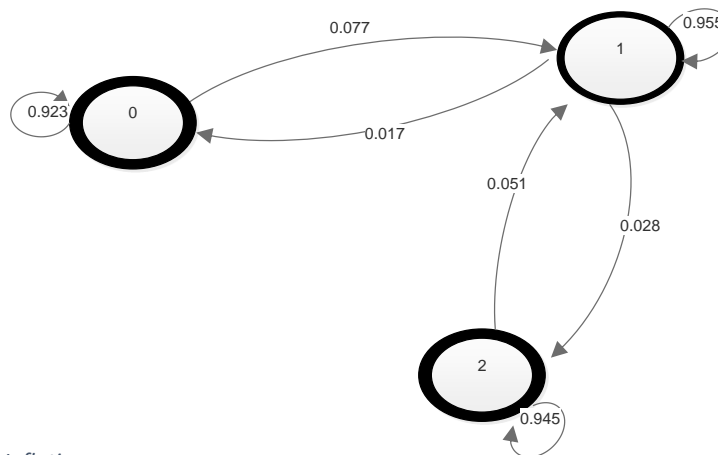


Figure 4.6. 2 Markov Graph for Inflation

From the Markov graph, it is not possible to have a one-step transition from state zero to state two and vice versa. However, you can move from state zero to state one and from state one to state two. You are also able to move from state two to state zero through state one. Since it is possible to move from one state to the other, it is evident that the state space $S = \{0,1,2\}$ is irreducible and then communicate. Also, $P_{00} = \frac{36}{39} > 0$ implies that state **0** has period 1. Based on the fact that periodicity is a class property and all the states belong to one equivalent class the chain has proven to be aperiodic. Satisfying the geometrically ergodic property the process can be said to be aperiodic and irreducible. Meaning the process is having a long-run stationary distribution π with $\pi = \lim_{n \rightarrow \infty} p^n$. The theoretical relationship between the long run distribution and the transition probability matrix \mathbf{p} is given by $\Pi = \pi \mathbf{p}$ where $\pi = (x, y, z)$ with the constraint $x + y + z = 1$.

The step to step transition probabilities for the long run distribution was done iteratively and by using the definition of limiting distribution. The result of both procedures is presented in the appendix. According to the definition of limiting distribution, given transition probability matrix \mathbf{P} of an aperiodic, irreducible, m -state finite Markov chain, there exists a unique probability vector $\Pi = (\pi_1, \pi_2, \pi_3, \dots, \pi_m)$ such that $\Pi \mathbf{P} = \Pi$ with $\sum_{i=1}^m \pi_i = 1$ and $\pi = \lim_{n \rightarrow \infty} p(X_n = i)$ where $\lim_{n \rightarrow \infty} p^n = \Pi = [\pi \ \pi \ \dots \ \pi]'$ The probability vector Π gives the stationary or the long run distribution of the process.

The first procedure was done by iteratively multiplying the transition matrix by subjecting it to powers' until the values become stationary for each state. The recursive method which was done in excel, suggest stationarity in inflation rates in Ghana after 316 months. The difficulty with the second method is that we are unable to estimate the time in which the stationarity is observed. The

result of the two procedures, however, resulted in the same estimates. From the two procedures, the long run distribution of inflation is given by:

$$\pi = (0.1236786469 \quad 0.5644820296 \quad 0.3118393235) \text{ or } \pi = (12.37\% \quad 56.45\% \quad 31.18\%)$$

$$X = \frac{117}{946} \qquad Y = \frac{267}{473} \qquad Z = \frac{295}{946}$$

The values obtained from the limiting distribution show that, in the long run there is a 56.45% possibility that inflation rate will lie between 10 and 20%, inclusive classification, 31.18% chance that it will be greater than 20% while there is only 12.37% chance that it will be below 10% (i.e. a single digit inflation).

Table 4.6. 3 Categorization of Exchange rate into three states

State of inflation	Representation of state	Frequency
Depreciate	0	294
Stable	1	8
Appreciate	2	33

Table 4.6.3 also gives the groupings and the frequencies of the three-state Cedi per US dollar rate. Again, starting from January 1990 through to December 2017, monthly exchange rate values were tagged as 0, 1 or 2 depending on whether the Cedi depreciates, stay stable or appreciates as represented in the table above. From the table, the Cedi depreciates 294 times, stable 8 different occasions (i.e. month on month) and appreciates 33 times during the sampled period.

Table 4.6. 4 Exchange Rate Transition Frequencies

One step transition from state 0	Frequency
0 =====> 0	270
0 =====> 1	4
0 =====> 2	20
<u>Total transition from state 0</u>	<u>294</u>
One step transition from state 1	Frequency
1 =====> 0	6
1 =====> 1	2
1 =====> 2	0
<u>Total transition from state 1</u>	<u>8</u>
One step transition from state 2	Frequency
2 =====> 0	18
2 =====> 1	2
2 =====> 2	13
<u>Total transition from state 2</u>	<u>33</u>

Table 4.6.4 shows the frequencies of one step transition (i.e. moving from one state to the other). It shows that for 13 times the Cedi appreciated for two or more consecutive months within the sampled period (that is transitioning from state 2 to state 2). From the table, while it is possible to move from state zero and two to any other states, state one can only communicate with itself and state zero. Particularly, there was no transition from state one to state two. Thus, there was no time within the sampled period that the Cedi moves from a stable state to appreciate. The highest frequency recorded was 270, which is the number of times the Cedi depreciated against the dollar for consecutive months.

Using the frequencies from the above table, the transition probabilities are given by:

$$P_{00} = \frac{270}{294} \quad P_{01} = \frac{4}{294} \quad P_{02} = \frac{20}{294}$$

$$P_{10} = \frac{6}{8} \quad P_{11} = \frac{2}{8} \quad P_{12} = 0$$

$$P_{20} = \frac{18}{33} \quad P_{21} = \frac{2}{33} \quad P_{22} = \frac{13}{33}$$

We can then compute the first step transition probability matrix as follows:

$$P = \begin{bmatrix} P_{00} & P_{01} & P_{02} \\ P_{10} & P_{11} & P_{12} \\ P_{20} & P_{21} & P_{22} \end{bmatrix} = \begin{bmatrix} \frac{270}{294} & \frac{4}{294} & \frac{20}{294} \\ \frac{6}{8} & \frac{2}{8} & 0 \\ \frac{18}{33} & \frac{2}{33} & \frac{13}{33} \end{bmatrix} = \begin{pmatrix} 0.92 & 0.01 & 0.07 \\ 0.75 & 0.25 & 0.00 \\ 0.55 & 0.06 & 0.39 \end{pmatrix}$$

Again, from the transition matrix above, the next step is to estimate the long-run distribution by showing whether the transition matrix P is geometrically ergodic. We again show that the process is irreducible and aperiodic by theorems on ergodicity.

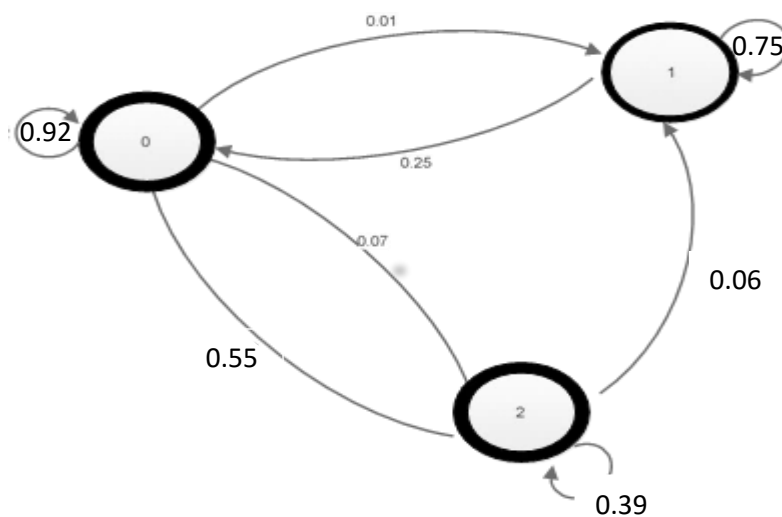


Figure 4.6. 3 Markov Graph for Exchange Rate

Again, from the directed-multigraph, you can move from one state to the other i.e. there is communication between the states since all the three states communicate. It can be concluded that, the state space $S = \{0,1,2\}$ is irreducible. Also, $P_{00} = \frac{270}{294} > 0$ implies that state **0** has period 1. Based on the fact that periodicity is a class property and all the states belong to one equivalent class the chain has proven to be aperiodic. Now, the geometrically ergodic property has been satisfied as the process is proven to be aperiodic and irreducible and therefore implies that the process is having a long-run stationary distribution π with $\pi = \lim_{n \rightarrow \infty} p^n$.

From the above, assuming we want to have the two-step transition starting from state zero to state one, there are three possible ways we can achieve that:

$$\text{Zero to zero to one} = (P_{00})(P_{01}) = (0.92)(0.01) = 0.012495$$

$$\text{Zero to one to one} = (P_{01})(P_{11}) = (0.01)(0.25) = 0.003401$$

$$\text{Zero to two to one} = (P_{02})(P_{21}) = (0.07)(0.06) = 0.004123$$

We can now compute the probability of moving from state zero to state one in two-step transition as:

$$P_{01}^{(2)} = P_{00} P_{01} + P_{01} P_{11} + P_{02} P_{21} = 0.012495 + 0.003401 + 0.004123 = 0.020019$$

Again, the computation of the long run distribution was done iteratively and by using the definition of limiting distribution. The result of both procedures is presented in the appendix. Here, we expect the exchange rate to stabilize in twenty months from the time of the study with the Cedi depreciating against the US dollar since the recursive procedure shows that the probability of state one is higher than the other states.

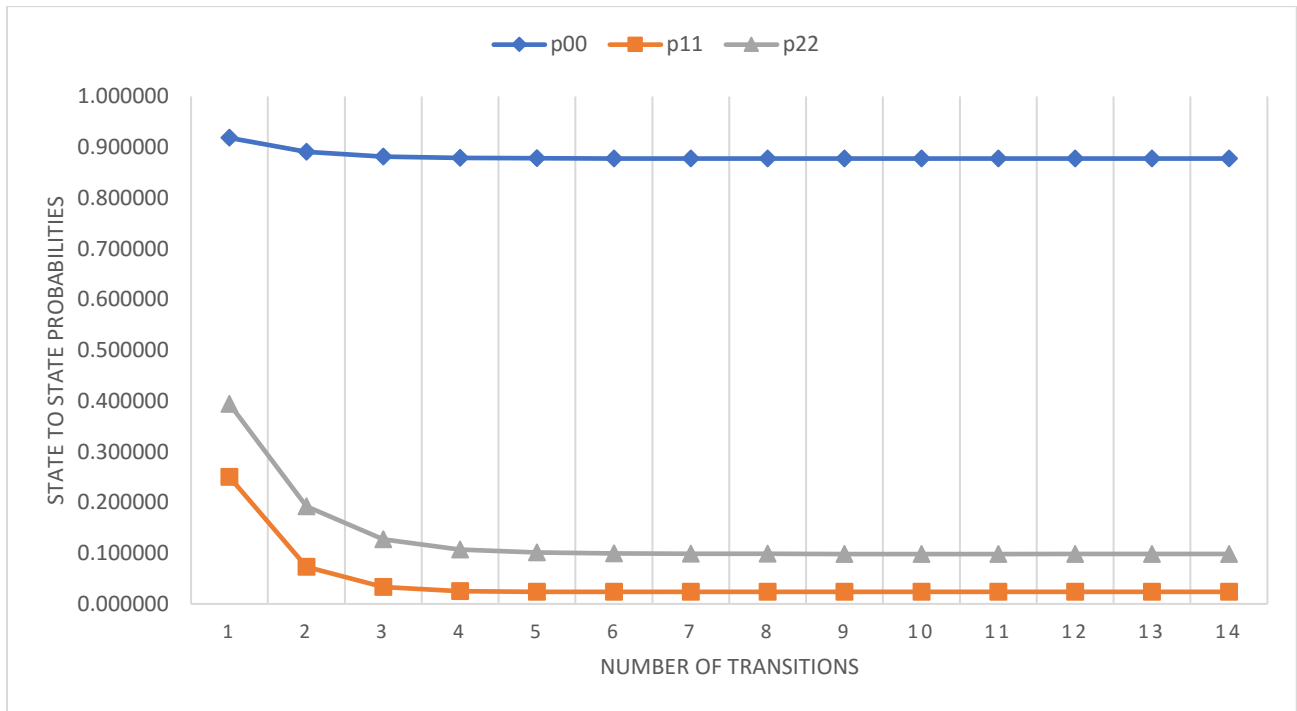


Figure 4.6. 4 n-step transition probabilities for the exchange rate

The fourteen-month n-step transition probabilities for the exchange rate in figure 4.6.4 do show that the probabilities decreased up to the third and fourth and then appear to be stabilizing as n increases by the month. It indicates that the long run distribution is obtainable, after a few numbers of transitions. The line for state zero is wide apart from the other two states showing a very high probability of being in state zero. Hence, the expectation of the exchange rate to be in state zero in the long run.

From the two procedures, the long run distribution of exchange rate is given by:

$$\pi = (0.8776119403 \ 0.0238805970 \ 0.0985074627) \text{ or } \pi = (87.76\% \ 2.39\% \ 9.85\%)$$

$$X = \frac{294}{335} \qquad Y = \frac{8}{335} \qquad Z = \frac{33}{335}$$

Again, the recursive method which was done in excel, suggest stationarity in exchange rates in Ghana after 20 months. The limiting distribution shows the long run possibility of having the exchange rate to depreciate, appreciate and to be stable with their respective probabilities. The values obtained shows that, in the long run, there is 87.76% chance that the Cedi will depreciate, 9.85% chance that the Cedi will remain stable and finally a 2.39% chance that the Cedi will appreciate against the US dollar.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the Study

The chapter presents a summary of the findings from the study as well as the conclusions, recommendations and the areas for future research. The objectives of the study were to investigate the relationship exchange rate, interest rate, and inflation has with the budget deficit in Ghana and Test for possible co-integration. It's also set to determine the long-run distribution of inflation, and the exchange rate, using Markov transition probabilities. An overview of the budget deficit, exchange rate, interest rate and the inflationary trends in Ghana was presented. The literature review was organized along four themes: Theories on fiscal policy to support the relationship that exists between budget deficits and the other three variables, theories underpinning the relationship between the exchange rate, interest rate and inflation, long-lived debates of the impact budget deficit has an exchange rate, interest rate and inflation, and finally an empirical survey of the literature on the interrelationship between budget deficits, exchange rate, interest rate and inflation in both the developed and developing countries including Ghana. Twisting both sides of the coin for budget deficit impacts on the exchange rate, interest rate, and inflation, for some studies, evidence from developing and emerging economies presented the fact that inflationary pressures, currency depreciation, and interest rate hikes are victims of government budget deficits. Whiles evidence from the developed nations on the role of budget deficit appeared to be less significant in determining those. Some other studies also ended up with inconclusive findings in contrast to theoretical expectations. In general, some of the empirical studies suggested no relationship, weak correlation, and a strong positive link between the budget deficit, exchange rate, interest rate and inflation.

To satisfy the objectives of this study, a threefold analysis was carried out. The first was the ARDL model adopted for Exchange rate, interest rate and the inflation to determine the existence of long and short-run relationships between each of them and the budget deficit. For each of the three ARDL model, the budget deficit was used as the dynamic regressor while the other two variables served as fixed regressors. In the second analysis, all the four variables were considered as endogenous variables for which a VAR model was set up to analyze the interrelationships existing between the budget deficit, exchange rate, interest rate and inflation in Ghana. The final part is the determination of the long-run stationary distribution of inflation and the exchange rate in Ghana. The results of the study revealed that co-integration exists between budget deficit and exchange rate as well as the budget deficit and inflation. There is however no co-integration between budget deficit and the interest rate. Upon the establishment of long-run relations, for inflation and exchange rate, the Markov transition probabilities were used in estimating the long-run stationary distributions. The study predicts the long-run distribution of the exchange rate in 20 months while inflation was predicted to be in 316 months.

5.2 Conclusion

The economic consequences of the budget deficit, exchange rate, interest rate, and inflation imply that there is a constant effort by the government to control this phenomenon. The study shows a positive long-run relationship between the budget deficit and inflation and a negative long-run relationship between the budget deficit and the exchange rate. The speed of adjustment estimated by the error correction model for the exchange rate and inflation in relation to the budget deficit shows that changes in the budget deficit cause the inflation to adjust faster than the exchange rate. This implies that budget deficit changes can have a short-lived impact on inflation than it will have

on the exchange rate in Ghana. Finally, it was realized that in the long run there is a 56.45 % chance that inflation rate will lie between 10% and 20%, inclusive in Ghana whereas the Cedi in the long-run has a 87.76 % chance of depreciating against the US dollar. The long-run distributions as estimated by Markov transition probabilities serve as a yardstick for economists, academia and investors in analyzing the long run prospects of the economy and also aids the government in planning reforms in order to meet the country's long-run objectives.

5.3 Recommendations

The findings provide important information for policy formulation and implementation.

We recommend that, since, the central bank exists to pursue monetary and financial policies geared towards price stability, its independence must further be strengthened. Bank of Ghana must also limit the proportion of the deficits being monetized while the government resort to alternative domestic borrowing sources through the open market operations, including the issuance of Treasury bills and bonds from depository money and non-banks.

The growth path of Ghana just like any other African country requires the provision of power, good roads, hospitals and schools. These infrastructures which call for increased government spending should be tailored towards complementing the private sector to allow the government the lean way to concentrate on other public goods which are not lucrative for the private investor. Essentially, domestic revenue mobilization also should be increased through the provision of simplified tax laws and regulations, widening the tax net to incorporate the large informal sector of the economy, increased fairness and transparency of the tax system administration, public education and combating tax evasion, tax avoidance and corruption at all levels of governance

Finally, for Ghana to fully enjoy the consolidated gains of deficit reduction, the budget deficit should not only be reduced by the government but must convince private investors to increase their demand for domestic securities. This reduction must also be large enough and consistently pursued to be viewed by private investors as credible, long term, and sustainable. External borrowing should be directed to sectors that can help improve exports. The income that will be through the export which will be in foreign currency can help beef up the nation foreign reserves and foreign currency stock.

5.4 Limitations of the Study

The principal setback of this study is the limitation of obtaining all data for the intended study period. The study initially intended to run a regression to investigate the relationship of budget deficits on the exchange rate, interest rate and inflation in Ghana from 1960 to 2017. However, due to the unavailability of data for some of the variables such as budget deficit and interest rate, particularly in developing countries like Ghana, the study had to run its model based on data from 1982 to 2017. Efforts made to extrapolate the missing data by graphical method, was unsuccessful as it resulted in huge values which were simply unrealistic. The option available here is either to exclude the variables or to find proxies for them in the empirical model. These options may come with the risk of an omitted variables bias or the proxies found may not effectively be the true representative impact of the actual variables, which can cause inconsistent results. Although, these problems seem not to have significantly affected the findings presented in this study, the challenges posed by finding a balance between the options of omitting the variables or finding proxies to empirical studies cannot be hastily discarded. Also, for the second objective, there is no proven

theorem that makes comparisons of long-run distributions from Markov transition matrices in a case where the length of time for transitions are different even for the same data. We are of the opinion that, just like all academic endeavours, the weaknesses of this study could be addressed by future authors.

REFERENCES

- Abel, A. B. (1990). Asset prices under habit formation and catching up with the Joneses. *National Bureau of Economic Research*. No. w3279.
- Abell, J. D. (1990). The Role of the Budget Deficits During the Dollar Exchange Rate From 1979-85. *Southern Economic Journal* 66-74.
- Aboagye, Q. A. (2018). Accounting for Ghana's External Borrowings, Trade Balances, and Domestic Currency in Recent Times. *African Journal of Management Research*, Vol 25, 45-61
- Adu, G., & Marbuah, G. (2011). Determinants of inflation in Ghana: An empirical investigation. *South African Journal of Economics*, 79 (3), 251-269.
- Agha, A. I., & Khan, M. S. (2006). An empirical analysis of fiscal imbalances and inflation in Pakistan. *SBP research Bulletin*, 2 (2), 343-362.
- Ahiakpor, F. (2013). Role of Human Capital in Economic Growth in Ghana. *International Journal of Economics & Business Studies*, 3 (2).
- Akaike, H. (1973). Information Theory and an Extension of the Maximum Likelihood Prin.
- Alagidede, P., Baah-Boateng, W., & Nketiah-Amponsah, E. (2013). The Ghanaian economy: an overview. *Ghanaian Journal of Economics*, 1 (1), 4-34.
- Ali, T. M., Mahmood, M. T., & Bashir, T. (2015). Impact of Interest Rate, Inflation and Money Supply on Exchange Rate Volatility in Pakistan. *World Applied Sciences Journal*, 33 (4), 620-630.
- Alum, T. (2012). Exchange rate and foreign interest rate linkage for Sub- Saharan Africa floaters
- Amoah, B., & Loloh, F. W. (2008). Causal Linkages between Government Revenue and Spending: Evidence from Ghana. Bank of Ghana Research *Working Paper*, WP/BOG-2008/08.
- Antwi, S., & Atta-Mills, E. (2013). Consequential effects of budget deficit on economic growth: Empirical evidence from Ghana. *International Journal of Economics and Finance*, 5(3).
- Appiah, Y. (2015). *Examining the effects of fiscal deficits on Inflation in Ghana*. Unpublished Thesis
- Arestis, P., & Sawyer, M. (2006). The nature and role of monetary policy when money is endogenous. *Cambridge Journal of Economics*, 30(6), 847-860.
- Aryeetey, E., & Baah-Boateng, W. (2007). Growth, investment and employment in Ghana. *International Labour Organization*.

- Aryeetey, E., Harrigan, J., & Nissanke, M. (Eds.). (2000). Economic reforms in Ghana: The miracle and the mirage. *Africa World Press*.
- Asari, F. F. A. H., Baharuddin, N. S., Jusoh, N., Mohamad, Z., Shamsudin, N., & Jusoff, K. (2011). A vector error correction model (VECM) approach in explaining the relationship between interest rate and inflation towards exchange rate volatility in Malaysia. *World Applied Sciences Journal*, 12 (3), 49-56.
- Aschauer, D. A. (1985). Fiscal policy and aggregate demand. *The American Economic Review*, 75 (1), 117-127.
- Atta-Mensah, J., & Bawumia, M. (2003). A Simple vector error correction forecasting Model for Ghana. *Bank of Ghana Working Paper*.
- Auerbach, A. J., Gale, W. G., & Orszag, P. R. (2002). The Budget Outlook and Options for Fiscal Policy. Available at SSRN 308562.
- Aworinde, O. B. (2013). The tax-spend nexus in Nigeria: evidence from nonlinear causality. *Economics Bulletin*, 33 (4), 3117-3130.
- Aworinde, O.B (2013) *Budget Deficits and Economic Performance*; University of Bath: Unpublished Doctoral Thesis.
- Bank of Ghana (2008). *Annual Report and Accounts 2008*. Accra
- Bank of Ghana (2012). Annual Report 2012, Bank of Ghana, Accra-Ghana.
- Bank of Ghana (2013). Annual Report 2013, Bank of Ghana, Accra-Ghana.
- Barro, R. J. (1974). Are government bonds, net wealth? *Journal of political economy*, 82 (6), 1095-1117.
- Barro, R. J. (1978). Unanticipated money, output, and the price level in the United States. *Journal of Political Economy*, 86(4), 549-580.
- Barro, R. J. (1979). On the determination of the public debt. *Journal of political Economy*, 87(5, Part 1), 940-971.
- Baumol, W. J., & Blinder, A. S. (2005). Macroeconomics: Principles and Policy, 9e. *Mason OH: Thomson/South-Western*.
- Bawumia, M., & Abradu-Otoo, E. (2003) Monetary Growth, Exchange Rate and Inflation in Ghana: An Error Correction Analysis. *Working paper BoG Accra*
- Bergen, J. V. (2010). Factor that Influence Exchange Rates. Investopedia, <http://www.investopedia.com/article/basic/04/050704.asp#axzz288SmcagR>

- Bernheim, B. D. (1989). A neoclassical perspective on budget deficits. *Journal of Economic Perspectives*, 3(2), 55-72.
- Blanchard, O. (1987). Comment to Runkle's Vector Autoregression and Reality. *Journal of Business and Economic Statistics* 5, 449-451.
- Blanchard, O. (1987). *Why does money affect output? A Survey* (No. 2285). NBER working paper.
- Blanchard, O. J. (2008). Crowding out. *The New Palgrave Dictionary of Economics: Volume 1-8*, 1223-1225.
- Bovenberg, A. L. (1998). Environmental taxes and the double dividend. *Empirica*, 25(1), 15-35.
- Bowe, M., & Saltvedt, T. M. (2004). Currency invoicing practices, exchange rate volatility and pricing-to-market: evidence from product level data. *International Business Review*, 13(3), 281-308.
- Budlender, D. (2009). Informal Economy Budget Analysis in Pakistan and Ravi Town, Lahore. *Lahore: Women in Informal Employment Globalizing and Organizing*.
- Calvo, G. A., & Reinhart, C. M. (2000). Fixing for your life (No. w8006). *National Bureau of Economic Research*.
- CEPA (1996). Ghana Macroeconomic Review 2000. Centre for Policy Analysis, Accra.
- Charemza, W., & Deadman, W. (1992). New direction in econometric practice: General to specific modelling, cointegration and vector autoregression.
- Chibber, A. (1991). Africa's rising inflation: causes, consequences, and cures (Vol. 577). *World Bank Publications*.
- Dai, Q., & Philippon, T. (2005). *Fiscal policy and the term structure of interest rates* (No. w11574). National Bureau of Economic Research.
- Darrat, A. F. (1990). Stock returns, money, and fiscal deficits. *Journal of Financial and Quantitative Analysis*, 25(3), 387-398.
- Darrat, A. F., & Glascock, J. L. (1989). Real estate returns, money and fiscal deficits: Is the real estate market efficient? *The Journal of Real Estate Finance and Economics*, 2(3), 197-208.
- Devapriya, T. N. K., & ICHIHASHI, M. (2012). How does the budget deficit affect inflation in Sri Lanka (pp. 1-38). *IDEA Discussion Paper*.

- Devereux, M. B., Engel, C., & Tille, C. (2003). Exchange Rate Pass- Through And The Welfare Effects of The Euro. *International Economic Review*, 44(1), 223-242.
- Dornbusch, R. (1976). Expectations and exchange rate dynamics. *Journal of political Economy*, 84(6), 1161-1176.
- Duarte, M., & Stockman, A. C. (2002). Comment on: Exchange rate pass-through, exchange rate volatility, and exchange rate disconnect. *Journal of Monetary Economics*, 49(5), 941-946.
- Easterly, W., & Schmidt-Hebbel, K. (1993). Fiscal deficits and macroeconomic performance in developing countries. *The World Bank Research Observer*, 8(2), 211-237.
- Eichengreen, B. (2004). Global imbalances and the lessons of Bretton Woods. *Economie internationale*, (4), 39-50.
- Eisner, R. (1989). Budget deficits: rhetoric and reality. *Journal of economic perspectives*, 3(2), 73-93.
- Eli, K. (2010). Financing the Budget Deficit in Philippines. Philippines Institute for Development endogenous. *Cambridge Journal of Economics*, 30(6), 847-860.
- Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.
- Engle, R. F. (2002) Dynamic conditional correlation – a simple class of multivariate GARCH models, *Journal of Business and Economic Statistics*, v.20, n.3, July
- Erkam, S., & Çetinkaya, M. (2014). Budget Deficits and Inflation: Evidence from Turkey. *The macro theme review*, 3(8), 12-22.
- Evans, D. S. (1987). Tests of alternative theories of firm growth. *Journal of political economy*, 95(4), 657-674.
- Ezirim, C. B., Amuzie, E., & Muoghalu, M. I. (2012). Autoregressive Distributed Lag Analysis of Interdependencies between Inflation and Exchange Rates in Sub-Saharan Nigeria. In *The IABPAD Conference Proceedings Dallas, Texas*, 9(2), 1082-1093.
- Fatima, G., Ahmed, M., & Rehman, W. (2012). Consequential effects of budget deficit on economic growth of Pakistan. *International Journal of Business and Social Science*, 3(7).
- Feldstein, M. (1974). Social security, induced retirement, and aggregate capital accumulation. *Journal of political economy*, 82(5), 905-926.
- Feldstein, M. S. (1986). The budget deficit and the dollar. *NBER Macroeconomics Annual*, 1, 355-392.

- Feldstein, M. (1995). The effect of marginal tax rates on taxable income: a panel study of the 1986 Tax Reform Act. *Journal of Political Economy*, 103(3), 551-572.
- Ferrando, G.M.L., & Vicente, L. (2007). The Lack of Fiscal Consolidation in an Inflationary Economy: Uruguay 1970–2006” in *Fiscal Policy: Current Issues and Challenges*. Banca d’Italia, pp. 415–458.
- Fitch Report (2014). <http://www.myjoyonline.com/business/2014/June-9th/bank-of-ghana-printing-money-to-fix-budget-deficit-fitch-claims.php>.
- Ford, R., & Laxton, D. (1999). World public debt and real interest rates. *Oxford Review of Economic Policy*, 15(2), 77-94.
- Frenkel, J. A., & Razin, A. (1987). The international transmission of fiscal expenditures and budget deficits in the world economy. In *Economic Policy in Theory and Practice* (pp. 51-100). *Palgrave Macmillan, London*.
- Friedman, B. M. (1978). Crowding out or crowding in? The economic consequences of financing government deficits.
- Friedman, M. (1968). Dollars and deficits; living with America's economic problems. *Prentice-Hall*.
- Ghana Statistical Service (2014). *Annual Report 2014*. Accra
- Granger, C. W. (1986). Developments in the study of cointegrated economic variables. *Oxford Bulletin of economics and statistics*, 48(3), 213-228.
- Grigorianm, D., Khachatryan, A., & Sargsyian, G. (2004). Exchange Rate, Money and Wages: Growth: Empirical Evidence from Ghana. *International Journal of Economics and Finance*,
- Gujarati, D. (1995). *Ekonometrika Dasar*. Jakarta: Penerbit Erlangga.
- Hakkio, C. S. (1996). The effects of budget deficit reduction on the exchange rate. *Economic Review-Federal Reserve Bank of Kansas City*, 81, 21-38.
- Hendry, D. F. (1986). Econometric modelling with cointegrated variables: an overview. *Oxford bulletin of economics and statistics*, 48(3), 201-212
- Hicks, J. (1980). *Causality in economics*. Canberra, ACT: Australian National University Press.
- Hoelscher, G. P. (1983). Federal borrowing and short term interest rates. *Southern Economic Journal*, 319-333.

- Hsin-Yi, L. & Hao-Pang, C. (2013). Are fiscal deficits inflationary?. *Journal of International Money and Finance* 32:214-233.
- Hudson, M. (2011). How economic theory came to ignore the role of debt. *Real-world economics review*, 57, 2-24.
- Immurana, M., Iddrisu, A. A., & Kyei-Brobbe, I. (2013). The Determinants of the Real Exchange Rate in Ghana: A Focus on Inflation Using a Bound Test Approach. *Journal of African Development and Resources Research Institute*, 3, 20-37.
- Immurana, M., Rahman, A. M. A., & Iddrisu, A. A. (2013). The Impact of Trade Liberalisation on Tax Revenue in Ghana: A Co-Integration Analysis. *Journal of Africa Development and Resources Research Institute*, 3(3), 1-19.
- International Monetary Fund (2010). International Financial Statistics online, <http://www.imf.org>, accessed various dates
- Institute of Economic Affairs (2008). Annual 2007 Economic Review and Outlook, Accra, Institute of Economic Affairs.
- Islam, R., & Wetzel, D. L. (1991). The macroeconomics of public sector deficits: The case of Ghana (No. 672). *World Bank Publications*.
- Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of economic dynamics and control*, 12(2-3), 231-254.
- Johansen, S. (1995). *Likelihood-based inference in cointegrated vector autoregressive models*. Oxford University Press on Demand.
- Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and statistics*, 52(2), 169-210.
- Kamin, S. B. (1997). A multi-country comparison of the linkages between inflation and exchange rate competitiveness.
- Kara, A., & Nelson, E. (2003). The exchange rate and inflation in the UK. *Scottish Journal of Political Economy*, 50(5), 585-608.
- Khan, M. N., & Zaman, S. (2012). Impact of macroeconomic variables on stock prices: Empirical evidence from Karachi stock exchange, Pakistan. *In Business, Economics, Financial Sciences, and Management* (pp. 227-233). Springer, Berlin, Heidelberg.
- Kormendi, R. C., & Protopapadakis, A. (2004). Budget Deficits, Current Account Deficits, and Interest Rates: The Systematic Evidence on Ricardian Equivalence. *Center for Society and Economy, Business School, University of Michigan*.

- Krugman, P. (1994). The myth of Asia's miracle. *Foreign affairs*, 62-78.
- Kuncoro, H. (2011). Fiscal Sustainability, Public Debt, and Economic Growth: the Case of Indonesia. *Journal of Applied Research in Finance*, 3(1), 50-61.
- Kuştepelı, Y., & Önel, G. (2005). Fiscal deficit sustainability with a structural break: An application to Turkey. Eastern Mediterranean University, *Review of Social, Economic and Business Studies*, 5-6.
- Kuttner, K., & Posen, A. (2004). Inflation, Transparency, and G3 Exchange Rate Volatility. *Institute for International Working Papers*, (6), 1-28.
- Larbi, D. A. (2012). The long term impact of budget deficits on economic growth in Ghana. *Journal of Business Research*, 6(2), 22-34.
- Laumas, G. S. (1989). Anticipated federal budget deficits, monetary policy and the rate of interest. *Southern Economic Journal*, 375-382.
- Lütkepohl, H. (1991). VAR processes with parameter constraints. In *Introduction to Multiple Time Series Analysis* (pp. 167-214). Springer, Berlin, Heidelberg.
- Makin, J. H. (1983). Real interest, money surprises, anticipated inflation and fiscal deficits. *The Review of Economics and Statistics*, 374-384.
- Marshal, A. (1890). The principles of economics; an introductory volume.
- Miller, P. J. (1983). Higher deficit policies lead to higher inflation. *Quarterly Review*, (Win).
- Moraa, M. E. (2014). Institutional factors influencing access to credit by youth-owned micro and small enterprises in Kenya: The case of Embakasi South constituency. *Unpublished UON thesis*.
- Mundle, S., Bhanumurthy, N.R., & Das, S. (2011). Fiscal consolidation with high growth: A policy simulation model for India. *Economic Modelling*, 28(6), 2657–2668
- Nachege, M. J. C. (2005). Fiscal dominance and inflation in the Democratic Republic of the Congo *International Monetary Fund*. (No. 5-221).
- Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. *Applied economics*, 37(17), 1979-1990.
- Narayan, P.K., & Smyth, R. (2006) Dead Man Walking: An Empirical Reassessment of the Deterrent Effect of Capital Punishment Using the Bounds Testing Approach to Cointegration. *Applied Economics*, 38, 1975

- Nchor D., & Darkwah S. A. (2015). Inflation, Exchange Rates and Interest Rates in Ghana: an Autoregressive Distributed Lag Model. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 63(3): 969–977
- Ndung'u, N. S. (1997). Price and exchange rate dynamics in Kenya: an empirical investigation (1970-1993). *Research paper/African Economic Research Consortium*; 58.
- Nkrumah, K. O., Orkoh, E., & Owusu, A. M. (2016). Exploring the budget deficit-economic growth nexus: new evidence from Ghana. *Journal for the Advancement of Developing Economies*
- Nucu, A. E. (2011). The Relationship between Exchange Rate and Key Macroeconomic Indicators. Case Study: Romania. *The Romanian Economic Journal*, 41, 127-145.
- Obi, B., Nurudeen, A., & Wafure, O. B. (2009). An empirical investigation of the Fisher effect in Nigeria: a cointegration and error correction approach. *International Review of Business Research Papers*, 5(5), 96-109.
- Oladipo, S. O., & Akinbobola, T. O. (2011). Budget deficit and inflation in Nigeria: A causal relationship. *Journal of Emerging Trends in Economics and Management Sciences*, 2(1), 1-8.
- Olczyk, M., & Kordalska, A. (2017). International Competitiveness of Czech Manufacturing-A Sectoral Approach with Error Correction Model. *Prague Economic Papers*, 2017(2), 213-226.
- Patinkin, D. (1965). *Money, interest, and prices; an integration of monetary and value theory* (No. 04; HG221, P3 1965)..
- Pattnaik, S. & Mitra A. K. (2001), —Interest Rate Defence of Exchange Rate: Tale of the Indian Rupee, *Economic and Political Weekly*, November 24, pp. 4418- 4427.
- Persson T. (1985) 'Deficits and intergenerational welfare in open economies.' *Journal of International Economics* 19, 1-19
- Pesaran, H. M., & Shin, Y. (1995). *Long-run structural modelling* (No. 9419). Faculty of Economics, University of Cambridge.
- Pesaran, M. H., Shin, Y., & Smith, R. J. (1996). *Testing for the 'Existence of a Long-run Relationship'* (No. 9622). Faculty of Economics, University of Cambridge.
- Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621-634.
- Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, 16(3), 289-326.

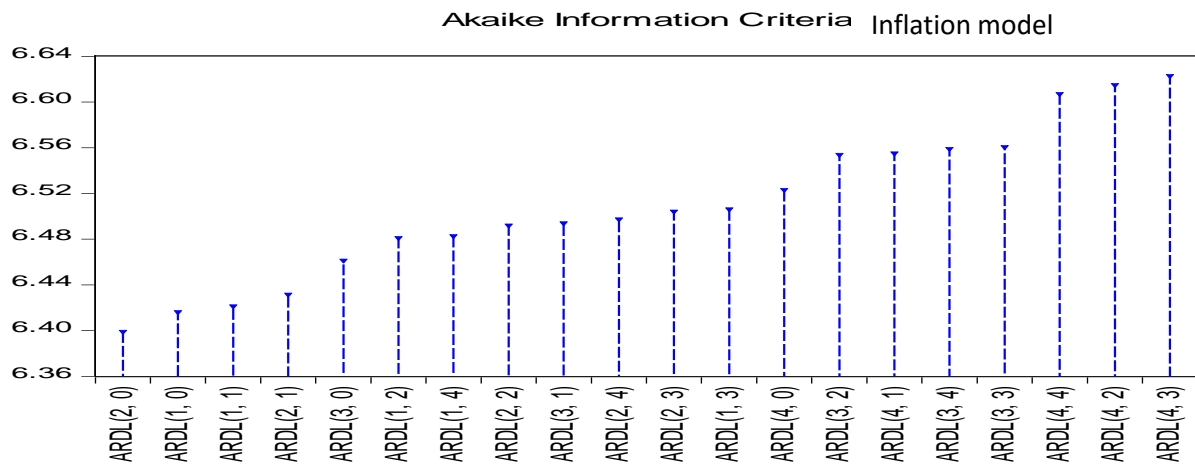
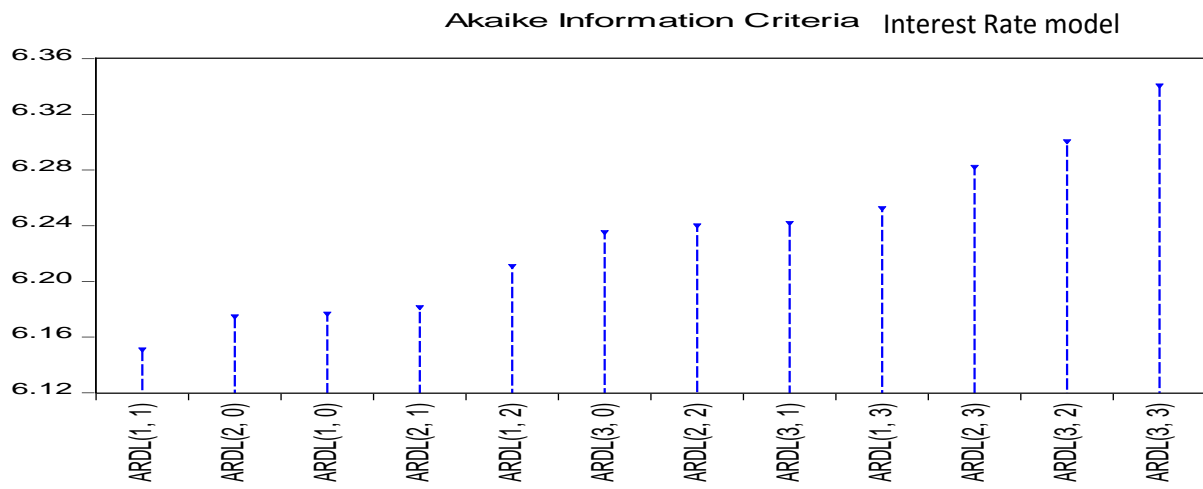
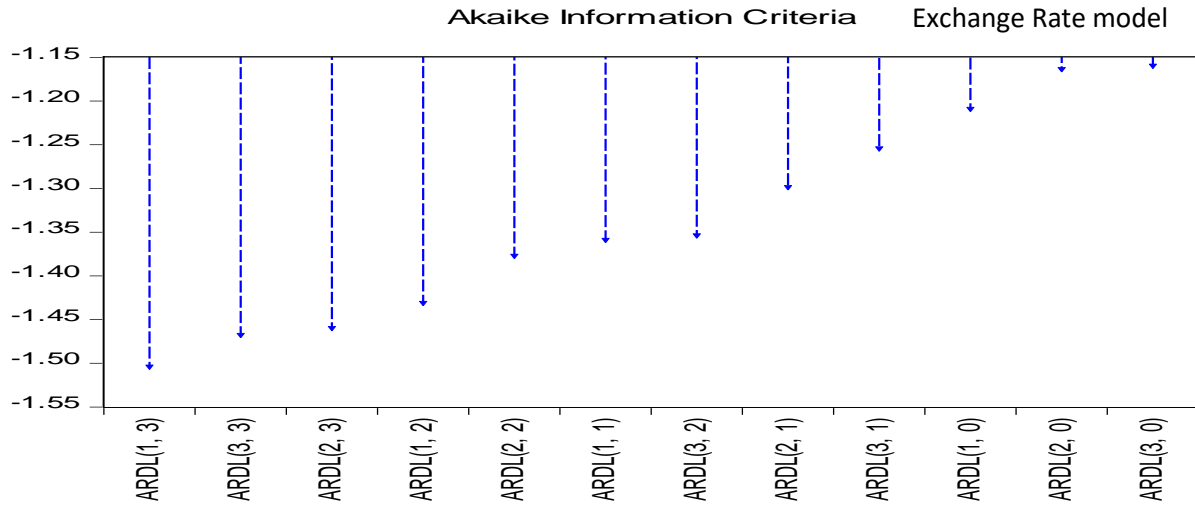
- Phillips, P. C., & Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I (1) processes. *The Review of Economic Studies*, 57(1), 99-125.
- Pomeyie, P. (2001). *Macroeconomics: An Introductory Textbook*. Accra, Wade Laurel co.
- PriceWaterhouse Coopers (2017). 2017 Budget Highlights. Accra, *Pricewaterhouse Coopers*.
- Rahman, N. H. A. (2012). The relationship between budget deficit and economic growth from Rate Volatility. Peterson Institute *Working Paper No. 00-06*.
- Reinhart, C., & Calvo, G. (2000). When capital inflows come to a sudden stop: Consequences and policy options.
- Ricardo, D. (1951). On the principles of political economy and taxation, ed. P. Sraffa. Works and Correspondence of David Ricardo,
- Risti, L. C., Nicolaescu, C., & Tagaduan, D. (2013). Budget Deficits Effects on Economic Growth. *Journal of Economics and Business Research*, 19(1), 162-170.
- Sargent, T. J., & Wallace, N. (1981). Some unpleasant monetarist arithmetic. *Federal Reserve Bank of minneapolis quarterly review*, 5(3), 1-17.
- Sachs, J. (1986). The debt overhang of the developing countries.
- Saysombath, P., & Kyophilavong, P. (2013). Twin deficits in the lao PDR: An empirical study. *International Business and Management*, 7(1), 69-72.
- Sheriff, I., & Amoako, G. (2014). Macroeconomic determinants of interest rate spread in Ghana: Evidence from ARDL modelling approach. *Journal of Finance and Bank Management*, 2(2), 115-132.
- Sowa, N., & Kwakye, J. (1993). Inflationary trends and control in Ghana.
- Straub, R., & Tchakarov, I. (2007). *Assessing the impact of a change in the composition of public spending: A DSGE approach* (No. 2007-2168). International Monetary Fund.
- Turnovsky, S. (1986). Optimal monetary policy and wage indexation under alternative disturbances and information structures.
- Utami, S. R., & Inanga, E. L. (2009). The Pecking Order Theory: Evidence from Manufacturing Firms in Indonesia. *Independent Business Review*, 1(1), 1-18.
- Van, V. B., & Sudhipongpracha, T. (2015). Exploring government budget deficit and economic growth: Evidence from Vietnam's economic miracle. *Asian Affairs: An American Review*, 42(3), 127-148.

- Vicente, L., & Licandro, F. G. (2007). The Lack of Fiscal Consolidation in an Inflationary Economy: Uruguay 1970-2006.
- Wallace, N. (1981). A Modigliani-Miller theorem for open-market operations. *The American Economic Review*, 71(3), 267-274.
- Xiomara, A., & Greenidge, K. (2003). Debt and Fiscal Sustainability in Barbados. *Bridgetown: Central Bank of Barbados*, 96.
- Zahid, K. H. (1988). Government budget deficits and interest rates: the evidence since 1971, using alternative deficit measures. *Southern Economic Journal*, 725-731.
- Zietz, J., & Pemberton, D. K. (1990). The US budget and trade deficits: A simultaneous equation model. *Southern Economic Journal*, 23-34.
- Zuze, M. (2016). Fiscal Deficit-Economic Growth Nexus in Zimbabwe: A Vector Regression Analysis. *International Journal of Innovative Research and Development*, 5(6).

APPENDIX

APPENDIX A

Model Selection



APPENDIX B

VECTOR AUTOREGRESSIVE RESULT

Vector Autoregression Estimates

Date: 07/25/18 Time: 15:55

Sample (adjusted): 1983 2017

Included observations: 35 after adjustments

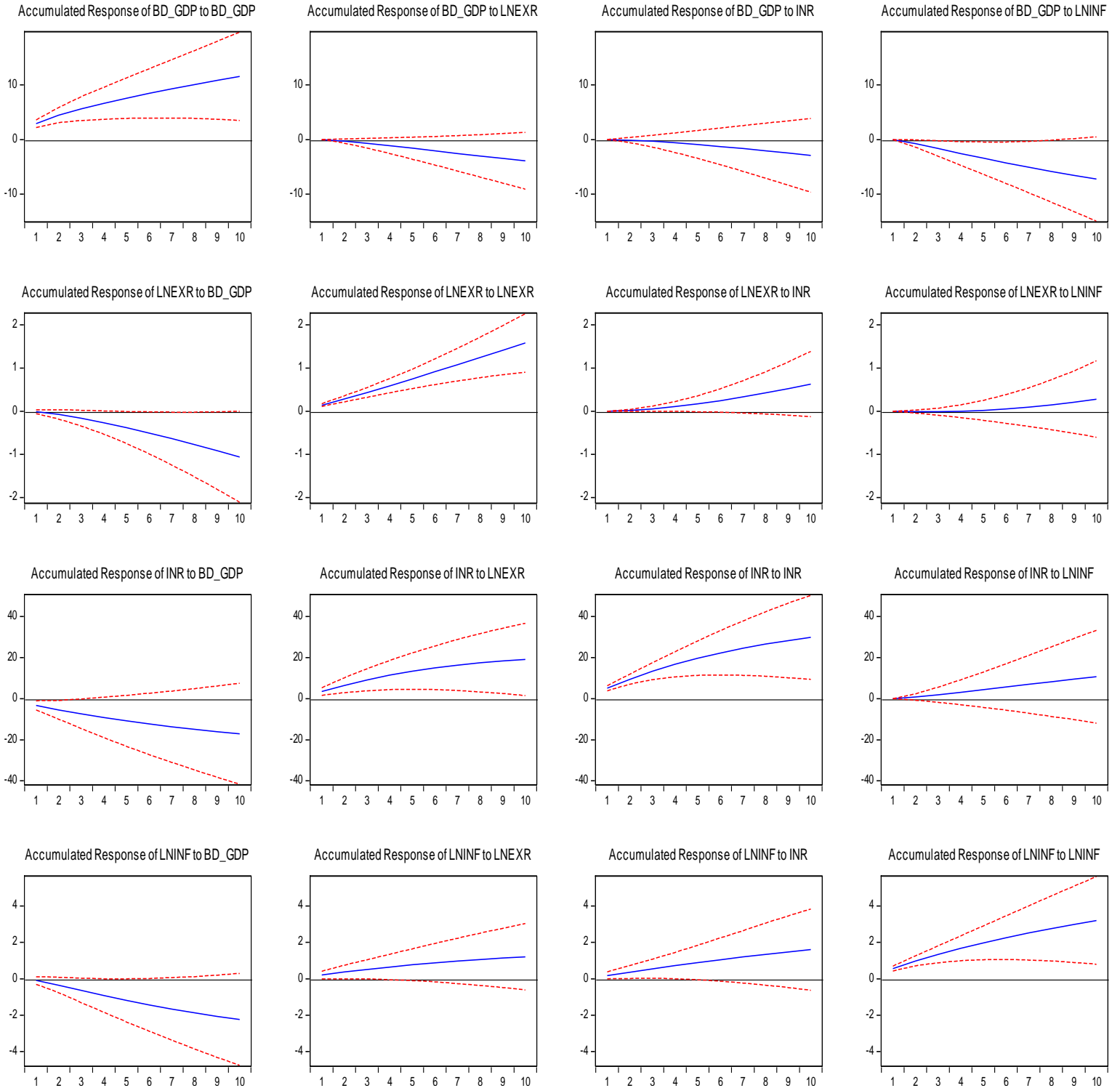
Standard errors in () & t-statistics in []

	BD_GDP	LNEXR	INR	LNINF
BD_GDP(-1)	0.410592 (0.16659) [2.46476]	-0.010709 (0.00820) [-1.30547]	0.486073 (0.38841) [1.25144]	0.001572 (0.02960) [0.05311]
LNEXR(-1)	-0.738658 (0.33148) [-2.22839]	0.940579 (0.01632) [57.6208]	-0.351045 (0.77287) [-0.45421]	-0.150358 (0.05890) [-2.55281]
INR(-1)	0.020105 (0.05204) [0.38631]	0.004622 (0.00256) [1.80350]	0.839766 (0.12135) [6.92043]	0.011637 (0.00925) [1.25836]
LNINF(-1)	0.112756 (1.07208) [0.10517]	-0.057627 (0.05279) [-1.09154]	-2.445709 (2.49966) [-0.97842]	0.061489 (0.19049) [0.32279]
C	-4.676095 (3.00056) [-1.55841]	0.134799 (0.14776) [0.91227]	12.63347 (6.99609) [1.80579]	2.275491 (0.53316) [4.26795]
R-squared	0.572511	0.996221	0.648513	0.391401
Adj. R-squared	0.515513	0.995717	0.601649	0.310254
Sum sq. resids	244.2785	0.592394	1327.985	7.712462
S.E. equation	2.853527	0.140522	6.653283	0.507033
F-statistic	10.04433	1977.021	13.83794	4.823379
Log likelihood	-83.66467	21.71844	-113.2941	-23.19391
Akaike AIC	5.066552	-0.955339	6.759662	1.611081
Schwarz SC	5.288745	-0.733147	6.981854	1.833273
Mean dependent	-4.377714	-1.439880	23.81031	2.979043
S.D. dependent	4.099595	2.147154	10.54151	0.610508
Determinant resid covariance (dof adj.)		0.885677		
Determinant resid covariance		0.478066		
Log likelihood		-185.7363		
Akaike information criterion		11.75636		
Schwarz criterion		12.64513		
Number of coefficients		20		

APPENDIX C

IMPULSE RESPONSE

Accumulated Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.



APPENDIX D

Table 4.5.5 Variance Decomposition

Variance Decomposition of BD_GDP:					
Period	S.E.	BD_GDP	LNEXR	INR	LNINF
1	2.853527	100.0000	0.000000	0.000000	0.000000
2	3.068274	99.82362	0.004164	0.142944	0.029271
3	3.107649	99.63113	0.041375	0.294086	0.033413
4	3.119414	99.44924	0.123796	0.392250	0.034719
5	3.125612	99.27347	0.249453	0.440400	0.036674
6	3.130487	99.09036	0.411840	0.457302	0.040498
7	3.135126	98.89051	0.603105	0.459539	0.046846
8	3.139854	98.67071	0.815294	0.458161	0.055835
9	3.144744	98.43230	1.041002	0.459484	0.067210
10	3.149772	98.17921	1.273729	0.466540	0.080525

Variance Decomposition of LNEXR:					
Period	S.E.	BD_GDP	LNEXR	INR	LNINF
1	0.140522	0.147381	99.85262	0.000000	0.000000
2	0.205719	5.757244	91.94682	0.595137	1.700803
3	0.259761	9.152258	86.66315	1.532255	2.652338
4	0.306215	10.85563	83.35865	2.559050	3.226665
5	0.346908	11.65433	81.14898	3.578323	3.618368
6	0.382993	11.98665	79.55839	4.547816	3.907139
7	0.415238	12.07780	78.34300	5.448736	4.130461
8	0.444183	12.04437	77.37287	6.274148	4.308617
9	0.470236	11.94816	76.57446	7.023544	4.453831
10	0.493717	11.82271	75.90333	7.699889	4.574070

Variance Decomposition of INR:					
Period	S.E.	BD_GDP	LNEXR	INR	LNINF
1	6.653283	17.70194	24.80099	57.49707	0.000000
2	8.213253	13.04778	24.51550	60.51485	1.921868
3	9.057418	10.77679	24.35759	62.08758	2.778042
4	9.570063	9.662976	24.14593	63.01721	3.173883
5	9.892152	9.084088	23.90623	63.63370	3.375978
6	10.09621	8.773021	23.67017	64.07208	3.484729
7	10.22517	8.607435	23.45646	64.39253	3.543583
8	10.30602	8.525257	23.27434	64.62623	3.574177
9	10.35619	8.492037	23.12718	64.79234	3.588443
10	10.38701	8.487404	23.01475	64.90446	3.593385

Variance Decomposition of LNINF:					
Period	S.E.	BD_GDP	LNEXR	INR	LNINF
1	0.507033	0.028395	9.163966	6.498906	84.30873
2	0.513598	0.298980	9.205129	8.018112	82.47778
3	0.515924	0.302127	9.147721	8.794178	81.75597
4	0.517275	0.320969	9.100388	9.230393	81.34825
5	0.518146	0.368658	9.076332	9.473090	81.08192
6	0.518756	0.426449	9.080394	9.600104	80.89305
7	0.519232	0.484596	9.112625	9.658167	80.74461
8	0.519655	0.539472	9.170168	9.676438	80.61392
9	0.520067	0.589977	9.248757	9.673251	80.48801
10	0.520490	0.635947	9.343695	9.659995	80.36036

Cholesky Ordering: BD_GDP LNEXR INR LNINF

APPENDIX E

INFLATION TRANSITION ITERATION

$$P_{ij}^{(1)} = \begin{pmatrix} 0.923000 & 0.077000 & 0.000000 \\ 0.017000 & 0.955000 & 0.028000 \\ 0.000000 & 0.051000 & 0.949000 \end{pmatrix}$$

$$P_{ij}^{(2)} = \begin{pmatrix} 0.853367 & 0.144472 & 0.002161 \\ 0.031654 & 0.914857 & 0.053489 \\ 0.000857 & 0.096824 & 0.902319 \end{pmatrix}$$

$$P_{ij}^{(3)} = \begin{pmatrix} 0.790159 & 0.203732 & 0.006109 \\ 0.044638 & 0.878895 & 0.076467 \\ 0.002423 & 0.138419 & 0.859158 \end{pmatrix}$$

$$P_{ij}^{(4)} = \begin{pmatrix} 0.732811 & 0.255668 & 0.011521 \\ 0.056017 & 0.846716 & 0.097267 \\ 0.004569 & 0.17607 & 0.81936 \end{pmatrix}$$

$$P_{ij}^{(5)} = \begin{pmatrix} 0.68075 & 0.301133 & 0.018117 \\ 0.065979 & 0.817916 & 0.116106 \\ 0.007185 & 0.210171 & 0.782644 \end{pmatrix}$$

$$P_{ij}^{(6)} = \begin{pmatrix} 0.63346 & 0.340885 & 0.025655 \\ 0.074688 & 0.792134 & 0.133177 \\ 0.010175 & 0.241073 & 0.748752 \end{pmatrix}$$

$$P_{ij}^{(7)} = \begin{pmatrix} 0.590477 & 0.375597 & 0.033926 \\ 0.082294 & 0.76905 & 0.148656 \\ 0.013455 & 0.269093 & 0.717451 \end{pmatrix}$$

$$P_{ij}^{(8)} = \begin{pmatrix} 0.551386 & 0.405863 & 0.042751 \\ 0.088925 & 0.748375 & 0.16270 \\ 0.016956 & 0.294515 & 0.68853 \end{pmatrix}$$

$$P_{ij}^{(9)} = \begin{pmatrix} 0.515812 & 0.43221 & 0.051978 \\ 0.094698 & 0.729853 & 0.175449 \\ 0.020615 & 0.317592 & 0.661793 \end{pmatrix}$$

$$P_{ij}^{(10)} = \begin{pmatrix} 0.483419 & 0.455105 & 0.061476 \\ 0.099714 & 0.713257 & 0.187029 \\ 0.024382 & 0.338555 & 0.637063 \end{pmatrix}$$

$$P_{ij}^{(11)} = \begin{pmatrix} 0.453903 & 0.474963 & 0.071134 \\ 0.104065 & 0.69838 & 0.197555 \\ 0.028212 & 0.357608 & 0.61418 \end{pmatrix}$$

$$P_{ij}^{(12)} = \begin{pmatrix} 0.426993 & 0.492149 & 0.080858 \\ 0.10783 & 0.685043 & 0.207127 \\ 0.032069 & 0.374935 & 0.592996 \end{pmatrix}$$

$$P_{ij}^{(13)} = \begin{pmatrix} 0.402442 & 0.506987 & 0.090571 \\ 0.111081 & 0.673081 & 0.215838 \\ 0.035922 & 0.390703 & 0.573375 \end{pmatrix}$$

$$P_{ij}^{(14)} = \begin{pmatrix} 0.380029 & 0.519763 & 0.100207 \\ 0.113881 & 0.662349 & 0.22377 \\ 0.039743 & 0.405061 & 0.555195 \end{pmatrix}$$

$$P_{ij}^{(15)} = \begin{pmatrix} 0.359556 & 0.530732 & 0.109712 \\ 0.116284 & 0.652719 & 0.230997 \\ 0.043513 & 0.418144 & 0.538343 \end{pmatrix}$$

$$P_{ij}^{(315)} = \begin{pmatrix} 0.1236786469 & 0.5644820296 & 0.3118393234 \\ 0.1236786469 & 0.5644820296 & 0.3118393235 \\ 0.1236786469 & 0.5644820296 & 0.3118393235 \end{pmatrix}$$

$$P_{ij}^{(316)} = \begin{pmatrix} 0.1236786469 & 0.5644820296 & 0.3118393235 \\ 0.1236786469 & 0.5644820296 & 0.3118393235 \\ 0.1236786469 & 0.5644820296 & 0.3118393235 \end{pmatrix}$$

APPENDIX F

Inflation Distribution Base on Definition of Limiting Distribution

$$\pi = \pi p \Rightarrow (x \ y \ z) = (x \ y \ z) \begin{pmatrix} \frac{36}{39} & \frac{3}{39} & 0 \\ \frac{3}{178} & \frac{170}{178} & \frac{5}{178} \\ 0 & \frac{6}{118} & \frac{112}{118} \end{pmatrix} \dots\dots\dots (1)$$

$$x + y + z = 1 \dots\dots\dots (2)$$

Simplification of equation (1) gives the following

$$\frac{36}{39} x + \frac{3}{178} y = x$$

$$\frac{3}{39} x + \frac{170}{178} y + \frac{6}{118} z = y$$

$$\frac{5}{178} y + \frac{112}{118} z = z$$

Now substituting the constraint into the three equations above we have:

$$\frac{651}{6942} y + \frac{1}{13} z = \frac{1}{13} \dots\dots\dots (a)$$

$$\frac{423}{3471} x + \frac{1006}{10502} z = \frac{4}{89} \dots\dots\dots (b)$$

$$\frac{3}{59} x + \frac{829}{10502} y = \frac{3}{59} \dots\dots\dots (c)$$

Solving equation (a), (b) and (c) simultaneously we get:

$$x = \frac{117}{946} \qquad y = \frac{267}{473} \qquad z = \frac{295}{946}$$

APPENDIX G

EXCHANGE RATE TRANSITION ITERATION

$$P_{ij}^{(1)} = \begin{pmatrix} 0.92000 & 0.01000 & 0.07000 \\ 0.75000 & 0.25000 & 0.00000 \\ 0.55000 & 0.06000 & 0.39000 \end{pmatrix}$$

$$P_{ij}^{(2)} = \begin{pmatrix} 0.890708 & 0.020019 & 0.089273 \\ 0.876276 & 0.072704 & 0.05102 \\ 0.761258 & 0.046448 & 0.192294 \end{pmatrix}$$

$$P_{ij}^{(3)} = \begin{pmatrix} 0.881706 & 0.022534 & 0.09576 \\ 0.8871 & 0.03319 & 0.07971 \\ 0.838838 & 0.033623 & 0.127538 \end{pmatrix}$$

$$P_{ij}^{(4)} = \begin{pmatrix} 0.878863 & 0.023433 & 0.097704 \\ 0.883054 & 0.025198 & 0.091748 \\ 0.865146 & 0.027548 & 0.107306 \end{pmatrix}$$

$$P_{ij}^{(5)} = \begin{pmatrix} 0.877987 & 0.023737 & 0.098276 \\ 0.879911 & 0.023874 & 0.096215 \\ 0.873713 & 0.025161 & 0.101126 \end{pmatrix}$$

$$P_{ij}^{(6)} = \begin{pmatrix} 0.877722 & 0.023836 & 0.098442 \\ 0.878468 & 0.023771 & 0.097761 \\ 0.87642 & 0.024306 & 0.099274 \end{pmatrix}$$

$$P_{ij}^{(7)} = \begin{pmatrix} 0.877643978 & 0.023866915 & 0.098489106 \\ 0.877908823 & 0.02381967 & 0.098271507 \\ 0.877254541 & 0.024017257 & 0.098728202 \end{pmatrix}$$

$$P_{ij}^{(8)} = \begin{pmatrix} 0.877621089 & 0.0238765 & 0.098502411 \\ 0.877710189 & 0.023855104 & 0.098434706 \\ 0.877506615 & 0.023923278 & 0.098570108 \end{pmatrix}$$

$$P_{ij}^{(9)} = \begin{pmatrix} 0.877614514 & 0.023879391 & 0.098506095 \\ 0.877643364 & 0.023871151 & 0.098485485 \\ 0.877581393 & 0.023893631 & 0.098524976 \end{pmatrix}$$

$$P_{ij}^{(10)} = \begin{pmatrix} 0.877612653 & 0.023880248 & 0.098507099 \\ 0.877621727 & 0.023877331 & 0.098500942 \\ 0.877603215 & 0.023884501 & 0.098512284 \end{pmatrix}$$

$$P_{ij}^{(19)} = \begin{pmatrix} 0.8776119403 & 0.0238805970 & 0.0985074627 \\ 0.8776119404 & 0.0238805969 & 0.0985074626 \\ 0.8776119403 & 0.0238805971 & 0.0985074627 \end{pmatrix}$$

$$P_{ij}^{(20)} = \begin{pmatrix} 0.8776119403 & 0.0238805970 & 0.0985074627 \\ 0.8776119403 & 0.0238805970 & 0.0985074627 \\ 0.8776119403 & 0.0238805970 & 0.0985074627 \end{pmatrix}$$

APPENDIX H

Exchange Rate distribution base on definition of limiting distribution

$$\pi = \pi p \Rightarrow (x \ y \ z) = (x \ y \ z) \begin{pmatrix} \frac{270}{294} & \frac{4}{294} & \frac{20}{294} \\ \frac{6}{8} & \frac{2}{8} & 0 \\ \frac{18}{33} & \frac{2}{33} & \frac{13}{33} \end{pmatrix} \dots \dots \dots (1)$$

$$x + y + z = 1 \dots \dots \dots (2)$$

Simplification of equation (1) gives the following

$$\frac{270}{294} x + \frac{6}{8}y + \frac{18}{33} z = x$$

$$\frac{4}{294} x + \frac{2}{8}y + \frac{2}{33}z = y$$

$$\frac{20}{294} x + \frac{13}{33}z = z$$

Now substituting the constraint into the three equations above we have:

$$\frac{163}{196} y + \frac{338}{539}z = \frac{4}{49} \dots \dots \dots (a)$$

$$\frac{449}{588} x + \frac{107}{132}z = \frac{3}{4} \dots \dots \dots (b)$$

$$\frac{1090}{1617} x + \frac{20}{33}y = \frac{20}{33} \dots \dots \dots (b)$$

Solving equation (a), (b) and (c) simultaneously we get:

$$X = \frac{294}{335} \qquad y = \frac{8}{335} \qquad z = \frac{33}{335}$$