

**TOTAL DEBT SERVICING AND MACROECONOMIC PERFORMANCE IN KENYA**

**JOSHUA MAGERO OTIENO**

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**DECLARATION**

This research project is my original work and has not been presented for award of a degree or any other award in any other university.

JOSHUA MAGERO OTIENO

B. Economics and Statistics

Reg.No K102/24528/2013

Signature .....

Date.....

This research project has been submitted to the department of Econometrics and Statistics, Kenyatta University, with our approval as university supervisors.

Signature.....

Date.....

Dr. Angelica Njuguna (Ph.D)

Department of econometrics and statistics

Kenyatta University

Nairobi, Kenya

Signature.....

Date .....

Dr. Jeniffer Njaramba (Ph.D)

Department of econometrics and statistics

Kenyatta University

Nairobi, Kenya

## **DEDICATION**

To my lovely mum Susan and my deceased father John and mentor Elijah Aduke in absentia.

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I am grateful to God the Almighty for his marvelous grace, daily guidance and providence to this end .To Him be the glory forever and ever. I would like to acknowledge the relentless support and sacrifice from my mum in seeing me through this investment. I express my sincere gratitude to my supervisors, Dr. Angelica and Dr. Njaramba for their intellectual contribution towards having this write-up. Their positive criticisms and advice were invaluable in this course. I cannot thank them enough for having agreed to invest time out of their busy schedules and for being so patient with me just to see into the completion of this proposal.

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## ABSTRACT

Kenya seeks to meet the Millennium Development Goals, under the guidance of *The Kenya Vision 2030*. The leading challenge to this course remains the soaring debt servicing obligations, capturing a significant portion of the national budget. Kenya has been borrowing externally at higher rates and continually expanding the debt ceiling. The government will therefore in future spend a significant portion of its revenue repaying the debts at the cost of important local investment. The government is therefore limited to fully fund critical sectors of the economy that will spur sustainable growth and increased investment opportunities; key to widening the tax base. This has an overall implication on the country's revenue, income, employment and poverty level.

This study aimed at determining the long-run relationship between total debt service and selected macroeconomic variables and to analyze the dynamic response of the variables following innovations in total debt service. Long run equations expressing the relationship between total debt service and real Gross Domestic Product, Real effective Exchange Rate and private investment were estimated. The results showed evidence of crowding out effect but no existence of debt overhang. Kenya was also found to have weak policy institutions thus remained vulnerable to adverse global exogenous shocks. In analyzing the dynamic impact of innovations in debt servicing on selected macroeconomic variables, a Vector Autoregressive (VAR) model was estimated with subsequent derivation of the Impulse Response Functions (IRF) and Variance Decompositions that explained the dynamics of the model. Based on the results, the impact of an unexpected shock in total debt service in the economy lasts for more than ten years to fully decay. The study tested time series behaviours like presence of unit root and serial correlation in the data to guard against spurious results. A string of diagnostic tests were also undertaken to establish the predictive power of the models. The Akaike Information Criterion (AIC) was used to determine the optimal lag length of the variables included in the VAR model.

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## ABBREVIATIONS

GDP	Gross Domestic Product
IMF	International Monetary Fund
HIPC	Highly Indebted Poor Countries
MDRI	Multilateral Debt Relief Initiatives
MDG	Millennium Development Goals
DSA	Debt Sustainability Analysis
ERS	Economic Recovery Strategy
MTDS	Medium Term Debt Strategy
OLS	Ordinary Least Squares
VAR	Vector Autoregression
IRF	Impulse Response Functions
VDA	Variance Decomposition Analysis
EMU	European Monetary Union
ARDL	Autoregressive Distributed Lag Model
RGDP	Real Gross Domestic Product
NX	Net Exports
TDS	Total Debt Service
RER	Real Exchange Rate
RIR	Real Interest Rate
PIGR	Private Investment Growth Rate
PI	Private Investment
INFL	Inflation

## OPERATIONAL DEFINITION OF TERMS

**Debt crisis** – occurs when a country with a weak economy is not able to repay external debt, or can do so at unacceptably high costs owing to the dynamics of the debt and its servicing requirements.

**Macroeconomic performance** – an assessment of how well a country is doing in reaching key objectives of government policy in terms of variables such as economic growth, inflation, investment, consumption and employment.

**External debt ceiling**- also referred to as debt limit in this study; refers to the maximum amount a country can borrow from foreign lenders.

**Debt sustainability**- the ability of a country to meet its debt obligations without requiring debt relief or accumulating arrears.

**Debt overhang hypothesis**- a debt burden that is so large that a country cannot take on additional debt to finance future projects, even when those that have higher returns enough to enable it reduce its indebtedness over time.

**Liquidity constraints theory**- When a country's debt service burden is so heavy that a significant portion of its current output accrues to foreign lenders and creates disincentive to invest.

**Gross Domestic Product**; The monetary value of all the finished goods and services produced within a country's borders in a specific time- period (calculated on an annual basis). It includes all of private and public consumption, government outlays, investments, and exports less imports that occur within a defined territory.

**Debt Burden-** when a county's external debt portfolio is so large that its servicing costs is too high.

**Vector Autoregression-** a forecasting technique in economics that treats all variables symmetrically but is concerned with the path through time of a vector of variables.

**Private investment:** additions to capital stock less depreciation attributed to non-public sector.

**Private consumption:** the use of goods and services such that they are not available for future use by the non-public sector.

**Exchange rate:** the price of a currency in terms of another superior currency.

**Inflation:** a sustained increase in the general price level of an economy.

**Causality:** the ability of past values of a variable to predict the future value of another variable.

## **CHAPTER ONE: INTRODUCTION**

### **1.1Background**

Debt servicing, refers to the portion of national budget funds allocated for paying a country's debt obligation, including the principal payments and interest payments (Republic of Kenya, 2014). High cost of debt servicing has an implication on the social and economic sectors' investments and ultimately on the overall output of an economy. The overall output of an economy can be disaggregated into four components: private consumption, private investment, government spending and net exports (Njuguna, 2008).

An assessment of how well a country is doing in reaching key objectives of government policy in terms of variables such as economic growth, inflation, investment, consumption and employment constitutes macroeconomic performance (Kosimbei, 2009). It is measured using an index of macroeconomic stability or the growth of annual Gross Domestic Product (GDP). Macroeconomic stability reflected by low and stable inflation, sustainable debt to GDP ratio and appropriate exchange rates-sends important signal to the private sector about the soundness of economic policies and credibility of the authorities' commitment to manage the economy efficiently (Ghura and Hadjimichael, 1996).

Developing countries having insufficient domestic savings will essentially acquire financial aid to bridge the resource gaps (Ihoya, 1999). Over the past decades; the 1980s to the mid-2000s rising debt levels raised concerns for many developing nations. This was evidenced by the Highly Indebted Poor Countries Initiative (HIPC's): an emblem of African countries' struggle to tackle the debt problem (Awiti, 2015). By 2003, 19 out of 23 beneficiaries of the HIPC's

initiative were from sub-Saharan Africa. This initiative aimed at getting the world's rich countries forgive debts owed to them by very poor countries and who were overwhelmed by its servicing, which they could only sustain at an unacceptably very high social and environmental costs (Cunningham, 1993). The eligibility of beneficiary countries under this initiative was based on a good track record of reforms, pursuance of sound policies and ability to translate the resources into better prospects for the poor, despite its relatively high level of external debt to GDP ratio. Kenya did not benefit from this programme because its debt ratios were relatively lower and it could meet the debt obligations without requiring debt relief (Njuguna, 2008).

Today, rising debt level is a global concern and no longer a problem exclusively associated with developing countries. Developed economies in the European Monetary Union badly hit by the financial crisis of 2008, like Greece, Ireland, Italy, Portugal and Spain (also known by the acronym, GIIPS) have been grappling with the challenge of debt. These countries have debt ratios of 177.2 percent, 121 percent, 135.2 percent and 100.2 percent respectively. The two big economies, France and Germany have debt ratios of 95.6 percent and 76 percent respectively. On average, the European monetary union (EMU) states have a debt ratio of 96 per cent. Kenya's debt-to-GDP ratio stands at 46 per cent (World Bank statistics, 2014).

Relatively, Kenya looks modest though it does not mean that the country is better off. Joint World Bank and IMF debt sustainability analysis (DSA) in April 2013 concluded that Kenya's debt is sustainable relative to the total size and productivity of the economy since the macroeconomic fundamentals are strong (World Bank, 2013). However, fears are being expressed that the persistent rise in external debt could jeopardize the sustainability situation and stability in the debt markets. The current trend of Kenya's debt has elicited mixed reactions

among experts and policy makers. While some people feel that its high time Kenya put an eye on borrowing, others feel that compared to other developing economies in Europe, the country is relatively performing well and that there is no cause for alarm yet.

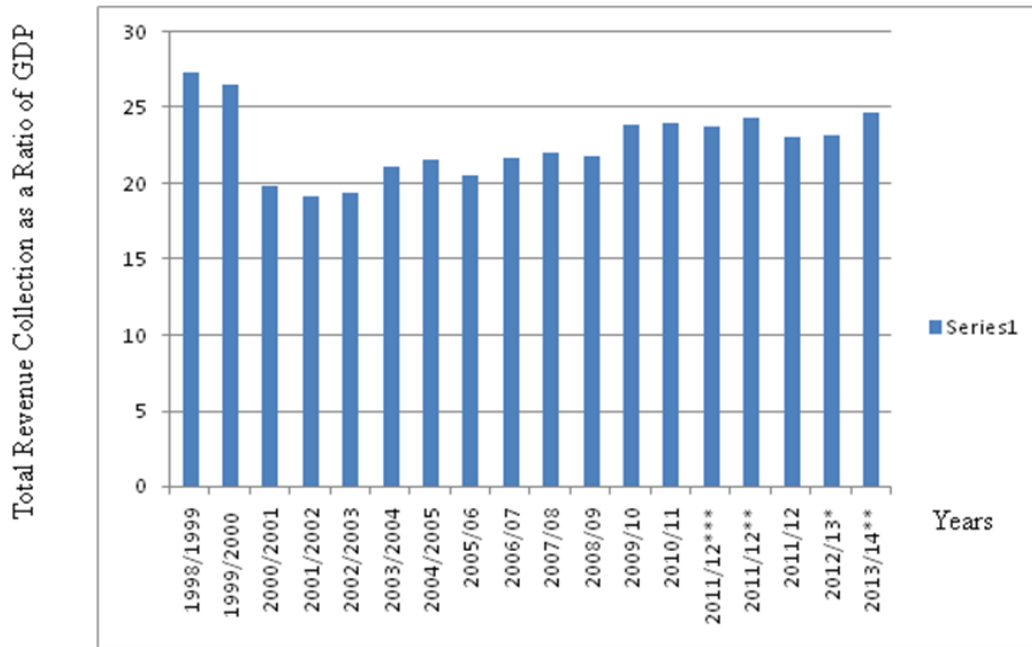
The critical issue is the effect of rising debt stock, with its servicing requirements on the economy since debt is generally easy to accumulate but difficult to shrivel in the long- run (Claessens *et al*, 1996). The question remains how much debt the economy can carry in the long term with reference to the risks associated with large debt portfolios and its future repayment ability. Debt portfolio above 40 per cent signifies less quality institutions and may pose substantial risk to the national budget and the country's financial stability (Awiti, 2015). If not managed prudently, it poses risk to the budget and can lead to risk of default and large economic losses beside undermining investor sentiment and sparking financial instability and increasing a country's susceptibility to crisis (Sachs, 2002).

High levels of public debt are not sustainable in the long term (Were, 2001). While the ideal situation is to spend only what the country is able to raise in taxes, this may not be realistic. It is therefore of essence to assess the effect of rising debt levels on the government's future spending. Rising debt means that the government will in future spend most of its revenue repaying it at the cost of important local investment. This was the case for the HIPC countries before they got the much-needed relief (Were, 2001). Important investments, such as infrastructure development, are sacrificed as debt repayment takes a significant share of budgetary allocation. This has an effect on income levels and may lead to rising unemployment. Concentrating more funds on debt servicing rather than in the social and economic sectors means

the government will be to fully fund critical sectors of the economy that will spur the intended growth and open up more investment opportunities; key to widening the tax base (Awiti, 2015). This has an overall implication on revenue yield.

A critical examination of the expenditure scenario of the Kenyan economy reveals dismal improvements in revenue collection and ever-growing budgetary needs (Awiti, 2015). This expansionary phase in the fiscal policy is reflected in the widening primary deficit. The country has experienced fiscal expansion over the last three financial years; 2011/2012, 2012/13 and 2013/14. Aggregate expenditure averaged 25 percent of GDP and revenue at 18 percent of GDP (Republic of Kenya, 2014). For instance, the total budget for the year 2009 was ksh 865.6 billion and the total revenue collected was 569 billion (Republic of Kenya, 2009). The budget deficit stood at ksh 168.2 billion; and was financed through borrowing. In the 2010 budget, Treasury unveiled an ambitious budget of Ksh 998.8 billion where revenues totaled Ksh 609.6 billion with Ksh 199 billion from development partners, implying a deficit of Ksh 188 billion borrowing (Republic of Kenya, 2010). In the fiscal year 2014/2015 the budget stood at ksh. 1757.4 billion, total revenue expected amounted to 1180.5 billion. Kenya's fiscal deficit for the financial year 2014/2015 stood at Sh342.4 billion which was 8.03percent of GDP (Republic of Kenya, 2014). The government therefore, has substantially had recourse to borrowing to fill the budget shortfalls occasioned by insufficient revenue collection and the desire to expand the economy and infrastructure that demands many resources beyond the government's reach (Kamau, 2011). The trend in revenue collection is shown in the figure 1.1 below.

**Fig 1.1 Trends In Revenue Collection a Percentage of Gross Domestic Product**



**Source: Central Bank of Kenya: Fiscal Results (1998-2014).**

Investment of the borrowed funds in productive sectors, coupled with stable macroeconomic environment and backed by good quality institutions, through the multiplier effect will yield enough revenue to pay the debt in future, ensure debt sustainability, and therefore low risk. With proper management, debt financed investments are capable of producing a multiplier effect which leads to increased employment, adequate infrastructural base, a large export market, improved exchange rate and favourable terms of trade (Fosu, 2007). However, there is need to assess whether Kenya has a considerably good macroeconomic environment and if this is indeed backed by strong quality institutions. Germany and France, with much higher debt levels than Kenya, are considered to have more sustainable debt because of quality of institutions (World Bank, 2015).

Even though the government through the medium term debt strategy has put forth a good mix of internal and external borrowing to guard against the risk of vulnerability to external shocks and crowding out effect, this is not enough because the current levels must match the present value of future revenue (World Bank, 2013). In Kenyan scenario, the stock of debt has been rising against an insufficient increase in revenue collection. This signals that in future the country could fall short of repaying its debt obligations. Inability to pay debt leads to inability to borrow. This is yet another challenge which the Greece government is facing because most lenders see it as a high- risk economy. Besides, where such governments are able to secure loans, it comes at a very high cost (Ullah, 2011).

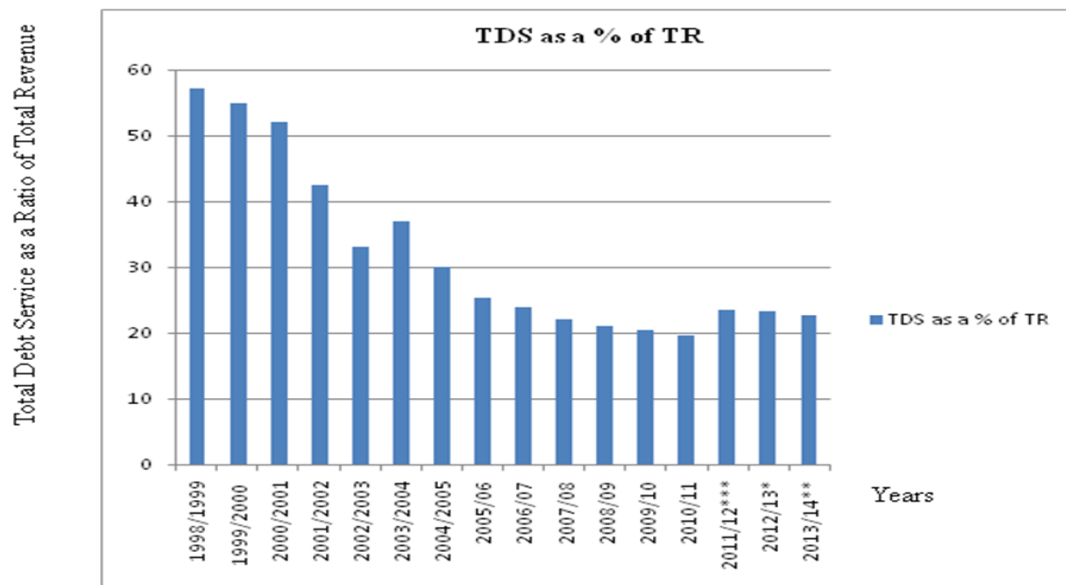
#### **1.1.1 Trend in debt servicing as a ratio of total revenue**

A critical look at Kenya's fiscal scene reveals an expansionary fiscal phase indicated by an increase in the primary deficit. These fiscal developments have resulted to an increase in the share of debt service in total spending over the years. This is due to accumulating debt stock, which increases servicing amounts. For instance, debt servicing rose from 13 percent to 15 percent of recurrent spending, equivalent to 2.6 percent of GDP between 2013 and 2014 (Republic of Kenya, 2014). In 2009, the government allocated ksh 60 billion to service public debts representing 7 percent of the total budget (Republic of Kenya, 2009), while apportioning ksh 83 billion for the same exercise in the 2010 budget estimates representing 8 percent of the year's total budget (Republic of Kenya, 2010). This was more than Ksh 18.9 billion allocated to agriculture over the same period. In 2014/15, debt servicing without factoring in debt redemption, amounted to 121.4 billion, representing 9.8 percent of the total budget (Republic of Kenya, 2014) indicating that debt servicing is consuming a big share of

budgetary allocations.

Trends in debt servicing as a ratio of total revenue in Kenya is presented in Figure 1.2 below, using data for the period 1998 to 2014.

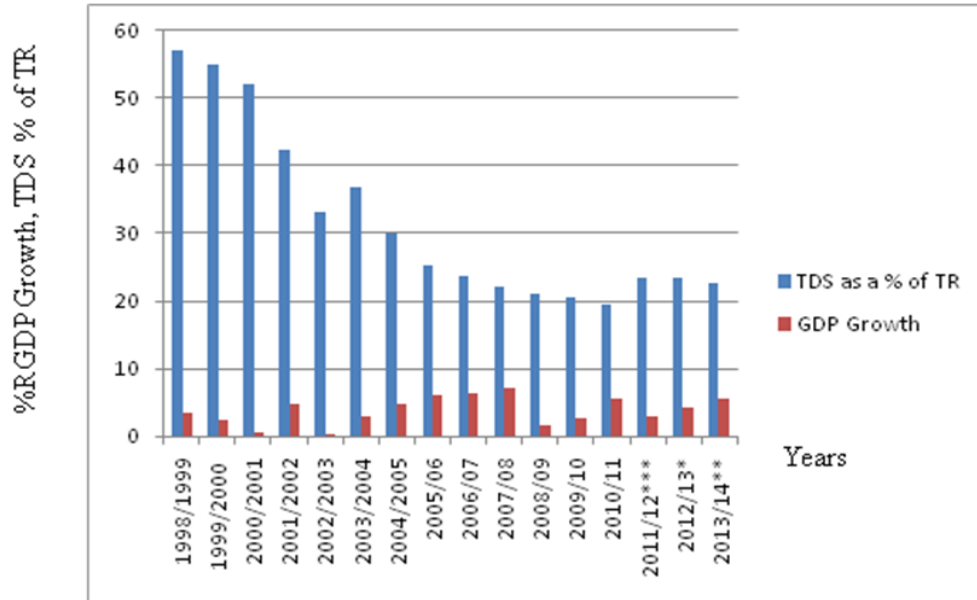
**Figure 1.2 Trend of Debt Service as a Percentage of Total Revenue**



**Source: Central Bank of Kenya: Fiscal Results (1998-2014)**

### Figure 1.3: Trends in Debt Servicing and Macroeconomic Performance in Kenya

Figure 1.3 below shows the relationship between total debt service as a percentage of total revenue and annual real GDP growth rate.



Source: Central Bank of Kenya: Fiscal Results (1998-2014)

From the diagram, it can be seen that there could be some relationship between debt servicing and economic growth. For instance, periods of high debt service amounts; such as the years 1998-2004 are associated with generally low economic growth rates. From mid-2000 to 2014, growth has improved where debt servicing is generally low. However, this trend is not consistent across all the years since the reverse can be observed for particular years, for example in 1999 where the debt service ratio was relatively high, the economic growth rates was also higher relative to 2003 with lower total debt service ratio. Hence, there seems to be no precise relationship, basing on this inconsistency.

Studies have shown that the relationship between debt payment and macroeconomic variables such as inflation, private investment, current account of balance of payment and private consumption is not clear. The relationship between debt servicing and inflation for example is blurred by factors such as unstable money demand, inflationary exchange rate depreciation, widespread indexation practices and sticky expectations (Kosimbei, 2009).

## **1.2 Problem statement**

Kenya has been borrowing at faster rates over the last five years than before, to complement the budget deficit resulting from insufficient revenue collection and desire to expand the economy and infrastructure development (Republic of Kenya, 2014). For instance, external debt ceiling doubled from ksh.1.2 trillion by 2012 to 2.5 trillion by 2013 (Republic of Kenya, 2013). Servicing these stocks of debt results in various macroeconomic imbalances. Debt servicing captures a large proportion government recurrent expenditures and total revenue. This poses risk to the national budget and the country's financial stability. Escalating debt signals that the government will in future spend a significant portion of its revenue repaying it at the cost of important local investment (Easterly, 1993). The government therefore fails to fully fund critical sectors of the economy that will spur sustainable growth and increased investment opportunities; key to widening the tax base. This has an overall implication on revenue, country's income, employment and poverty reduction effects. It is therefore of essence to assess the effect of rising debt levels on the government's future spending and the country's economic growth (Cottesi, 2012).

The relationship between debt servicing and macroeconomic performance has been of interest to

academicians and policy makers. Several empirical studies have been done in various countries yielding different results (Were, 2001; Maana, Owino and Mutai, 2008; Matiti, 2013; Hameed et.al 2008; Ahmed, 2005; Elbadawi, 1999 and Ayadi, 1999). The review of existing empirical studies has shown that it is inadequate to generalize on the link between macroeconomic performance and debt servicing; thus, it remains a key research issue. However, only a few are specific with reference to Kenyan economy, thus the findings from these economies may not be applicable to Kenya because of cross-country variations in economic structures. Many of these studies have yielded conflicting and inconclusive results on the possible growth impacts of debt servicing; which casts doubts about the precise relationship.

This study therefore sought to examine the long run relationship between debt servicing and macroeconomic performance; captured by selected macroeconomic variables such as economic, growth rate, gross capital formation, private consumption, savings, exchange rate, real interest, external balance of goods and services and inflation rate in Kenya; and to assess the impact of changes in the level debt servicing on these variables.

### **1.3 Research questions**

The study was guided by the following questions:

- i. What is the long run relationship between total debt servicing and selected macroeconomic variables in Kenya?
- ii. How responsive are the selected macroeconomic variables to changes in the level of total debt service?

#### **1.4 Study objectives**

The main objective of this study was to analyze the effect of debt servicing on macroeconomic performance in Kenya. The specific objectives are were to:

- i. Determine the long run relationship between total debt service and selected macroeconomic performance.
- ii. Investigate the dynamic response of the selected macroeconomic variables to changes in the level of debt servicing obligations.

#### **1.5 Significance of the study**

Fiscal policy remains one of the important tools of macroeconomic management in Kenya. This study is motivated by the fact that a relatively insufficient number of empirical studies have been done on the effects of external debt on macroeconomic performance especially with focus to Kenya thus very little is known. Understanding these relationships would provide information to policy makers for planning purposes, strategy formulation and proper economic management. This will improve the overall fiscal policy formulation that is needed for the attainment of the Vision 2030. The study also adds to the existing literature on debt serving and its impact on the economy's performance.

#### **1.6 Scope of the study**

The study aimed at establishing the relationship between debt servicing and selected macroeconomic variables in Kenya. The study was limited to the period 1970-2013 for several

reasons. First, time series data was available for this period and this period was believed to be long enough to capture the relationship between debt servicing and the indicators of macroeconomic performance.

### **1.7 Organization of the study**

This study is organized in five chapters. The foregoing chapter presents introduction, the background information and the objectives of the study. Chapter two presents literature review and chapter three discusses the research design and methodology. Model estimation and analysis of results are presented and discussed in chapter four, while chapter five gives summary of the study, conclusion and policy recommendations from the study.

## **CHAPTER TWO: LITERATURE REVIEW**

### **2.1 Introduction**

This chapter presents the literature review. The chapter is divided into three sections; theoretical literature, empirical literature and overview of literature.

### **2.2 Theoretical Literature Review**

#### **2.2.1 Theories on Debt Burden**

In analyzing the effect of debt burden (servicing) on the macroeconomic performance, four views providing different submissions can be identified (Inter-Generational models, Keynesian model, Neoclassical model and Ricardian model).

The neo-classicalists consider individuals to be planning their consumption decision over the entire life cycle. By shifting tax burden to the future generations, borrowing increases present consumption. This school of thought assumes full employment implying that increase in consumption decreases savings, causing interest rates to increase in the capital markets to restore the equilibrium. The higher interest rates in turn results in a decline in private investment. This crowding out effect impedes the effectiveness of the government to influence the economy through fiscal policies (Bailey, 1971; Buiter, 1977). The weakness of this theory is that very few economies especially in Sub-Saharan Africa, including Kenya have not achieved even near full employment level.

The Keynesian economists bring forth a counter proposition by pointing out the multiplier effects of external debt (Eisner, 1989). It suggests that increased external borrowing results in an increase in domestic production, which boosts investor sentiments about the future path of the economy. Moreover, borrowing implies investment in infrastructure, which could lead to a reduction in the cost of doing business in future. There is a dichotomy between Keynesians and the neo-classical economists' views in two ways. Keynesians permit less than full employment of resources and presuppose the existence of a large number of liquidity constrained individuals.

The Ricardian Equivalence theory advanced by Barro (1974) argues that increase in borrowing must be paid for, either now or later. Therefore, a reduction in current taxes must be matched by an increase in future tax burden to repay the debts, leaving interest rates and consequently private investments essentially equivalent. Government finance is therefore irrelevant (Ricardo, 1942). However, the relevance of this theory to a developing country has met criticism because the planning horizon of individuals is not long enough, an assumption in this model. Furthermore, information on the implications of current deficits for future tax burdens is not easy to obtain and it is not even clear how big the debt is.

In the Lerner's model (Lerner, 1948), an internal debt creates no burden for the future generation. Members of the future generation simply owe it to each other (Rosen and Gayer, 2008). When the debt is paid off, there is a transfer of income from one group of citizens (those who do not hold bonds) to another (bondholders). However, the future generation as a whole is no worse off in the sense that its consumption level is the same as it would have been. Here, a generation consists of everyone who is alive at a given time.

For external debts, the future generation certainly bears a burden if the money borrowed is used to finance current consumption because its consumption level is reduced by an amount equal to the loan plus the accrued interest that must be sent to foreign lenders. (Modigliani, 1961) If, on the other hand, the loan is used to finance capital accumulation, the outcome depends on the project's productivity. If the marginal return on the investment is greater than the marginal cost of funds obtained abroad, the combination of the debt and capital expenditure actually makes the future generation better off. To the extent that the project's return is less than the marginal cost, the future generation is worse off.

According to the overlapping generation's model, a generation is defined as everyone who was born at about the same time. Hence at any given time several generations coexist simultaneously. The model assumes no private savings (everyone consumes their entire income) and the situation is expected to continue forever. In this model, the population consists of equal number of the young, middle-aged and old people. The burden of a debt can be transferred across generations; the old age passes the burden to the middle-aged and the middle-aged to the young. The internal-external debt distinction that is vital in Lerner's model is irrelevant here; even though the debt is all internal, it creates a burden for the future generation.

By comparing the net taxes paid by different generations, one can get a sense of how government policy redistributes income across generations. The overlapping generation's model does not allow for the possibility that individuals in a given generation may care about their descendants as well as themselves.

The intergenerational models (Lerner's and the overlapping generation) discussed do not allow for the fact that economic decisions can be affected by government debt policy, and changes in these decisions have consequences for who bears the burden of the debt. Instead, it is assumed that the taxes levied to pay off the debt affect neither work nor savings behaviour. If taxes distort these decisions, real costs are imposed on the economy. More importantly, they ignore the potentially important effect of debt finance on capital formation.

## **2.2.2 Growth Theories**

### **Neoclassical Growth Theories**

Solow- Swan growth model developed by Solow and Swan in 1956 to explain the long run economic growth of countries postulates that the steady state growth is mainly exogenously determined by technological progress and population growth (Solow, 1956). In the short run in the absence of technological progress, there is no growth in the steady state per capita output; however, in the long- run, the per capita output grows at the rate of technological progress, owing to diminishing returns to capital. In this view, economic policies do not affect steady state economic growth, although they can affect the level of output or its growth rate when the economy is in transition from one steady state to another (Diamond, 1965).

The neoclassical growth models therefore hold that the output level of countries with similar technologies should converge to a given level in the steady state; a paradigm that has appeared to be inconsistent with empirical evidence, unless when the per capita growth of the rate of investment and public policies are taken into account (Ghura and Hadjimichael, 1996). The policy implication of the neoclassical growth theorists is that emerging economies (less

developed and developing) should save more to fund additional investment in order to realize improved performance and self-sustaining growth.

Key weaknesses of the neoclassical growth models are the dependence of growth on the exogenous technological progress and the apparent inconsistency of the unconditional convergence hypothesis with the actual data prompting investigation of alternative growth theories. The theories also do not consider the other factors, other than technology that indirectly affect the labor productivity and consequently the real wages growth.

### **Endogenous Growth Theories**

Endogenous growth models hold that economic growth primarily depends on endogenous or within factors and not external factors. Here, investment in human capital, innovation and knowledge are significant contributors to economic growth. Most importantly, long run economic growth rate of a country depends on policy measures. A key contribution of these theories is that they generate a linkage between public policies and long run growth by assuming aggregate production functions exhibiting non-decreasing returns to scale (Renelt, 1991).

Endogenous growth models show that human capital accumulation can be an important source of long-term growth either because it is a direct input into research (Romer (1990)) or because of its positive externalities or spillover effects (Lucas (1988), and Becker, Murphy and Tamura (1990)). The decision of individuals to invest in human capital enhances technological progress hence policies that promote public and private investment in human capital promote long run economic growth.

Ghura and Hadjimichael (1996) asserts that macroeconomic policies may affect economic growth, either directly through their effect on accumulation of factors of production; capital or indirectly through their impact on efficiency with which factors of production are used. Macroeconomic stability- reflected by low and stable inflation, sustainable debt relative to GDP and appropriate exchange rates-sends important signals to the private sector about the soundness of economic policies and the credibility of the authorities' commitment to manage the economy efficiently. A lack of macroeconomic stability, by creating an atmosphere of uncertainty steals away investor confidence and leads to inefficient allocation of resources since economic agents find it difficult to extract correct signals from relative prices such as real returns to investment (Ghura and Hadjimichael, 1996).

Endogenous growth models hold that fiscal policy has significant effects on long run economic growth. Other things held constant, a larger budget deficit crowds out private sector because of lower access to bank credit, higher real rates of interest and a more appreciated real exchange rate (Barro 1989 and 1990). These models also emphasize on outward-oriented trade policies as conducive to foster growth because they promote competition, improve access to trade opportunities and raise the efficiency of resource allocation; structural and institutional reforms to remove the impediments to private sector development (Romer and Rivera- Batiz (1991)).

### **2.3 Empirical Literature Review**

Three distinct groups of empirical findings in this scene exist. A first group of theories suggest since middle-income countries are far away from steady states, external financing could make them have accelerated economic growth through capital accumulation and productivity growth

hence foreign debt has a positive impact on growth up to certain threshold level. Second group of theories hold that high debt stock accumulation affects growth negatively; explained by the debt overhang hypothesis and liquidity constraints theory of crowding out effect. Third group of theories combines these two effects and argue that the impact of debt on growth is nonlinear.

Were, (2001) examined the structure of Kenya's external debt and its implications on economic growth using OLS technique covering the period 1970-95. In the study, the channels through which the foreign debt affects growth included stock of external debts as a ratio of GDP, past debt accumulation and the debt service ratio. The empirical results showed that external debt has a negative impact on economic growth and private investment, confirming the existence of debt overhang problem in Kenya. However, the results also indicated that current debt inflows stimulate private investment.

Clements et al (2003) examined the channels through which debt affects economic growth in 55 less income countries over the time 1970-1999. The study suggested that beyond a certain threshold, higher debt is associated with lower rates of growth of per capita income. The results indicated a threshold level of around 30–37 percent of GDP or around 115–120 percent of exports. The study observed that the negative effect of debt on growth works not only through its impact on the stock of debt, but also through the flow of service payments on debt, which are likely to 'crowd out' public investment. The damaging impact of debt servicing on economic growth is attributable to the reduction of government expenditure resulting from debt induced liquidity constraints.

Amaoteng and Amoako (2006) investigated on the export driven economic growth introducing debt servicing as a variable that in the export growth analysis. The findings indicated bidirectional causality between external debt servicing, economic growth and exports. The study recommended structural adjustment programmes designed to remove economic distortions, promote exports, and encourage external debt management to realize increased growth.

Boopen et al (2007) investigated the relationship between public debt and the economic performance in Mauritius over the period 1960-2004. The results were that debt is negatively associated with the output level of the economy in both short and long run. Bi-directional causality between external debt and economic development was also reported. Moreover, there were also evidences that debt has negative impact on both private and public capital stock of the country thus confirming the debt overhang and crowding out hypotheses.

Abu Baker and Hassan (2008) analyzed the impact of external debt on economic growth in Malaysia. The empirical results indicated that total external debt positively affect the economic growth. In the short run, total external debt had positive effects on economic growth. It also revealed that Malaysia had not suffered from debt overhang problem.

Maana, Owino, and Mutai (2008) examined the effect of domestic debt on economic growth in Kenya for the period 1996–2007 using generalised method of moments regression model. The results indicated that, lagged values of GDP, ratio of government expenditure to GDP, broad money supply, secondary school enrolment, private sector credit, ratio of debt to GDP and trade

affect the level of economic growth. Increase in domestic debt resulted in increase in interest payments without crowding out private investments due to the favourable level of financial development.

Cholifihani (2008) analyzed the short run and long run relationship between external debt and income in Indonesia from 1980 to 2005. The findings showed that GDP, DSR, capital stock, labor force and human capital inputs have a long run equilibrium relationship. External debt servicing showed a significant negative relationship with GDP, which indicated that debt overhang phenomenon, has occurred in Indonesia.

Safia and Shabbir (2009) investigated the impact of external debt on economic growth in 24 developing countries from 1976-2003. The study applied random effect and fixed effect estimation. The results showed that debt servicing to GDP negatively affect the economic growth and may leave less funds available to finance private investment in these countries leading to a crowding out effect.

Reinhart and Rogoff (2010) studied on economic growth in a time of debt. The paper analyzed economic growth and inflation at different levels of government external debt. The study considered 44 countries. The main findings of the study were that the relationship between government debt and real GDP growth is weak for debt to GDP ratios below a threshold of 90% of GDP. For emerging economies, they face lower thresholds for external debts. When external debts reach 60% of GDP, annual growth declines by about 2%. The study also found no apparent contemporaneous correlation between inflation and public debt levels for the advanced

economies as a group some countries like USA have experienced higher inflation when debt/GDP is high, unlike the emerging economies where inflation rises sharply as debt increases.

Wafula (2010) studied on debt sustainability and optimal debt for the government of Kenya that could enhance a 10% growth as projected in the Vision 2030. Cointegration testing of the present value of budget constraint was used to analyse the sustainability of the historical fiscal process and simulation was used to determine the optimal debt level. The findings were that public debt was sustainable, pointing to prudent public sector policies by the fiscal authorities. Further, the study found out the optimal debt level to be 35.2%. This seems to be consistent with the international threshold of debt/ GDP ratio of 40% for developing countries. However, debt is a flow variable, sustainability position cannot be predicted with certainty to remain constant in the near future especially with the slow performance of the export sector and the constant rise in the external debt ceiling.

Akram (2011) employed Autoregressive Distributed Lag (ARDL) modelling to assess the impact of public debt on the economic growth in Pakistan. The study found out the existence of debt overhang in Pakistan and a negative and significant relationship between economic growth and public external debt. However, the crowding out effect of external debt could not be confirmed as the relationships between investment and per capita GDP to debt servicing was found to be insignificant. Domestic public debt was found to have a crowding out effect on private investments and a negative relationship with per Capita GDP.

Nagarajan and Spears (2012) examined the behavioral parameters of the IS equations for eight countries in sub Saharan Africa. The empirical results showed an overall destabilizing effort rooted in the IS functions. The study lent support to the view that recourse to external financing to balance the IS gap in the short run leads to LDCs economies into a state of structural dependency on foreign capital, entailing a reduction in domestic capital formation and growth through an increased reliance on imports and an inefficient allocation of domestic savings.

Nurazira and Podivinsky (2012) in the study on the contribution of external debt to the expansion of economic growth for 31 developing countries over a 36 year period using a dynamic panel data econometrics estimation GMM system found out that accumulation of external debt is associated with a slowdown in the economies of developing countries. In addition, there was evidence to support spatial dependence in the growth model, suggesting a spillover effect of growth in the neighbouring countries.

Matiti (2013) used regression analysis to determine the relationship between public debt and economic growth in Kenya. The study used domestic debt and external debt as the only variables affecting economic growth. Public debt was found to have a negative relationship with economic growth.

## **2.4 Overview of Literature**

Economic theory presents various schools of thought having different paradigms on the effect of debt burden on the economy. Neoclassical model argues that by shifting the tax burden to the future generations, current borrowing crowds out private investment (Bailey, 1971; Buiter,

1977). Keynesians present a different view that borrowing increases domestic production and investment through its multiplier effects (Eisner, 1989). Ricardian equivalence theory suggests that borrowing today implies an increase in taxes tomorrow to repay the debts, leaving current interest rates and investment constant (Barro, 1974). Lerner's theory argue that internal debt does not burden the future generation, members of different generations simply owe it to each other (Rosen and Gayer, 2008). However, external debts creates burden for the future generation if the borrowed money channeled to consumption; the unproductive sectors (Lerner, 1948).

Neoclassical growth theories hold that output growth is exogenously determined hence economic policies are irrelevant in influencing economic growth. This is contrary to the endogenous growth models which hold that economic growth primarily depends on endogenous or within factors and not external factors. Therefore, these theories generate a link between public policies and economic growth.

The existing empirical evidences have shown conflicting results and therefore no conventional generalizations can be made (Wafula, 2010, Kamau, 2011, Were, 2001, and Amaoteng, 1996).

Many of the existing studies are with specific reference to West African countries. This reveals that little is known in Kenya, especially with regards to precise nature of relationship between total debt service and various macroeconomic variables. The varying results from these studies could be attributed to the methodological variations and data sources.

The current study, unlike most of the studies that have only narrowed down to the examining the effect of debt stocks on economic growth (Were, 2001, Mukui, 2011 and Matiti, 2013), has gone further to investigate how servicing these accumulated debt stocks dynamically impact the economy through selected variables over a forecasting horizon of twenty years.

## **CHAPTER THREE: RESEARCH METHODOLOGY**

### **3.1 Introduction**

This chapter describes the research design, theoretical framework and presents the empirical model that was adopted for the study. Definition and measurement of variables used in the study is also captured. The data, data sources, data collection and how the data was analyzed are also explained.

### **3.2 Research Design**

This study aimed at establishing the empirical effects of debt burden (servicing) on macroeconomic performance in Kenya. The study employed a non- experimental research design which used economic models for analysis. Annual time series data were collected for the following variables: total debt service, government consumption expenditure, private investment, external balance of goods and services, real exchange rate, inflation rate, real interest rate, and GDP for the period 1970-2013. The data was collected from various secondary sources including government documents such as Kenya Economic Surveys, Sessional papers, Statistical Abstracts and Policy documents. The collected data was analyzed using classical linear regression.

### **3.3 Theoretical Framework**

This study adopted endogenous growth theory that guided the development of empirical model. This theory provide a linkage between public policies and long run growth by assuming aggregate production functions exhibiting non-decreasing returns to scale (Renelt, 1991). Endogenous growth models state that economic growth primarily depends on endogenous or

within factors and not on external factors. Here, investment in human capital, innovation, and knowledge are significant contributors to economic growth. Long run economic growth rate of a country is assumed to depend on government policy measures.

This study borrowed the initial model from Ghura and Hadjimichael (1996) and Akram (2011) which assumes a Cobb-Douglas production function with non-decreasing returns to scale, given as;

$$Y = A_0 (A_k K)^\alpha (A_h H)^\beta (A_l L)^{1-\alpha-\beta} \quad (3.1)$$

Where Y is output, K is the capital stock, H is the human Capital, L is Labour,  $A_0$  is the overall index for technology and efficiency in the economy,  $A_k$  is the physical capital augmenting technology,  $A_h$  is the human capital augmenting technology, and  $A_l$  is the labour augmenting technology.

Now, collecting all technology related variables yields:

$$A = A_l \left( A_0 A_k^\alpha A_h^\beta \right)^{1/(1-\alpha-\beta)} \quad (3.2)$$

Where A encompasses the factor augmenting, economy-wide levels of technology and efficiency as defined in Ghura and Hadjimichael (1996). Therefore equation (3.1) can be re-written as

$$Y = K^\alpha H^\beta (A.L)^{1-\alpha-\beta} \quad (3.3)$$

And taking the logarithms of equation (3.3) gives

$$\log Y = \alpha \log K + \beta \log H + (1 - \alpha - \beta) \log A + (1 - \alpha - \beta) \log L \quad (3.4)$$

In Ghura and Hadjimichael (1996) the level of technology is assumed to evolve according to the following function:

$$A = A_0 e^{gt + X\theta} \quad (3.5)$$

Where X refers a vector of government policy variables that affect the level of technology and efficiency in the economy and  $\theta$  is the corresponding vector of coefficients related to these policies: g is the rate of technological progress and t is time factor. Here, technology is assumed to progress with time and policies improve the economy- wide efficiency.

Taking the logarithm of technology in equation (3.5) gives:

$$\log A = \log A_0 + gt + X\theta \quad (3.6)$$

Combining equations (3.4) and (3.6) provides the theoretical growth model for this study as may be compactly written as

$$\log Y = \alpha \log K + \beta \log H + (1-\alpha -\beta) \log A_0 + (1-\alpha -\beta)gt + (1-\alpha -\beta)X\theta + (1-\alpha -\beta) \log L \quad (3.7)$$

Or

$$\log Y = \delta + \alpha \log K + \beta \log H + \mu t + X\xi + \gamma \log L \quad (3.8)$$

Where

$$\delta = (1-\alpha -\beta) \log A_0$$

$$\gamma = (1-\alpha -\beta)$$

$$\mu = (1-\alpha -\beta)g$$

And

$$\xi = (1-\alpha -\beta)\theta$$

### 3.4 Empirical Model

An empirical counterpart of equation (3.8) may be obtained by introducing debt service and other related policy variables into the production function as part of the X-vector of explanatory variables. As mentioned earlier, debt servicing has important implications growth of the economy as it takes a substantial part of the national budget that might otherwise be allocated to the other productive sectors of the economy. A nation that carries a significant debt burden requires spending a large portion of its resources to service its debt liabilities, having significant implications on decisions regarding the employment of labour and capital in the production function (Akram, 2011).

Following the theoretical model from the previous section, the empirical model for this study may be expressed in general form as follows:

$$RGDP = F(TDS, PI, RER, INF, SAV, CESR, RIR, NX) \quad (3.9)$$

where RGDP is the real annual output growth, TDS is total debt service, PIGR is growth in private investment, NX is net exports, INF is inflation rate, RER is movement in real exchange rate, CESR is growth in expenditure on private consumption, RIR is real interest rate and SAV is amount of savings by households as a percentage of GDP.

In theory, private investment is a component of output and positively affects growth. In this study, private investments proxies the growth in the capital stock. Similarly, consumption affects the country's output positively since it increases aggregate demand in the economy. In an open economy, an increase in the external balance of goods and services spurs economic growth. With growth in exports, a country can meet its debt obligations by selling its output to the lender

institutions. Inflation rate and real exchange rate are indices of macroeconomic stability in an economy. Macroeconomic stability reflected by low and stable inflation and appropriate exchange rates-sends important signal to the private sector about the soundness of economic policies and credibility of the authorities' commitment to manage the economy efficiently. Real interest rate and savings affect private output growth indirectly through private investments.

In his paper, Sims (1980) argued that the cyclical fluctuations in many macroeconomic variables are interrelated and therefore there is no division between endogenous and exogenous variables. In view of this, he introduced the Vector Autoregression (VAR) approach to estimation to address these phenomena. Sims (1980) criticized the imposition of unrealistic restrictions on a macro-model to make the equations identified. Instead of classifying the variables as either endogenous or exogenous, he suggested to treat all the variables to be endogenous where every variable is allowed to influence every other variable with a distributed lag of reasonable length. Using traditional models therefore would result to biased results due to simultaneous equation bias (Enders, 1995). Based on this reaction against the traditional econometric approach to solving multi-equation simultaneous models, VAR method therefore is an alternative to the unrealistic identification restriction in structural models (Thomas, 1997). Vector Autoregression also captures the evolution and interdependencies between multiple time series, generalizing the univariate autoregressive models (Stock and Watson, 2001). Even though VAR model does not use established economic theory in estimating economic relationships, it uses economic theory in specifying the variables to be included in the model.

### 3.4.1 The VAR Model Representation

The compact form of the VAR model which relates economic growth and other macroeconomic variables in equation (3.9) may be represented as:

$$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + \dots + A_p X_{t-p} + \varepsilon_t \quad (3.10)$$

where  $A_0$  is  $n \times 1$  vector of constant terms,  $A_1, A_2, \dots, A_p$  are  $n \times n$  matrices of coefficients,  $X_t$  is an  $n \times 1$  vector of endogenous variables:

$X_t = (RGDP, TDS, PI, RER, NX, SAV, RIR, CE)'$  and  $\varepsilon$  is a vector of serially uncorrelated disturbance terms with zero means and constant variances.

For example, the equations for growth, private investments and real exchange rate are expressed as:

$$RGDP_t = \delta_1 + \sum_{i=1}^p \alpha_{i1}^{(1)} RGDP_{t-i} + \sum_{i=1}^p \alpha_{2i}^{(1)} PI_{t-i} + \sum_{i=1}^p \alpha_{3i}^{(1)} RER_{t-i} + \dots + \sum_{i=1}^p \alpha_{i1}^{(1)} X_{t-i} + \varepsilon_{1t} \quad (3.11)$$

$$PI_t = \delta_2 + \sum_{i=1}^p \alpha_{i1}^{(2)} PI_{t-i} + \sum_{i=1}^p \alpha_{2i}^{(2)} RGDP_{t-i} + \sum_{i=1}^p \alpha_{3i}^{(2)} RER_{t-i} + \dots + \sum_{i=1}^p \alpha_{i1}^{(2)} X_{t-i} + \varepsilon_{2t} \quad (3.12)$$

$$RER_t = \delta_3 + \sum_{i=1}^p \alpha_{i1}^{(3)} RER_{t-i} + \sum_{i=1}^p \alpha_{2i}^{(3)} RGDP_{t-i} + \sum_{i=1}^p \alpha_{3i}^{(3)} PI_{t-i} + \dots + \sum_{i=1}^p \alpha_{i1}^{(3)} X_{t-i} + \varepsilon_{3t} \quad (3.13)$$

The three variables namely RGDP, RER and PIGR were selected as the macroeconomic indicators where the effect of TDS was examined. The interest of the study was to ascertain the existence of debt overhang, crowding out of private investment and the country's susceptibility to global exogenous shocks.

To estimate the VAR system of equations, each equation can be consistently estimated using the Ordinary Least Squares (OLS) method (Enders, 1995). Therefore each of the equations in the

VAR model was estimated using OLS technique. The results of the estimation are subsequently used to investigate the dynamics of the model.

### 3.4.2 The Long Run Relationship

The VAR equations presented above are generally in the form of an autoregressive distributed lag (ARDL) model.

From the expressions in equation (3.10), it is possible to derive an equilibrium solution or the long run path, if the variables are constant (Harvey 1990, Chapter 7). The assumption is that the model must be stable where the roots of the polynomial representing the coefficients of the dependent variable are outside the unit circle.

From VAR equation (3.11) for growth,

Let  $Y_t = RGDP$  and X represents all the variables on the right hand side, then:

$$Y_t = \delta + \sum_{i=1}^p \alpha_i Y_{t-i} + \sum_{i=1}^p \beta_i X_{t-i} + \dots + \varepsilon_{it} \quad (3.14)$$

Where

$$\sum_{i=1}^p \alpha_i Y_{t-i} = \text{the sum of the product of the past values of Y up to lag } p \text{ and their coefficients}$$

And

$$\sum_{i=1}^p \beta_i X_{t-i} = \text{the sum of the product of past values of the right hand side variables up to lag } p \text{ and their coefficients. } \varepsilon_{it} \text{ Is vector of serially uncorrelated disturbance terms and } \delta \text{ is a constant term.}$$

Expanding the terms gives

$$Y_t - \alpha_1 Y_{t-1} - \alpha_2 Y_{t-2} - \dots - \alpha_p Y_{t-p} = \delta_1 + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \dots + \beta_p X_{t-p} + \varepsilon_t \quad (3.15)$$

Introducing the lag operator yields

$$Y_t - \alpha_1 L^1 Y_t - \alpha_2 L^2 Y_t - \dots - \alpha_p L^p Y_t = \delta_1 + \beta_1 L^1 X_t + \beta_2 L^2 X_t + \dots + \beta_p L^p X_t + \varepsilon_t \quad (3.16)$$

Factoring out  $X_t$  and  $Y_t$

$$(1 - \alpha_1 L^1 - \alpha_2 L^2 - \dots - \alpha_p L^p) Y_t = \delta_1 + (\beta_1 L^1 + \beta_2 L^2 + \dots + \beta_p L^p) X_t + \varepsilon_t \quad (3.17)$$

If in the long run,  $Y_t$  and  $X_t$  are constant at  $Y^*$  and  $X^*$ , then the equilibrium solution becomes:

$$Y_i = \rho_i + \mu_i X_i + \varepsilon_{it} \quad (3.18)$$

Where

$$\rho = (\delta_1) / (1 - \alpha_1 - \alpha_2 - \dots - \alpha_p) \quad (3.19)$$

$$\mu = \frac{(\beta_1 L^1 + \beta_2 L^2 + \dots + \beta_p L^p)}{(1 - \alpha_1 L^1 - \alpha_2 L^2 - \dots - \alpha_p L^p)} \quad (3.20)$$

Where  $\rho_i$  and  $\mu_i$  are long run coefficients of the long run equations (3.18).

Specifically, the long run- equations to be estimated are expressed as follows:

$$GDP1 = \rho_1 + \mu_{11}PIGR + \mu_{12}SAV + \mu_{13}RIR + \mu_{14}INFL + \mu_{15}TDS + \mu_{16}NX + \mu_{17}CSGR + \mu_{18}D1 + \mu_{19}RER + \varepsilon_{1t} \quad (3.21)$$

$$PI = \rho_2 + \mu_{21}GDP1 + \mu_{22}SAV + \mu_{23}RIR + \mu_{24}INFL + \mu_{25}TDS + \mu_{26}NX + \mu_{27}CSGR + \mu_{28}RER + \mu_{29}D1 + \varepsilon_{2t} \quad (3.22)$$

$$RER = \rho_3 + \mu_{31}GDP1 + \mu_{32}CSE + \mu_{33}RIR + \mu_{34}YEAR + \mu_{35}TDS + \mu_{36}TRADE + \varepsilon_{3t} \quad (3.23)$$

### 3.4.3 The Dynamic Response

In practice, the estimated coefficients of the VAR models do not have meaningful economic interpretation since they are equivalent to the reduced form equations. Thus Sims (1980) introduced a way of using the estimated VAR coefficients, that is, to trace the dynamic path of each variable in the system given a certain shock or effects of innovation due to a change in a variable.

The dynamic response is measured through the impulse response functions (IRF) and the variance decomposition. Together they are called “innovation accounting”. VAR may be written as Vector Moving Average (VMA) where variables are expressed as a function of the current and the past values of the error terms. The VMA representation traces out the time path of various shocks on the variables in VAR.

### 3.4.4 The Impulse Response Functions

The impulse responses are derived from the Vector Moving Average of the VAR model. Impulse response analysis links the current value of the error term to the future values of the variables in the VAR (Enders, 1995).

For simplicity, considering a two-variable VAR (1) model:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad (3.24)$$

The VMA representation is given as

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{y} \\ \bar{z} \end{bmatrix} + \sum_{i=1}^{\infty} \begin{bmatrix} \phi_{11}(i) & \phi_{12}(i) \\ \phi_{21}(i) & \phi_{22}(i) \end{bmatrix} \begin{bmatrix} \varepsilon y_{t-1} \\ \varepsilon z_{t-1} \end{bmatrix} \quad (3.25)$$

More compactly,

$$X_t = \mu - \sum \phi_i \varepsilon_{t-1} \quad (3.26)$$

The four elements  $\phi_{jk}(i)$  are impact multipliers. For instance,  $\phi_{12}(0)$  is the instantaneous impact of a one unit change in  $\varepsilon z_t$  and  $\phi_{11}(1)$  is one period response of a unit change in  $\varepsilon z_{t-1}$  on  $y_t$ .

The accumulated effects of unit impulses in  $\varepsilon z_t$  and  $\varepsilon y_t$  can be obtained by appropriate summation of the impulse response functions. The sets of coefficients  $\phi_{11}(i)$ ,  $\phi_{12}(i)$ ,  $\phi_{21}(i)$  and  $\phi_{22}(i)$  are the impulse response functions.

### 3.4.5 Variance Decomposition Analysis

VAR models are usually over-parameterized and therefore they are not particularly useful for short term forecasts (Sims, 1980). However, understanding the perspectives of the forecast errors is exceedingly helpful in uncovering interrelationships among the variables in the system.

Given,

$$X_t = \mu + \phi_0 \varepsilon_t + \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} + \dots \quad (3.27)$$

Or

$$X_t = \mu + \sum_{i=0}^{\infty} \phi_i \varepsilon_{t-i} \quad (3.28)$$

The one- step ahead forecast error is given as

$$X_{t+1} - \hat{X}_{t+1} = \phi_0 \varepsilon_{t+1} \quad (3.29)$$

So that the n- period forecast error is

$$X_{t+n} - \hat{X}_{t+n} = \sum_{i=0}^{n-1} \phi_i \varepsilon_{t+n-i} \quad (3.30)$$

Taking the  $\{Y_t\}$  sequence, the n- step ahead forecast variance denoted as  $\sigma_y(n)^2$  will be given by

$$\sigma_y^2(n) = \sigma_y^2[\phi_{11}^2(0) + \phi_{11}^2(1) + \dots + \phi_{11}^2(n-1)] + \sigma_z^2[\phi_{12}^2(0) + \phi_{12}^2(1) + \dots + \phi_{12}^2(n-1)] \quad (3.31)$$

Since all values of  $\sigma_{jk}^2(n)$  are necessarily non negative, the variance of the forecast error increases as the forecast horizon n- increases.

It is possible to decompose the n- step ahead forecast error variance into the proportions due to each shock.

Respectively, the proportions of  $\sigma_y^2(n)$  due to shocks in the  $\varepsilon Y_t$  and  $\varepsilon Z_t$  sequences are:

$$\frac{\sigma_y^2[\phi_{11}^2(0) + \phi_{11}^2(1) + \dots + \phi_{11}^2(n-1)]}{\sigma_y^2(n)}$$

And

$$\frac{\sigma_z^2[\phi_{12}^2(0) + \phi_{12}^2(1) + \dots + \phi_{12}^2(n-1)]}{\sigma_y^2(n)}$$

The forecast error variance decomposition tells the proportion of the movements in a sequence due to its own shock versus shocks to other variables. If  $\varepsilon^z_t$  shocks explain none of  $\{Y_t\}$  at all, then  $\{Y_t\}$  is exogenous. On the other extreme,  $\varepsilon^z_t$  could explain all of  $\{Y_t\}$  implying that  $\{Y_t\}$  is entirely endogenous (Enders, 1995).

It is important to consider the ordering of variables when conducting VDA because in practice the error terms of the equations in the VAR are correlated. The results therefore depend on the order in which the equations are estimated in the model (Enders, 1995).

The plots of variance decomposition are discussed in the next chapter.

### 3.5 Data Analysis

The study aimed at determining the equilibrium relationship between total debt servicing and macroeconomic performance in Kenya. This was captured by the effect of total debt service on selected macroeconomic variables in the long run. Three variables namely; real effective exchange rate (RER), real output growth (RGDP) and private investment (PIGR) were selected and the effect of total debt service on these variables examined. The interest was to establish the existence of debt overhang in Kenya, crowding out effect and the vulnerability of the country to the global economic policies; this revealed the credibility of the domestic policies and the strength of the country's policy institutions. The long run equations for the models were derived from the Autoregressive distributed lag (ARDL) model in equation 3.10.

The study further sought to analyze the dynamic impact of total debt service. To this effect, VAR model was estimated. The optimal lag length was achieved by Akaike Information Criterion. The VAR coefficients were meaningless prompting construction of the Vector Moving Average subsequently deriving the Impulse Response Functions. Impulse response analysis links the current value of the error term to the future values of the variables in the VAR. IRFs essentially map out the dynamic response path of a variable due to a shock in the system of variables. The variations in other variables brought about by shocks to total debt service was further explained by the forecast error variance decomposition; an alternative method to Impulse Response Functions. This approach explained how much of the forecast error variance for any variable in the system accounted for by innovations to each of the right hand side variables over a series of time horizons; in this case, twenty years. The results of the estimations are discussed in the next chapter.

## CHAPTER FOUR

### MODEL ESTIMATION AND ANALYSIS OF RESULTS

#### 4.1 Introduction

This chapter presents the findings of the study, the estimation results and their interpretations.

#### 4.2 Data Characteristics

The study used annual time series data for the period 1970-2013. The sources of data included World Bank Statistics and Kenya Economic Surveys Statistical Abstracts from the World Bank and the Kenya National Bureau of Statistics respectively. Data was collected for the variables including Inflation rate (INFL), private investment (PIGR)), exports and imports (NX), Gross Domestic Product (RGDP), real interest rate (RIR), total debt service (TDS), consumption expenditure (CSGR), savings (SAV) and real exchange rate (RER). Nominal data for these variables. Real data was derived by dividing the nominal values by the GDP deflator and rebasing to the year 2009. This was because most of the variables were expressed as a percentage of GDP. Table 4.1 below describes the basic features of the real data for the variables. Descriptive statistics give summaries about the sample and they form a fundamental basis for every quantitative data analysis. The actual data and refined data for estimation is attached at the appendix 1.

**Table 4.1: Descriptive Statistics for Macroeconomic Variables Data Set**

	GDP1	CSGR	INFL	NX	PIGR	RIR	SAV	TDS
Mean	3.54	4.98	9.99	-0.460	2.89	6.55	15.21	5.89
Median	3.77	3.56	9.77	-5.233	7.63	5.26	16.96	5.074
Maximum	9.45	29.39	41.99	41.83	37.75	22.31	27.02	12.99
Minimum	-4.66	-5.384	-9.219	-10.13	-31.50	-8.132	3.9	1.005
Std. Dev.	2.84	6.066	7.89	13.62	16.91	8.10	6.00	3.27
Observations	43	43	43	43	43	43	43	43

**Source: Author's calculation**

From the data presented in Table 4.1, the mean for real GDP growth rate over the period covered by the data averaged 3.54 per cent with a standard deviation of 2.84, with values ranging from a minimum of -4.66 to a maximum of 9.45 for the periods 1970 and 1977 respectively. Notably, real GDP grew at an average of about 6.6 per cent for the period 1970-1977 due to massive agricultural production (Republic of Kenya, 1977). As for Total Debt Service as a percentage of GDP, the arithmetic mean value over the study period was 5.89 per cent with the standard deviation of 3.27 with real values ranging between a minimum of 1.01 and a maximum of 12.99 in 2010 and 1994 respectively.. The high total debt service for the period 1994 could be attributed to cutting of aid by the bilateral and multilateral aid to Kenya due to economic mismanagement, shrinking of agricultural production in the previous year and expansion of the budget deficit. This period was also marked by high inflation rate of 41.99 per cent (maximum) and high real interest rate of 22.31 per cent. (Republic of Kenya, 1995). Generally, basing on the means and standard deviation of the macroeconomic variables indicate that there are no outliers in the series since the standard deviation of the series is less than their respective means.

### **4.3 Testing Time Series Behaviour**

Classical linear regression technique requires that all the necessary assumptions be made alongside the fulfillment of certain properties that must hold for the variables under study (Enders, 1995). Before estimation, these requirements were ascertained.

#### **4.3.1 Unit root test**

The time series were tested for presence of unit root. This is a test conducted to establish the stationarity of the time series and to determine the order of integration of the variables. This ensures that the series has a constant mean and variance so that the regression results are meaningful. It is necessary to carry out the unit root test because of the problem of non-stationary variables producing spurious results due to presence of trend in the data series.

Augmented Dickey Fuller (ADF) and Kwiatkowski Phillips Schmidt-Shin (KPSS) tests were employed in this procedure. ADF test is a standard procedure conducted to test whether a series has a unit root. However, the ADF criterion is known for its low power of the test. The KPSS test for unit root eliminates the possible low power against stationary near unit root processes; which occur in the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests (Greene, 1989). It is a superior criterion because one can distinguish between series that appear to be stationary, series that appear to have unit root and series for which the tests are not informative on whether the series is stationary or integrated (Gujarati, 2003).

The basic equation used in the ADF test is expressed as:

(i) ADF without trend and intercept

$$\Delta Y_t = \rho Y_{t-1} + \sum_{i=1}^k \delta_i \Delta Y_{t-1} + \mu_t$$

(ii) ADF with an intercept but no trend

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \sum_{i=1}^k \delta_i \Delta Y_{t-1} + \mu_t$$

(iii) ADF with both trend and intercept

$$\Delta Y_t = \alpha + \beta_t + \rho Y_{t-1} + \sum_{i=1}^k \delta_i \Delta Y_{t-1} + \mu_t$$

The ADF tests the null hypothesis that  $|\rho| = 0$  against the alternative that  $|\rho| < 0$  in the autoregressive equations.

For the KPSS criterion, the hypothesis tests for the series was:

$$Y_t = \beta D_t + \varepsilon_t \quad (3.8)$$

$$H_o: \sigma_\varepsilon^2 = 0 \Rightarrow Y_t \text{ } I(0) \text{ Stationary}$$

$$H_a: \sigma_\varepsilon^2 > 0 \Rightarrow Y_t \text{ } I(1) \text{ Non-stationary.}$$

If the KPSS statistics were greater than the asymptotic critical values, the null hypothesis for stationarity is rejected thus the series is non-stationary. Below are the unit root tests results.

**Table 4.2: ADF Unit Root Test Results**

Variable	Form of test	Test Statistic	Conclusion
Real GDP growth	Intercept only	-5.250901***	Stationary
	Trend and intercept	-5.606895***	
Private Investment growth	Intercept only	-3.587856**	Stationary
	Trend and intercept	-3.404447**	
Net Exports as a %age of GDP	Intercept only	-2.519967	Stationary
	Trend and intercept	-3.572090**	
Inflation rate	Intercept only	-3.904356***	Stationary
	Trend and intercept	-3.872776**	
Savings as a % of GDP	Intercept only	-2.073817	Stationary
	Trend and intercept	-3.883937**	
Consumption expenditure growth	Intercept only	0.173685	Stationary
	Trend and intercept	-2.069113	
Real interest rate	Intercept only	-3.976151***	Stationary
	Trend and intercept	-4.252256***	
Total debt service as a % of GDP	Intercept only	-1.471309	Non stationary
	Trend and intercept	-2.496243	
Real exchange rate	Trend and intercept	-2.025061	Non stationary
	Intercept only	0.01667	Non stationary

**ADF Asymptotic Critical Values with intercept only**

	t-Statistic
Test critical values: 1% level	-3.592462
5% level	-2.931404
10% level	-2.603944

**ADF Asymptotic Critical Values with trend and intercept**

	t-Statistic
Test critical values: 1% level	-4.252256
5% level	-3.518090
10% level	-3.189732

**Note: \*\*\*stationary at 1%; \*\* stationary at 5%; \* stationary at 10% levels of significance.**

From the ADF criterion, all the variables except real exchange rate and total debt service were found to contain no unit roots. If the computed statistics greater than the asymptotic critical values in absolute terms, the null hypothesis that the series contained unit root was rejected and the series concluded to be stationary (Judge, 1985).

The KPSS stationarity test results are discussed below:

**Table 4.3: KPSS Stationarity Tests Results**

<b>Variable</b>	<b>Form of test</b>	<b>Test Statistic</b>	<b>Conclusion</b>
Real GDP growth rate	Intercept only	0.252511	Stationary
	Intercept and trend	0.139915	
Private Investment growth	Intercept only	0.393912	Stationary
	Trend and intercept	0.190298	
Net Exports as a %age of GDP	Intercept only	0.641582	Stationary
	Trend and intercept	0.161387	
Inflation rate	Intercept only	0.091525	Stationary
	Trend and intercept	0.087434	
Savings as a % of GDP	Intercept only	0.729050	Stationary
	Trend and intercept	0.120004	
Consumption expenditure growth	Intercept only	0.792143	Stationary
	Trend and intercept	0.113297	
Real interest rate	Intercept only	0.175165	Stationary
	Trend and intercept	0.083792	
Total debt service as a % of GDP	Intercept only	0.467651	Stationary
	Trend and intercept	0.200357	

Real exchange rate	Trend and intercept	0.112789	Non stationary
	Intercept only	0.789222	Stationary

**KPSS Asymptotic Critical Values with intercept only**

		LM-Stat.
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

**KPSS Asymptotic Critical Values with trend and intercept**

Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

In the KPSS criterion, all variables were stationary at levels. This is because the computed LM test statistics were less than the asymptotic critical values for rejection of the null hypothesis at 1 per cent, 5 per cent or 10 per cent level of significance (Judge, 1985). All the variables were therefore integrated of order I (0).

#### 4.4 Long-Run Relationship between Total Debt Service and Selected Variables

The first objective was to estimate the effect of total debt service on selected macroeconomic variables. This objective was achieved by running an ordinary least squares regression of TDS alongside other control variables on growth of real gross domestic product (RGDP), growth of private investment (PI) and real effective exchange rate (RER) as described in the equations (3.21), (3.22) and (3.23).

##### 4.4.1 Long-Run Relationship between Total Debt Service and Real Gross Domestic Product

The study estimated the effect of total debt service (TDS) alongside other control variables on output growth (GDP1). Specifically, the study focused on ascertaining the existence of debt overhang problem in Kenya, or otherwise. The estimation results are discussed below.

##### Estimation Equation (3.21):

$$GDP1 = \rho_1 + \mu_{11}PI + \mu_{12}SAV + \mu_{13}RIR + \mu_{14}INFL + \mu_{15}TDS + \mu_{16}NX + \mu_{17}CSGR + \mu_{18}D1 + \varepsilon_{1t}$$

##### Substituted Coefficients:

$$GDP1 = GDP1 = 8.174 + 0.0693*PIGR - 0.255*RIR - 0.237*SAV + 0.3801*TDS + 0.0054*NX + 4.837*D1 - 0.236*INFL + 0.0655*CSGR - 0.0033*RER$$

**Figure 4.4: Regression Output Results for Model 1- (GDP1).**

Dependent Variable: GDP1				
Method: Least Squares				
Included observations: 41 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.174029	2.238323	3.651854	0.0010
PIGR	0.069271	0.023576	2.938182	0.0062
RIR	-0.255062	0.053729	-4.747211	0.0000
SAV	-0.236792	0.119170	-1.987020	0.0558
TDS	0.380102	0.141449	2.687201	0.0115
NX	0.005393	0.029629	0.182025	0.8567
D1	4.837109	1.281503	3.774559	0.0007
INFL	-0.235639	0.055791	-4.223599	0.0002
CSGR	0.065488	0.060443	1.083452	0.2870
RER	-0.003316	0.021345	-0.155337	0.8776
R-squared	0.614703	Mean dependent var		3.537982
Adjusted R-squared	0.502843	S.D. dependent var		2.836366
S.E. of regression	1.999904	Akaike info criterion		4.432295
Sum squared resid	123.9881	Schwarz criterion		4.850240
Log likelihood	-80.86205	Hannan-Quinn criter.		4.584488
F-statistic	5.495276	Durbin-Watson stat		1.838061
Prob(F-statistic)	0.000160			

The estimation results revealed strong evidence of statistical significance of total debt service, real interest rate, savings, private investment growth and inflation rate in explaining economic growth. However, growth in consumption expenditure real exchange rate and external balance on goods and services (net exports) were found to be statistically insignificant. The signs of the estimated coefficients were also consistent with the expectation from economic theory. Total

debt service was found to affect economic growth positively (0.38), real interest rate was inversely related to real GDP growth (-0.256) and inflation rate (-0.2368) as well. Private investment (0.0678), Net Exports (0.005) and growth in consumption (0.0648) further were found to exhibit positive relationship with real GDP. The signs of these coefficients show consistency with expectation from economic theory. The coefficient of determination, R-squared (0.61) indicated that the right hand side variables accounted for around 60 percent of the variations in real GDP. Similarly, the p-value (0.00006) of the F-statistic indicated that the overall model was significant in explaining the relationship. Durbin-Watson statistic (1.84) tended towards 2 implying no serious autocorrelation problems. This is also supported by the serial correlation test results attached at the appendix 3(b).

The positive effect of total debt service (0.383) on economic growth evidenced non-existence of debt overhang in Kenya. Existence of debt overhang signifies a debt burden that is so large that a country cannot take on additional debt to finance future projects, even those that have higher returns enough to enable it reduce its indebtedness over time (Ajayi, 1999).

This meant that the country is not at a risk of financial distress in meeting its debt obligations. Due to multiplier effect, the return on the investment of the borrowed funds sufficiently meets the cost of servicing the debts. This may be attributed to proper investment of the borrowed capital into the productive sectors like infrastructure as opposed to investment in the non-productive sectors like consumption. The diagnostic test results for this model showed that all the OLS assumptions of no autocorrelation and normality of the residuals among others were satisfied. The model was also found to be correctly specified and stable hence it would be useful for forecasting. The model's diagnostic test results are discussed later in the chapter.

#### 4.4.2 Long- Run Relationship between Total Debt Service and Growth of Private Investment.

The study further sought to find out the effect of total debt servicing on the growth of private investment. The aim was to find out the existence of crowding out effect of private investment due to debt servicing.

#### Estimation Equation (3.22):

$$PI = \rho_2 + \mu_{21}GDP1 + \mu_{22}SAV + \mu_{23}RIR + \mu_{24}INFL + \mu_{25}TDS + \mu_{26}NX + \mu_{27}CSGR + \mu_{28}RER + \mu_{29}D1 + \varepsilon_{2t}$$

#### Substituted Coefficients:

$$PIGR = -1601.35 - 0.374*CSGR - 11.04*D1 - 3.56*TDS + 0.80*YEAR + 2.99*SAV + 1.30*RIR - 0.50*NX + 1.32*INFL + 2.90*GDP1$$

**Table 4.5: Regression Output Results for Model 2 (Private Investment)**

Dependent Variable: PIGR				
Method: Least Squares				
Included observations: 41 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-61.07834	14.31515	-4.266692	0.0002
GDP1	3.144478	1.070212	2.938182	0.0062
RIR	1.146486	0.428840	2.673456	0.0119
SAV	2.785082	0.690321	4.034472	0.0003
TDS	-2.759486	0.934961	-2.951444	0.0060
NX	-0.369048	0.188410	-1.958753	0.0592
D1	-12.30484	10.19437	-1.207024	0.2366
INFL	1.169406	0.422478	2.767971	0.0094
CSGR	-0.520652	0.404200	-1.288107	0.2072
RER	0.288606	0.134207	2.150460	0.0394
R-squared	0.507693	Mean dependent var		2.888432
Adjusted R-squared	0.364765	S.D. dependent var		16.90596
S.E. of regression	13.47432	Akaike info criterion		8.247669
Sum squared resid	5628.280	Schwarz criterion		8.665613
Log likelihood	-159.0772	Hannan-Quinn criter.		8.399861
F-statistic	3.552095	Durbin-Watson stat		2.167957
Prob(F-statistic)	0.003942			

From the estimation results, total debt service (-2.75) with p-value 0.006 affected private investment negatively. According to the liquidity constraints theory, when a country's debt service burden is so heavy that a significant portion of its current output accrues to lenders it creates disincentive to invest.

The findings reveal that despite the government's continuous efforts in implementing the medium term debt management strategy (MTDS) aimed at having an optimal borrowing mix (between external and domestic debts) to guard against crowding out effect, the policy has not been effective. The other variables that showed strong statistical significance in this relationship were: real interest rate (1.14), gross domestic product growth (3.14), net exports (-0.369), inflation (1.16) real exchange rate (0.2889) and savings (2.79) with p-values 0.01, 0.0062, 0.06, 0.01 0.04 and 0.0003 respectively; all less than 0.05. The coefficient of determination, R-squared (0.51) indicated a significant percentage of above 50 percent variations in private investment being explained by the right hand side variables; evidence of the goodness of fit of the model in explaining the relationship. The p-value of the F-statistic (0.004) further revealed a strong evidence of the overall significance of the estimated model for forecasting. The study therefore found out crowding out effect of debt servicing. The diagnostic results for this model is discussed later in the chapter and the output results are presented in the appendix 4.

#### 4.4.3 Long-Relationship between Total Debt Service and real exchange rate.

The study sought to establish the long run relationship between total debt service and the real effective rate of exchange rate. The interest was to determine the credibility of the country's domestic policies and consequently ascertain susceptibility of the country to global exogenous shocks.

##### Estimated equation:

$$RER = \rho_3 + \mu_{31}GDP1 + \mu_{32}CSE + \mu_{33}RIR + \mu_{34}YEAR + \mu_{35}TDS + \mu_{36}TRADE + \varepsilon_{3t}$$

##### Substituted Coefficients:

$$RER = -4487.3 - 3.22*CSE - 0.403*GDP1 + 2.3*YEAR + 0.48*TRADE - 2.03*TDS + 0.326*RIR$$

**Table 4.6: Regression Output Results for Real Exchange Rate.**

Dependent Variable: RER				
Method: Least Squares				
Included observations: 41 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4487.269	177.9873	-25.21118	0.0000
CSE	-3.215179	0.632054	-5.086872	0.0000
GDP1	-0.403264	0.300270	-1.343006	0.1882
YEAR	2.293916	0.086297	26.58150	0.0000
TRADE	0.477907	0.068844	6.941910	0.0000
TDS	-2.029364	0.261534	-7.759471	0.0000
RIR	0.326360	0.102648	3.179398	0.0031
R-squared	0.976937	Mean dependent var		37.59268
Adjusted R-squared	0.972867	S.D. dependent var		29.27061
S.E. of regression	4.821481	Akaike info criterion		6.138291
Sum squared resid	790.3872	Schwarz criterion		6.430852
Log likelihood	-118.8350	Hannan-Quinn criter.		6.244826
F-statistic	240.0368	Durbin-Watson stat		1.841891
Prob(F-statistic)	0.000000			

The estimation results revealed strong statistically significant relationships of real exchange rate with total debt service (-2.03), real interest rate (0.326), expenditure on consumption (-3.22), trade (0.478) and growth in technology (2.294) (proxied by year). R-squared (0.977) implied a very strong relationship between real exchange rate and the right hand side variables. Further, the p-value of the F-statistic (0.0000) indicated a joint significance of the variables hence the model precisely explained the estimated relationship.

Based on the results, the negative significant relationship between total debt service (-2.03) with real effective rate of exchange reveal that increase in debt servicing deteriorated the real effective exchange rate. The implication is that Kenya remained vulnerable to the international community shocks and the country does not have strong policy institutions. Put differently, the country's domestic policies are incredible in influencing the country's economic management. Strong institutions is the reason why the European Monetary Union country's with much higher debt portfolio (over 100 percent of GDP) relative to Kenya (46 percent of GDP) are considered to have more sustainable debts (Checherita, 2010). The diagnostic test results are discussed in the following section.

#### 4.5 Diagnostic Tests Results

Before making any conclusions from the estimation results, a series of diagnostic results were carried out to ascertain the statistical soundness of the models and whether they could be used for forecasting (Gujarati, 2004).

**Table 4.7: Summary of GDP Model Diagnostic Tests Results**

Histogram-Normality Test	Jarque- Berra	1.3615
	Probability	0.506
Breusch-Godfrey Serial Correlation Test	Observed R-squared	0.481949
	Probability	0.7859
Ramsey RESET Test	F-statistic	2.510678
	Probability	0.0981

**Table 4.8: Summary of Private Investment Model Diagnostic Tests Results.**

Histogram-Normality Test	Jarque- Berra	0.876
	Probability	0.645
Breusch-Godfrey Serial Correlation Test	Observed R-squared	1.101
	Probability	0.602
Ramsey RESET Test	F-statistic	0.393
	Probability	0.53

**Table 4.9: Summary of RER Model Diagnostic Tests Results.**

Histogram-Normality Test	Jarque- Berra	2.11
	Probability	0.34
Breusch-Godfrey Serial Correlation Test	Observed R-squared	0.86
	Probability	0.4534
Ramsey RESET Test	F-statistic	0.41
	Probability	0.53

#### **4.5.1 Discussion of Residual-Based Tests Results**

A critical requirement in the classical linear regression is that the residuals must be normally distributed with zero mean and constant variance (Enders, 1995). The following sections report the diagnostic tests that were done for the regression models. Test was undertaken to establish whether the residuals were normally distributed. The null hypothesis for the histogram-normality test is; the residuals are normally distributed, against the alternative hypothesis that the residuals do not exhibit normal distribution. The p-value for the Jarque-Bera statistic for the models for GDP, PIGR, and RER were 0.51, 0.64 and 0.34 respectively; all of which are greater than 0.05, hence the null hypothesis could not be rejected. Conclusion was thus made that the regression residuals followed a normal distribution. A linear function of normally distributed variables is considered to be normally distributed. Normal distribution of the residuals implied that the coefficients of the estimates themselves were also normally distributed (Greene, 2008).

The study tested for the presence of serial autocorrelation amongst the estimated variables using the Breusch-Godfrey Lagrange Multiplier Tests. This test was postulated by Breusch (1978) and Godfrey (1978), being capable of handling higher order autocorrelation. The null hypothesis for this test is that there is no serial correlation, against the alternative that the variables are autocorrelated. The computed auxiliary R-squared for the B-G tests for the models had corresponding p-values of 0.78, 0.60 and 0.65 which are greater than 0.05, hence the null hypothesis of no autocorrelation could not be rejected at 5 per cent level of significance.

#### **4.5.2 Regression Specification Error Test (RESET) and Model Stability.**

The preceding section discussed residual-based individual tests such as normality tests and serial autocorrelation tests. The tests results gave evidence that the estimation models satisfied all the OLS assumptions hence were desirable. To detect specification errors in a model which could have been mis-specified but nevertheless give desirable results, Ramsey and Alexander (1984) proposed Regression Specification Error Test (RESET) to establish departure from the classical linear regression assumptions. This is a general test for omitted variable problem, correlation between the exogenous variables and the residuals and incorrect functional relationship in a model. The specification errors could be due to measurement errors of the regressors and expressing the endogenous variable as a function of its past values in the model.

The results indicated that the p-values (0.09, 0.53 and 0.53) for GDP, PI and RER models respectively of the F-statistic were greater than 0.05 hence the null hypothesis of the model being correctly specified could not be rejected. This meant that the standard errors were correct and the F-statistics was valid.

Finally, stability test of the model's recursive estimates was conducted on the estimated equation. In this regard, CUSUM tests and CUSUM of squares tests were run. The results gave sufficient evidence to reject the null hypothesis of the model not being stable at 5 per cent level of significance. The results therefore supported the claim that the model is stable since the residuals lie within the dual standard error range. The CUSUM test results are appended in figures A2, A4 and A7. In general, the estimation models for the effects of total debt service on selected macroeconomic variables were stable since they fulfilled all the necessary requirements for a good estimation model: sufficient coefficients of determination (R-squared above 60 percent), implying that the explanatory variables sufficiently explained the changes in the dependent variables; the F-statistic of the overall models, t-statistic and the corresponding p-

values of most of the regressors were statistically significant; thus the parameters individually and jointly explained the changes in the regressand (Greene, 1997). The signs of the coefficients of the explanatory variables also met the expectation from economic theory. The residuals also satisfied all the necessary OLS assumptions. The diagnostic test results further yielded sufficient evidence of stability of the models and correct specification thus the estimated models are fit for forecasting.

#### **4.6 The Responsiveness of the Variables to Changes in the Level of Debt Service**

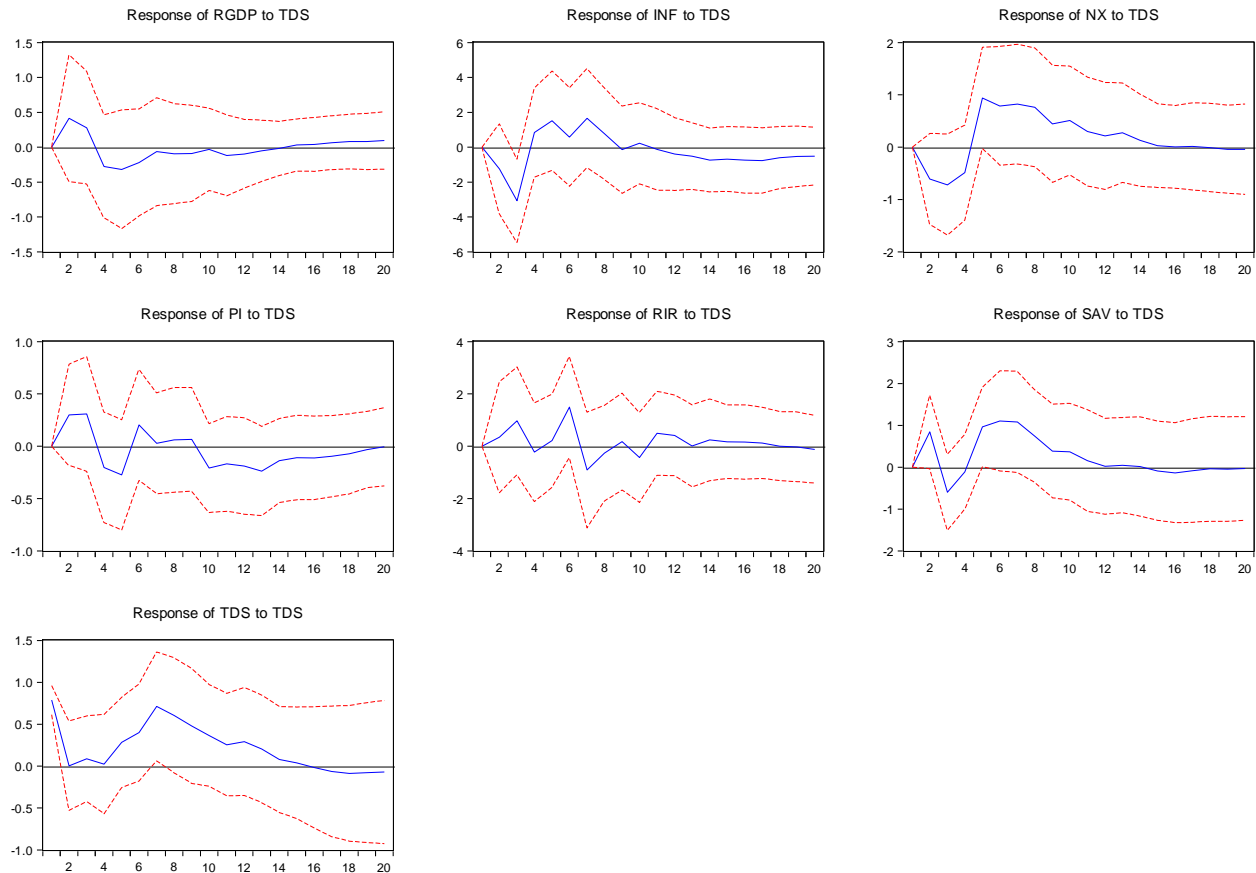
The second objective of the study was to analyze the dynamic impact of the macroeconomic variables due to shock in debt service. This was achieved by running a VAR estimation and further derivation of impulse response functions of these variables. The forecasting was done over a twenty-year time horizon.

##### **4.6.1 Estimation Results for VAR Model and the Impulse Responses**

The VAR estimates presented in Appendix were not interpreted like the ordinary least squares estimates because they were not derived from structural equations (Sims, 1980). The estimated coefficients of the VAR are meaningless because they lack theoretical foundation (Enders, 1995). However, the coefficients are used in the derivation of impulse responses and forecast error decompositions. Impulse response analysis links the current value of the error term to the future values of the variables in the VAR. IRFs essentially map out the dynamic response path of a variable due to a shock in the system of variables. The plots of the impulse responses that follow summarize the results of the shock evolution, tracing the dynamic responses of each of the variables over twenty years period to the initial one standard deviation positive shock to total debt service. Figure 4.3 presents the dynamic impact of total debt service on the various variables.

**Figure 4.1: Impulse Response Functions of the Variables.**

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



Source: author's calculation.

#### 4.6.1 Response of Real GDP to Total Debt Service

A one standard deviation innovation to total debt service results in a stable impact which declines to zero after thirteen years, after which it remains in the positive range with respect to real GDP. The impact swings in both in the positive and negative ranges. This suggests that total debt servicing has mixed effect on real GDP and this effect is felt long in the economy. The resultant effect depends on the usage of the borrowed funds being serviced. If the borrowed money is invested in the productive sectors, there will be a positive impact on real GDP. However if the borrowed money is channeled to the unproductive sectors like consumption, the resultant effect will be negative (Lerner, 1948).

#### **4.6.2 The Impact of Total Debt Service on Private Investment**

As shown in figure above, it would take nineteen years for the impact of a shock in total debt service on private investment to decay. The impact is initially positive for the first five years then moves to the negative territory, back to positive bound and then shrivels in the negative region and back to zero in the twentieth year. This suggests that total debt service impacts private investment negatively since the effect of the change is felt for longer duration (12 years) in the negative bound. This suggests the possibility of crowding out of private investment in Kenya. These findings also support the view by the neo-classicalists (Bailey, 1971; Buiter, 1977)

#### **4.6.3 The Impact of Total Debt Service on Net Exports**

The figure shows that a one standard deviation shock in total debt service would last for fifteen years before it clears. The effect remains negative for the first five years after which it impacts negatively until the fifteenth year and then clears hence it can be deduced that the impact of debt service on external balance of goods and services is positive in the long run since the impact is longer in the upper bound.

#### **4.6.4 The Response of Inflation to Total Debt Service**

It would take more than twenty years for the effect of a one standard deviation shock in total debt service to cease. The initial impact is negative for the first four years, the positively for the next six years. The effect thereafter remains infinitely negative across the twenty-year forecasting

horizon. Thus total debt service impacts inflation and persists for long in the economy just like the other macroeconomic variables.

#### **4.6.5 Response of Real Interest Rate to Total Debt Service**

There is a stable response of real interest rate to a one standard deviation shock to total debt service, which declines after seventeen years. The impact persists more on the positive range, suggesting that the effect total debt service on real interest rate is positive. This impact lasts for sixteen years. This is also consistent with the neoclassical view; increase in total debt servicing increases present consumption thus reducing savings. This leads to a rise in interest rate.

#### **4.6.7 Response of Savings to Total Debt Service**

As depicted in the diagram, a one standard deviation shock in total deviation in total debt service induces an overall positive impact on savings. The effect is first positive for the first two years, then negative for the next two years. Thereafter it persists in the positive range until it fizzles out in the seventeenth year.

#### **4.6.8 Response of Total Debt Service to Own Shock.**

A one standard deviation own shock to total debt service induce a positive impact to itself that lasts for sixteen years after which it decays, as can be observed in the diagram.

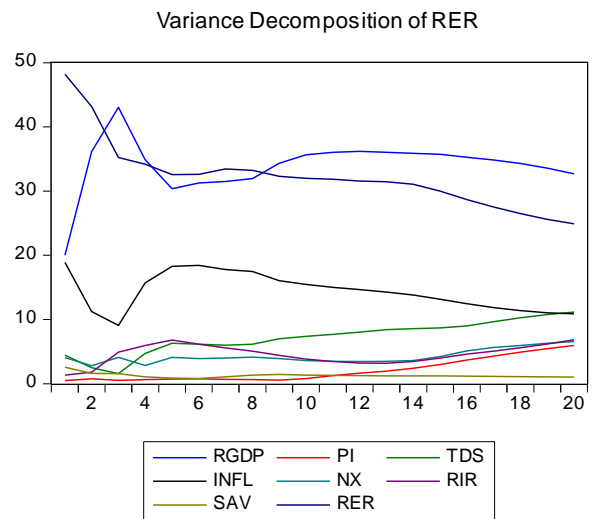
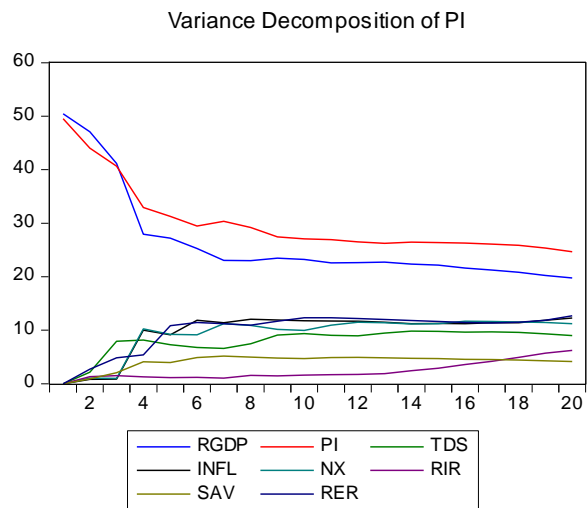
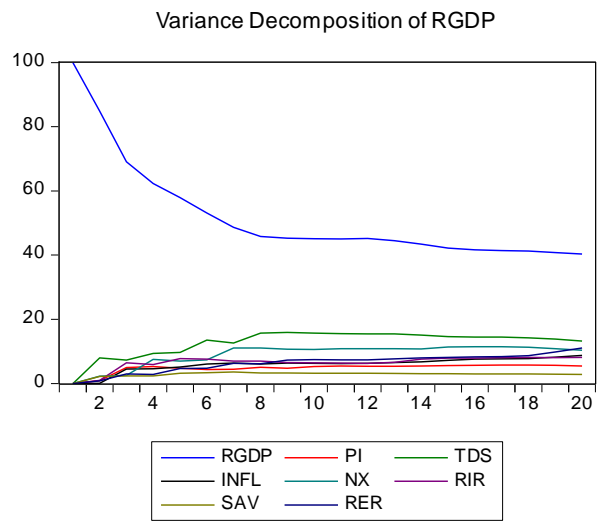
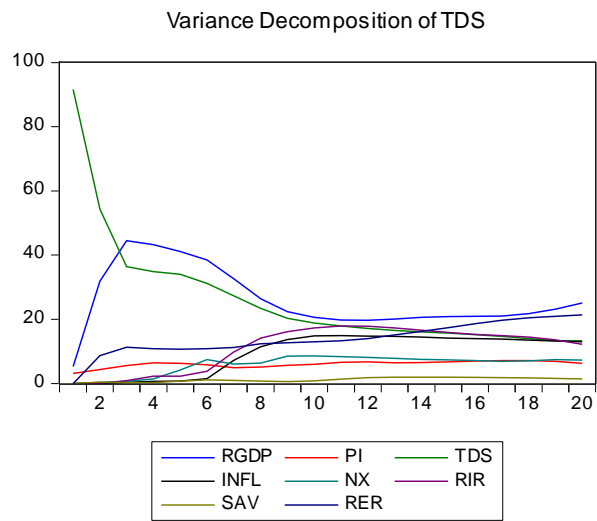
In summary, impulse response functions traced out the dynamic responses of current and future values of each of the variables to a one unit increase in the current value of the error of total debt service, assuming that this error returned to zero in the subsequent periods and that the other

errors were equal to zero. The derived impulse responses showed patterns of persistent common variation. An unexpected rise in total debt service slowly decayed over ten years, hence the impact takes long to settle. The resultant impact for most of the variables was associated with both increases and decreases in the variables.

#### **4.7 Variance Decomposition Analysis**

Since VAR model is over-parameterized, they are not particularly useful for short term forecasts. However understanding the perspectives of the forecast error variance is exceedingly useful in explaining interrelationships among the variables in the system. Variance decomposition presents a further step of establishing the percentage of variations in a series due to its own shocks and the proportion of the variance attributed to other variables in the system at a given period (Enders, 1995). In this context, the variations in the variables due to own shocks and shocks due to other variables total debt service were analyzed. The results are discussed below.

**Table 4.1 Results of Variance Decomposition of Selected Variables**



The plots of the forecast error decompositions indicate that in the first period for most of the variables, a higher percentage of variations were due to their own shocks. However these variations reduced with the increase in the forecast horizon. The impact due to unexpected shocks to other variables on the selected variables increased as the forecast horizon expanded. The focus was to determine the percentage of the variations in the selected variables that is contributed by the total debt service.

Notably, the proportion of the forecast error variance of the selected macroeconomic variables due to total debt service was significant. For GDP growth the proportion of the forecast error variance grew and persisted at around an average of 16 percent infinitely across the forecast horizon. For private investment, it was low in the initial periods but rose steadily to about 19 percent where it persisted even beyond the forecast period. The impact of total debt service was more prominent on real effective exchange rate. Actually, the percentage rose as the forecast horizon increased. The impact was initially mild at below 5 percent but consistently rose to around 20 percent.

The plots of the forecast errors variance decomposition reveal strong interrelationships amongst these variables. The analysis show that innovations in total debt service yield feedback effects with the variables and these effects are multidirectional. Total debt servicing therefore has a significant effect on macroeconomic performance.

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 Introduction**

This chapter summarizes the study findings and makes conclusions based on the study findings.

The policy implications from the study findings and areas for further research are also discussed.

#### **5.2 Summary**

The overall objective of this study was to investigate the long run relationship between total debt servicing and macroeconomic performance. Establishing the precise quantitative nature of the relationship between total debt service and various macroeconomic variables would be meaningful for fiscal policy formulation and proper economic management, which is much needed for the attainment of the Kenya Vision 2030.

In order to achieve the objectives of the study, data on various macroeconomic variables were collected for the period 1970 to 2013 from various sources such as the World Bank and the Kenya Economic Surveys from the Kenya National Bureau of Statistics. A theoretical growth model that formed the basis of inclusion of variables in the empirical model was derived.

The first objective of this study was to determine the long run relationship between total debt service and selected macroeconomic variables. Given the dynamic nature of the derived

theoretical model, the long run equilibrium model was derived to estimate the effect of total debt service alongside other control variables on Real GDP Growth, Private Investment Growth and Real Effective Exchange Rate. The main interest was to ascertain the existence of debt overhang, crowding out of private investment due to servicing the debts and the credibility of domestic policies and macroeconomic stability (captured by real exchange rate and inflation). The study found out no existence of debt overhang but there was evidence of crowding out effect. The study also found out that the country remained vulnerable to adverse exogenous shocks from the international community.

The second objective of the study was to analyze the dynamic response of the variables due to innovations in total debt servicing. A VAR model was estimated and the estimation coefficients used to derive the impulse response functions of the various variables. The dynamic response was analyzed over a twenty year time horizon. From the findings, the impact of unexpected changes in total debt service lasted for long in the economy before finally fizzling out. This was observed in the various variables such as GDP, private investment, real interest rate, savings and external balance of goods and services among others. From variance decomposition analysis, TDS had feedback effects on the variables and the effects were multidirectional. The impact of the shocks increased as the forecast horizon progressed. The study thus concluded that debt servicing has significant impact on the macroeconomic fundamentals.

### **5.3 Conclusions**

Based on the study findings, the study concludes that total debt servicing has a significant effect on macroeconomic performance. This is due to the estimated effects on the macroeconomic fundamentals. Debt servicing crowded out private investment with no existence of debt

overhang. Further innovations in total debt servicing would persist in the economy for over ten years to shrivel.

#### **5.4 Policy Implications**

In view of the research findings, private investment is adversely affected by debt servicing. This could be attributed to less stronger institutions which undermines the investor confidence of the country's commitment to efficiently manage the economy. However there was no existence of debt overhang, implying that Kenya has sustainable debt and the borrowed funds are invested in the productive sectors of the economy such that the from multiplier effect, the returns on the investments are exceed the cost of the debt. Therefore servicing the debt stocks does not pose financial risk to the country.

The study therefore recommends effectiveness in the implantation of the medium term debt strategy aimed at having an optimal borrowing mix between domestic debt and external debt to guard against vulnerability to external shocks and crowding out effect. Further, policies on debt management should be carefully designed not to weaken macroeconomic fundamentals because of their lasting impact in the economy.

#### **5.5 Areas for Further Research**

The focus of this study was limited to effect of total debt service on selected macroeconomic variables and analyzing the dynamic response of these variables due to changes in the debt

service level. The study proposes further investigation on the relationship between debt servicing, revenue and public expenditure in Kenya.

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- World Bank Development Indicators Online Data.

## APPENDICES

### Appendix 1(c): Refined Data for Estimation.

YE AR	RGDP growth	GDP1	TDS/G NI	CEXP growth	INFL	DSAV/ GDP	NX/G DP	GCF growth	RIR	RER
197 0	-4.66	-4.66	3.16	3.42	15.32	23.56	-0.84	37.75	22.3 1	7.14
197 1	22.17	2.22	2.99	15.02	-9.22	17.37	-6.55	1.41	20.0 7	7.14
197 2	17.08	1.71	2.33	8.45	1.21	20.18	-2.14	-8.17	7.70	7.14
197 3	5.90	5.90	2.72	3.60	10.20	24.54	-1.28	20.94	-1.09	7.02
197 4	4.07	4.07	3.40	8.53	16.05	18.53	-7.22	-5.38	-5.64	7.13
197 5	0.88	0.88	4.77	11.94	11.84	13.45	-4.69	-31.50	-1.64	7.34
197 6	2.15	2.15	5.08	7.40	18.91	20.93	0.69	11.93	-7.49	8.37
197 7	9.45	9.45	7.52	12.21	16.90	27.02	3.37	35.84	-5.90	8.28
197 8	6.91	6.91	4.22	14.82	3.08	20.01	-9.75	23.86	6.71	7.73
197 9	7.62	7.62	4.98	5.72	5.64	16.43	-5.86	-24.49	4.13	7.48
198 0	5.59	5.59	6.15	2.27	9.55	18.12	-6.38	13.65	0.94	7.42
198 1	3.77	3.77	7.30	-5.38	10.85	19.55	-3.36	-4.72	1.41	9.05
198 2	1.51	1.51	8.04	-1.51	11.59	16.96	-4.90	-22.72	2.61	10.9 2
198 3	1.31	1.31	8.90	8.55	11.84	18.66	-2.26	-9.95	3.57	13.3 1
198 4	1.76	1.76	9.66	0.01	10.19	14.51	-5.30	0.72	3.84	14.4 1
198 5	4.30	4.30	10.48	1.01	8.31	20.48	-4.85	28.03	5.26	16.4 3
198 6	7.18	7.18	9.68	7.15	8.71	17.72	-4.04	-18.36	4.86	16.2 3
198 7	5.94	5.94	8.99	3.24	5.40	19.20	-5.09	22.24	8.16	16.4 5
198 8	6.20	6.20	9.18	1.86	6.46	20.22	-5.23	1.76	8.03	17.7 5
198	4.69	4.69	8.83	1.43	9.77	17.77	-7.09	10.13	6.82	20.5

9										7
1990	4.19	4.19	9.62	4.60	10.64	18.53	-5.64	-6.99	7.33	22.91
1991	1.44	1.44	9.25	5.82	12.53	19.46	-1.51	-7.85	5.75	27.51
1992	-0.80	-0.80	8.52	9.12	18.90	16.51	-0.41	-18.22	1.83	32.22
1993	0.35	0.35	11.72	7.50	25.70	22.56	4.95	14.97	3.41	58.00
1994	2.63	2.63	12.99	29.39	17.02	22.11	2.81	9.09	16.43	56.05
1995	4.41	4.41	10.36	9.83	11.22	15.26	-6.56	8.40	15.80	51.43
1996	4.15	4.15	7.09	2.71	41.99	8.09	-6.91	9.98	-5.78	57.11
1997	0.47	0.47	5.07	-0.45	11.44	6.46	-8.68	8.55	16.88	58.73
1998	3.29	3.29	4.75	3.56	6.93	8.13	-8.56	20.78	21.10	60.37
1999	2.31	2.31	5.44	-2.38	4.19	8.99	-6.53	-8.13	17.45	70.33
2000	0.60	0.60	4.70	-2.24	6.08	7.28	-10.13	11.11	15.33	76.18
2001	3.78	3.78	3.76	2.77	1.57	8.71	-10.08	12.12	17.81	78.56
2002	0.55	0.55	4.06	1.64	0.93	9.76	-5.38	-20.37	17.36	78.75
2003	2.93	2.93	3.93	6.01	6.20	10.52	-5.96	10.01	9.77	75.94
2004	5.10	5.10	2.23	0.58	7.13	10.83	-6.26	7.63	5.05	79.17
2005	5.91	5.91	2.87	-0.78	4.90	9.45	-7.46	13.24	7.61	75.55
2006	6.32	6.32	1.90	1.46	7.79	8.06	-9.89	22.45	-8.13	72.10
2007	6.99	6.99	1.43	1.67	5.34	5.34	37.03	-11.03	4.96	67.32
2008	0.23	0.23	1.15	1.36	11.86	11.86	41.83	-14.23	-0.98	69.18
2009	3.31	3.31	1.05	5.00	10.50	6.68	38.31	-13.07	2.84	77.35
2010	8.41	8.41	1.01	7.20	4.10	3.90	38.94	-12.98	12.03	79.23
2011	6.12	6.12	1.04	2.80	14.02	5.64	-17.20	1.07	3.85	88.81

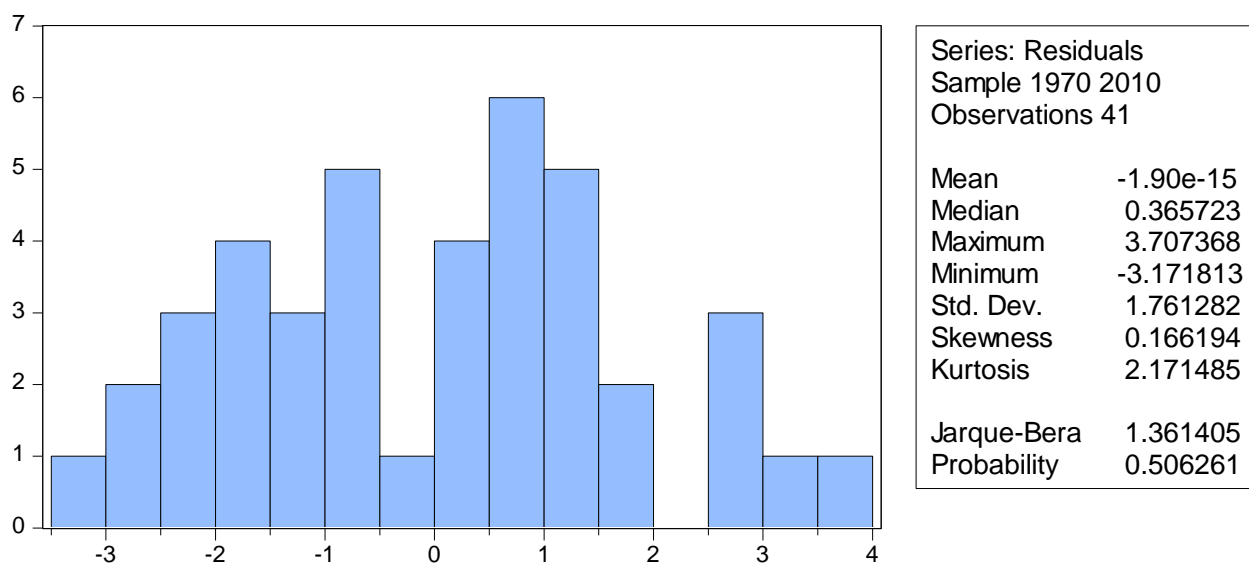
201 2	4.45	4.45	1.13	7.00	9.38	6.00	-15.61	0.06	9.51	84.5 3
201 3	5.74	5.74	1.13	6.50	5.72	4.24	-15.44	0.92	10.9 4	86.1 2

**Appendix 1: table A1 Data Description.**

	GDP1	CSGR	INFL	NX	PIGR	RIR	SAV	TDS
Mean	3.537982	4.978855	9.988600	-0.460	2.888432	6.548059	15.21217	5.885252
Median	3.773544	3.557783	9.769010	-5.233	7.627532	5.257538	16.95941	5.074008
Maximum	9.453798	29.39412	41.98877	41.83268	37.74889	22.31000	27.02296	12.98719
Minimum	-4.660	-5.384	-9.219	-10.134	-31.502	-8.132	3.900000	1.005282
Std. Dev.	2.836366	6.066218	7.886745	13.62348	16.90596	8.097222	5.998651	3.273864
Skewness	-0.260	1.647637	1.480190	2.401953	0.022036	0.171587	-0.178	0.262889
Kurtosis	3.254768	7.654931	8.545582	7.368915	2.273129	2.310299	1.922176	1.950535
Jarque-Bera	0.572824	55.56732	67.50877	72.03175	0.905901	1.013819	2.200175	2.353774
Probability	0.750953	0.000000	0.000000	0.000000	0.635750	0.602354	0.332842	0.308237
Sum	145.0573	204.1330	409.5326	-18.878	118.4257	268.4704	623.6990	241.2953
Sum Sq. Dev.	321.7990	1471.960	2488.030	7423.965	11432.46	2622.600	1439.353	428.7275
Observations	41	41	41	41	41	41	41	41

**Source: Author's calculation**

**Figure 4.1: Histogram-Normality test results for model 1 (RGDP).**



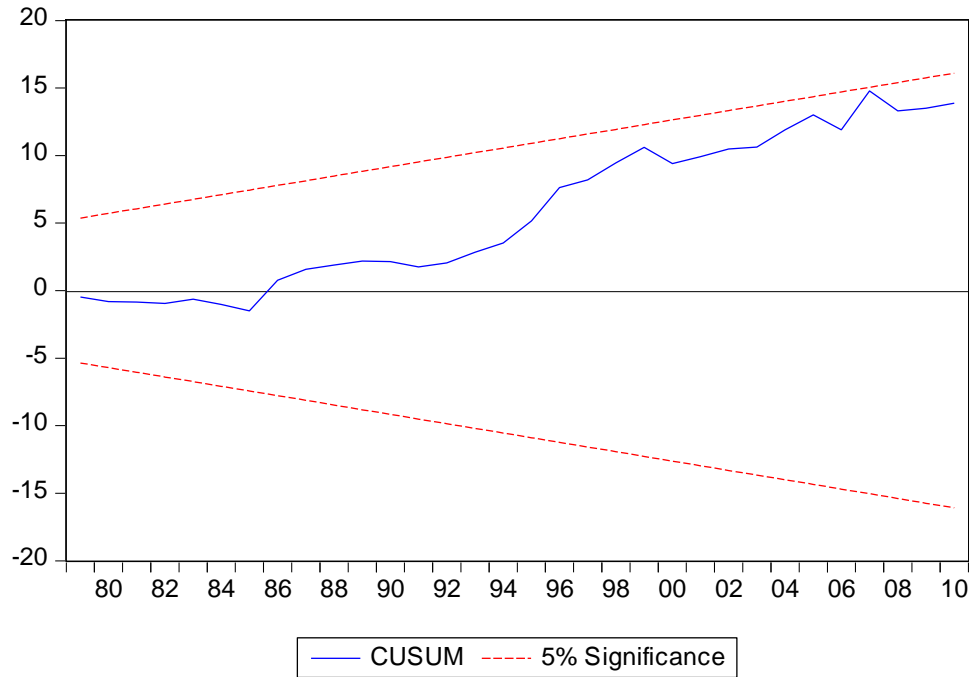
**Table 4.1: Breusch- Godfrey Serial Correlation Tests Results for GDP Growth**

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.178420	Prob. F(2,30)	0.8375
Obs*R-squared	0.481949	Prob. Chi-Square(2)	0.7859

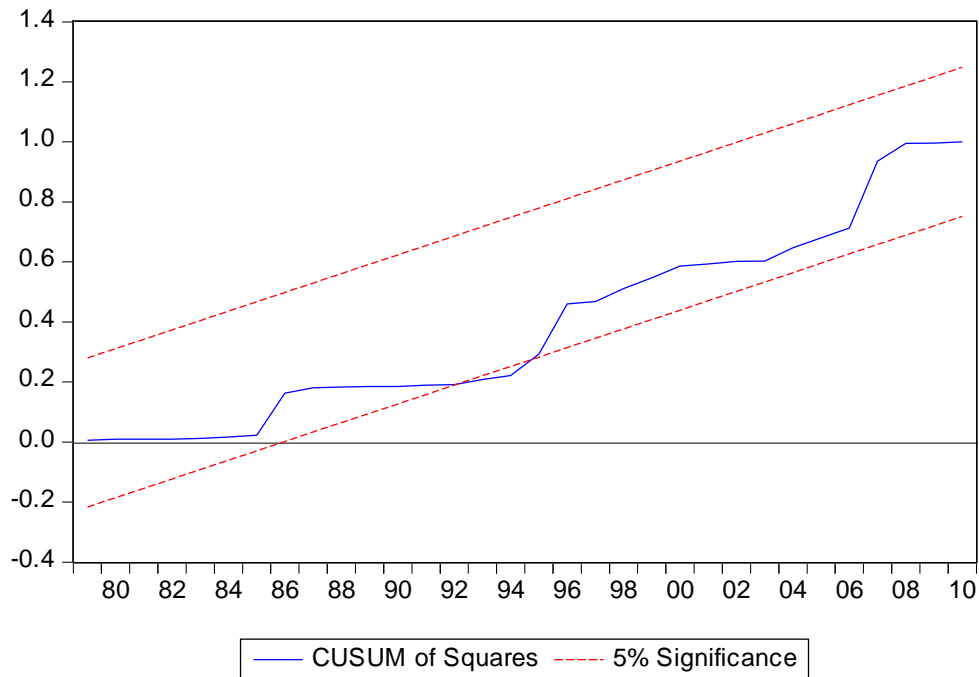
**Table 4.2: Model Specification tests for model 1-Ramsey-RESET Tests**

Specification: GDP1 C CSGR D1 NX PIGR INFL RIR SAV TDS				
Omitted Variables: Powers of fitted values from 2 to 3				
	Value	Df	Probability	
F-statistic	2.510678	(2, 30)	0.0981	
Likelihood ratio	6.345186	2	0.0419	

**Figure A2: Model Stability Tests CUSUM of Squares Tests Results for GDP Growth**



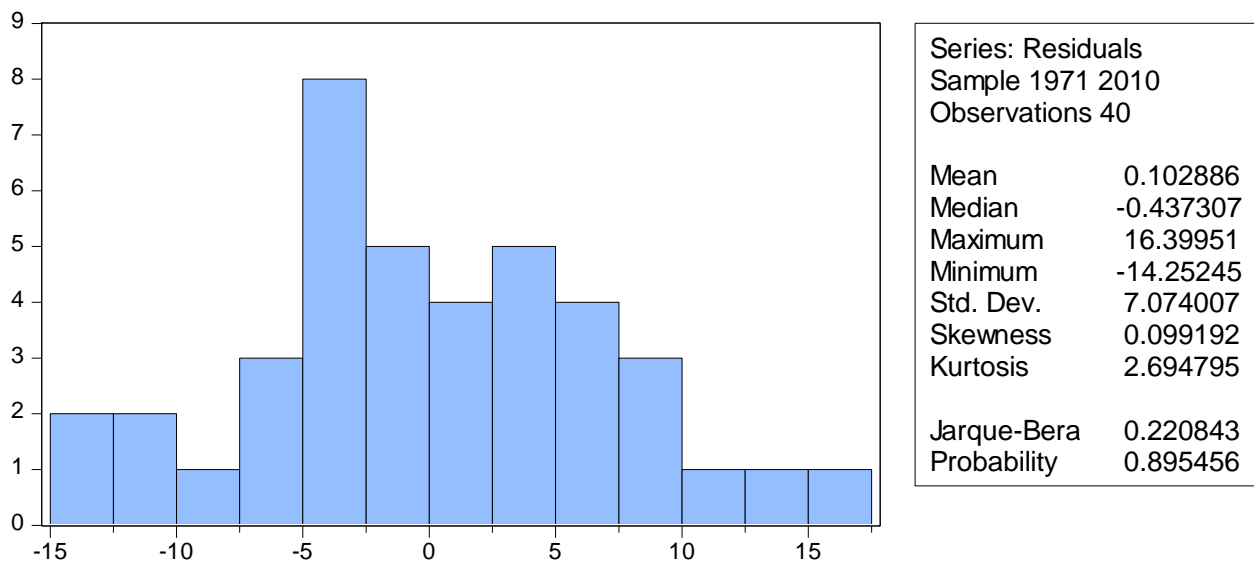
**Figure A3: CUSUM of Squares Stability Test Result.**



**Table 4.3: Summary of diagnostic tests results for GDP equation (model 1)**

Histogram-Normality Test	Jarque- Berra	1.3615
	Probability	0.506
Breusch-Godfrey Serial Correlation Test	Observed R-squared	0.481949
	Probability	0.7859
Breusch- Pagan Godfrey Heteroskedasticity Test	Observed R-squared	7.798468
	Probability	0.4534
Ramsey RESET Test	F-statistic	2.510678
	Probability	0.0981

**Figure A4: Normality Test for Model 2-Private Investment Growth.**



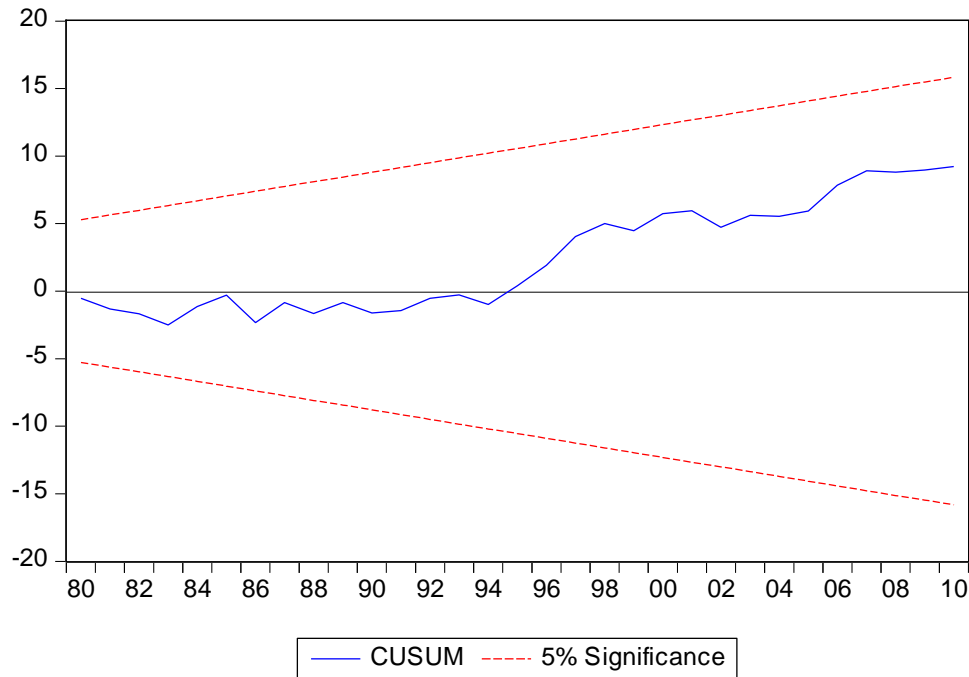
**Table 4.4: Serial Correlation Test Results for Private Investment Equation**

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.367777	Prob. F(2,29)	0.6955
Obs*R-squared	1.014198	Prob. Chi-Square(2)	0.6022

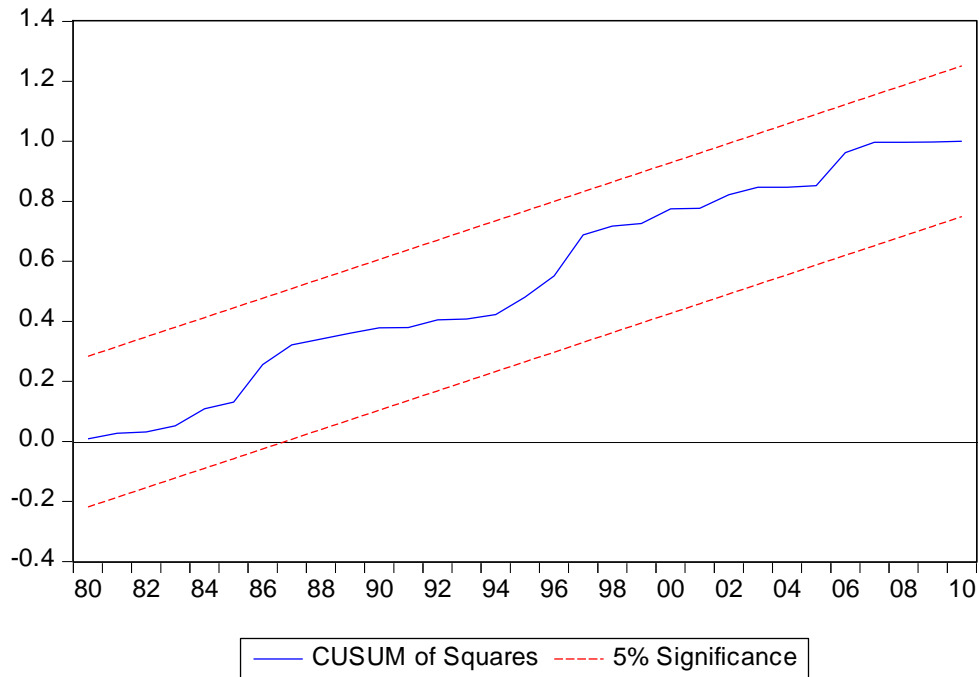
**Table 4.5: Model Specification Test Results-Ramsey RESET Test for PIGR**

Ramsey RESET Test				
Equation: EQPIGR				
Specification: PIGR C CSGR D1 TDS YEAR SAV RIR NX INFL GDP1				
Omitted Variables: Squares of fitted values				
	Value	Df	Probability	
t-statistic	0.627088	30	0.5353	
F-statistic	0.393240	(1, 30)	0.5353	
Likelihood ratio	0.533936	1	0.4650	

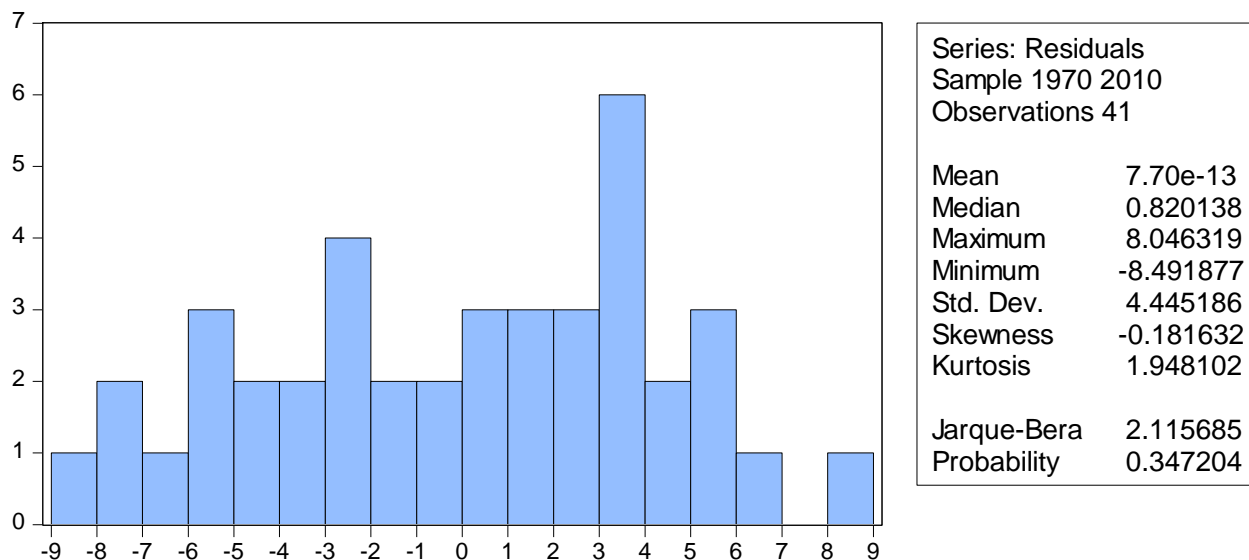
**Figure A4: Model Stability Tests- CUSUM Tests Results for Private Investment**



**Figure A5: Model Stability Tests CUSUM of squares Tests Results for GDP Growth**



**Figure A5: Normality Tests for Real Effective Exchange Rate**

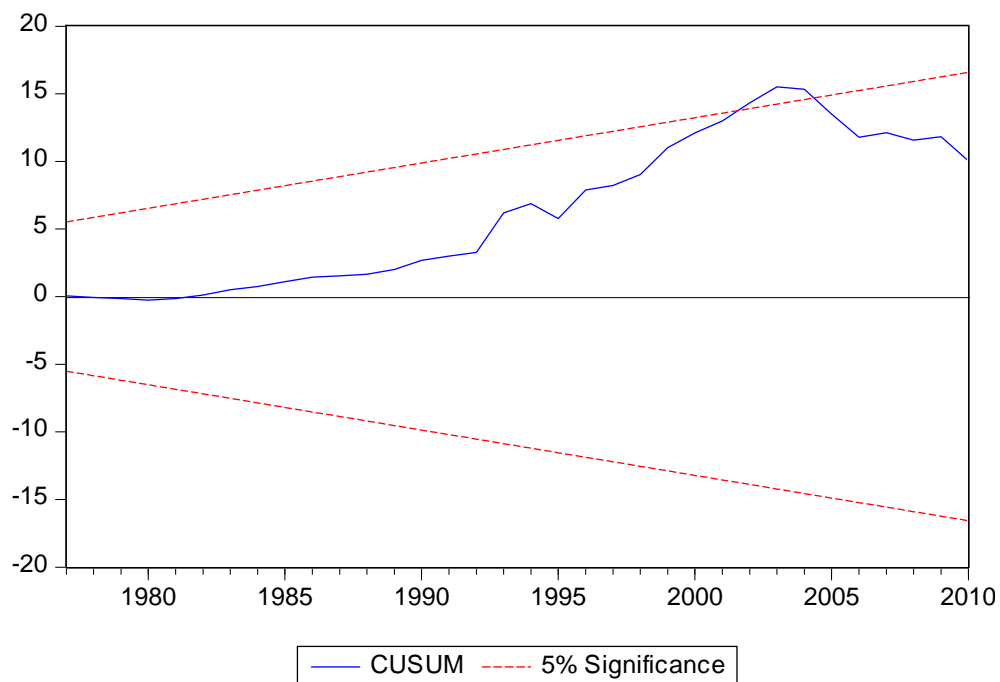


**Table 4.6: Serial Correlation Test for Exchange Rate Equation**

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.343340	Prob. F(2,32)	0.7120
Obs*R-squared	0.861327	Prob. Chi-Square(2)	0.6501

**Table 4.6: Model Specification Test Results-Ramsey RESET Test for RER**

Ramsey RESET Test				
Equation: UNTITLED				
Specification: RER C CSE GDP1 YEAR TRADE TDS RIR				
Omitted Variables: Squares of fitted values				
	Value	df	Probability	
t-statistic	0.636675	33	0.5287	
F-statistic	0.405355	(1, 33)	0.5287	
Likelihood ratio	0.500555	1	0.4793	



## Appendix 6(a): Optimal Lag Selection Criteria Results for Objective Two

VAR Lag Order Selection Criteria

Endogenous variables: GDP1 CSE NX INFL PI RER SAV

RIR TDS

Exogenous variables: C

Sample: 1970 2013

Included observations: 38

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-971.9530	NA	2.14e+11	51.62910	52.01695	51.76710
1	-752.2075	323.8355	1.61e+08	44.32671	48.20520	45.70665
2	-630.3806	121.8269	40814226	42.17792	49.54706	44.79981
3	-366.1648	139.0610*	45006.50*	32.53499*	43.39477*	36.39881*

\* 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-Quinn information criterion

## Appendix 6(b): VAR regression output results

Vector Autoregression Estimates								
Standard errors in ( ) & t-statistics in [ ]								
	RGDP	PI	TDS	INFL	NX	RIR	SAV	RER
RGDP(-1)	0.34442 4	0.55653 8	- 0.178133	- 1.279439	- 0.597321	0.91771 0	0.17691 2	- 1.055020
	(0.38135 )	(0.41425 )	(0.21280 )	(0.92177 )	(0.85947 )	(0.91865 )	(0.50160 )	(0.93111 )
	[ 0.90316]	[ 1.34349]	[- 0.83708]	[- 1.38803]	[- 0.69499]	[ 0.99897]	[ 0.35269]	[- 1.13307]
RGDP(-2)	0.04589 2	0.16210 5	- 0.035078	- 0.122605	0.66105 6	- 0.122585	- 0.357849	- 0.851924
	(0.24023	(0.26095	(0.13405	(0.58066	(0.54141	(0.57870	(0.31598	(0.58655

	)	)	)	)	)	)	)	)
	[0.19104]	[0.62121]	[-0.26167]	[-0.21115]	[1.22098]	[-0.21183]	[-1.13251]	[-1.45244]
RGDP(-3)	0.004695	-0.071735	0.036783	0.583596	0.383258	-0.386099	-0.020012	0.035271
	(0.22602)	(0.24551)	(0.12612)	(0.54631)	(0.50939)	(0.54446)	(0.29729)	(0.55185)
	[0.02077]	[-0.29218]	[0.29165]	[1.06825]	[0.75239]	[-0.70914]	[-0.06731]	[0.06391]
PI(-1)	-0.395860	-0.211451	-0.086707	-0.610757	1.480112	0.967298	-0.688020	0.350169
	(0.38546)	(0.41871)	(0.21510)	(0.93170)	(0.86873)	(0.92855)	(0.50701)	(0.94115)
	[-1.02698]	[-0.50500]	[-0.40311]	[-0.65553]	[1.70377]	[1.04173]	[-1.35702]	[0.37207]
PI(-2)	-0.409031	-0.416831	-0.155892	-0.126489	0.431869	-0.070283	-0.084654	-0.219424
	(0.27879)	(0.30283)	(0.15557)	(0.67385)	(0.62831)	(0.67157)	(0.36669)	(0.68068)
	[-1.46719]	[-1.37644]	[-1.00209]	[-0.18771]	[0.68735]	[-0.10465]	[-0.23086]	[-0.32236]
PI(-3)	0.006909	-0.095368	0.055611	0.343168	1.003235	-0.171484	0.542559	0.325070
	(0.21119)	(0.22940)	(0.11785)	(0.51046)	(0.47596)	(0.50874)	(0.27778)	(0.51564)
	[0.03272]	[-0.41572]	[0.47189]	[0.67227]	[2.10781]	[-0.33708]	[1.95319]	[0.63042]
TDS(-1)	-0.526099	0.547115	0.344175	1.139408	0.806149	-1.696647	-0.668337	-1.070782
	(0.52304)	(0.56816)	(0.29187)	(1.26424)	(1.17880)	(1.25997)	(0.68797)	(1.27706)
	[-1.00584]	[0.96296]	[1.17921]	[0.90126]	[0.68387]	[-1.34658]	[-0.97146]	[-0.83847]
TDS(-2)	0.744371	-0.880973	0.247551	1.014699	1.264652	-0.199130	0.901992	-1.599612
	(0.94737)	(1.02909)	(0.52865)	(2.28989)	(2.13512)	(2.28215)	(1.24610)	(2.31311)

	[ 0.78572]	[- 0.85607]	[ 0.46827]	[ 0.44312]	[ 0.59231]	[- 0.08726]	[ 0.72385]	[- 0.69154]
TDS(-3)	0.079158	0.861162	0.268247	- 1.669523	- 0.642598	1.778595	- 0.125216	2.667351
	(0.74018)	(0.80403)	(0.41304)	(1.78909)	(1.66817)	(1.78305)	(0.97358)	(1.80724)
	[ 0.10694]	[ 1.07106]	[ 0.64945]	[- 0.93317]	[- 0.38521]	[ 0.99750]	[- 0.12861]	[ 1.47593]
INFL(-1)	- 0.073035	- 0.095639	- 0.087365	- 0.617040	- 1.852480	0.284848	- 0.116668	- 0.786484
	(0.17972)	(0.19522)	(0.10029)	(0.43439)	(0.40503)	(0.43293)	(0.23639)	(0.43880)
	[- 0.40639]	[- 0.48990]	[- 0.87116]	[- 1.42046]	[- 4.57363]	[ 0.65796]	[- 0.49355]	[- 1.79236]
INFL(-2)	- 0.207328	0.047936	- 0.122688	0.284204	0.986048	0.716723	- 0.448812	0.100858
	(0.20331)	(0.22085)	(0.11345)	(0.49142)	(0.45820)	(0.48976)	(0.26742)	(0.49640)
	[- 1.01977]	[ 0.21705]	[- 1.08142]	[ 0.57834]	[ 2.15198]	[ 1.46342]	[- 1.67832]	[ 0.20318]
INFL(-3)	- 0.080253	- 0.286774	0.015430	0.764993	0.792510	- 0.626620	0.230308	0.789174
	(0.20381)	(0.22139)	(0.11373)	(0.49262)	(0.45932)	(0.49095)	(0.26807)	(0.49761)
	[- 0.39377]	[- 1.29536]	[ 0.13567]	[ 1.55291]	[ 1.72538]	[- 1.27633]	[ 0.85913]	[ 1.58591]
NX(-1)	- 0.188489	0.077966	0.008750	0.423148	1.177322	0.104601	0.029184	0.419510
	(0.10974)	(0.11920)	(0.06124)	(0.26524)	(0.24732)	(0.26435)	(0.14434)	(0.26793)
	[- 1.71765]	[ 0.65406]	[ 0.14289]	[ 1.59532]	[ 4.76037]	[ 0.39570]	[ 0.20219]	[ 1.56572]
NX(-2)	0.149815	0.016564	- 0.019296	- 0.067860	- 0.654016	- 0.264128	0.041221	0.133887
	(0.15546)	(0.16887)	(0.08675)	(0.37576)	(0.35037)	(0.37449)	(0.20448)	(0.37957)
	[ 0.96368]	[ 0.09809]	[- 0.22243]	[- 0.18059]	[- 1.86666]	[- 0.70529]	[ 0.20159]	[ 0.35273]

NX(-3)	0.191578	0.058283	-0.007317	-0.030051	0.116031	0.005543	-0.161559	-0.472274
	(0.11729)	(0.12741)	(0.06545)	(0.28350)	(0.26434)	(0.28254)	(0.15427)	(0.28637)
	[1.63340]	[0.45746]	[-0.11180]	[-0.10600]	[0.43895]	[0.01962]	[-1.04724]	[-1.64917]
RIR(-1)	-0.002216	-0.165067	-0.040572	-0.391154	-2.894425	-0.044791	0.086999	-0.845060
	(0.24543)	(0.26661)	(0.13696)	(0.59324)	(0.55314)	(0.59123)	(0.32283)	(0.59925)
	[-0.00903]	[-0.61914]	[-0.29624]	[-0.65935]	[-5.23268]	[-0.07576]	[0.26949]	[-1.41018]
RIR(-2)	-0.252879	0.191418	-0.070108	0.211755	1.034574	0.985297	-0.518472	0.408770
	(0.31074)	(0.33754)	(0.17340)	(0.75109)	(0.70033)	(0.74855)	(0.40872)	(0.75871)
	[-0.81380]	[0.56709]	[-0.40432]	[0.28193]	[1.47728]	[1.31627]	[-1.26851]	[0.53877]
RIR(-3)	-0.135847	-0.244880	-0.028578	0.773403	0.040705	-0.672156	0.250532	0.743766
	(0.21990)	(0.23887)	(0.12271)	(0.53152)	(0.49560)	(0.52973)	(0.28924)	(0.53691)
	[-0.61777]	[-1.02517]	[-0.23289]	[1.45508]	[0.08213]	[-1.26888]	[0.86617]	[1.38527]
SAV(-1)	0.332301	-0.113766	-0.005313	0.771967	-0.950925	-0.860731	0.607292	-0.231427
	(0.20171)	(0.21911)	(0.11256)	(0.48756)	(0.45461)	(0.48591)	(0.26532)	(0.49250)
	[1.64740]	[-0.51921]	[-0.04720]	[1.58333]	[-2.09175]	[-1.77137]	[2.28892]	[-0.46990]
SAV(-2)	-0.265975	0.012764	0.052496	0.736828	-0.068170	-0.164791	0.025081	1.082386
	(0.25416)	(0.27609)	(0.14183)	(0.61434)	(0.57281)	(0.61226)	(0.33431)	(0.62057)
	[-1.04648]	[0.04623]	[0.37014]	[1.19939]	[-0.11901]	[-0.26915]	[0.07502]	[1.74419]
SAV(-3)	-0.017375	-0.224617	0.028952	1.030215	-0.011229	-0.751292	0.074332	-0.171161

	(0.18526 )	(0.20124 )	(0.10338 )	(0.44778 )	(0.41752 )	(0.44627 )	(0.24367 )	(0.45232 )
	[- 0.09379]	[- 1.11619]	[ 0.28007]	[ 2.30071]	[- 0.02689]	[- 1.68350]	[ 0.30505]	[- 0.37840]
RER(-1)	- 0.064775	- 0.121560	0.13483 3	- 0.247004	0.78670 8	0.74628 2	0.11245 8	0.96821 8
	(0.11119 )	(0.12078 )	(0.06205 )	(0.26875 )	(0.25059 )	(0.26785 )	(0.14625 )	(0.27148 )
	[- 0.58257]	[- 1.00646]	[ 2.17313]	[- 0.91907]	[ 3.13943]	[ 2.78624]	[ 0.76894]	[ 3.56645]
RER(-2)	0.08245 6	0.23387 0	- 0.064180	- 0.449484	0.36491 4	0.06168 9	- 0.084933	0.16124 3
	(0.18548 )	(0.20147 )	(0.10350 )	(0.44831 )	(0.41801 )	(0.44680 )	(0.24396 )	(0.45286 )
	[ 0.44457]	[ 1.16079]	[- 0.62010]	[- 1.00261]	[ 0.87297]	[ 0.13807]	[- 0.34814]	[ 0.35606]
RER(-3)	- 0.024863	- 0.272016	- 0.106362	0.94120 4	- 0.728086	- 1.004553	- 0.112981	- 0.224421
	(0.16891 )	(0.18348 )	(0.09426 )	(0.40827 )	(0.38068 )	(0.40689 )	(0.22217 )	(0.41241 )
	[- 0.14720]	[- 1.48254]	[- 1.12844]	[ 2.30534]	[- 1.91260]	[- 2.46884]	[- 0.50853]	[- 0.54417]
C	23.3216 4	45.2074 1	7.79414 6	- 35.50540	- 61.86285	16.0852 6	15.5471 4	- 11.30150
	(11.9153 )	(12.9430 )	(6.64896 )	(28.8003 )	(26.8538 )	(28.7030 )	(15.6724 )	(29.0924 )
	[ 1.95729]	[ 3.49280]	[ 1.17224]	[- 1.23281]	[- 2.30369]	[ 0.56040]	[ 0.99201]	[- 0.38847]
R-squared	0.78792 7	0.87614 2	0.95917 6	0.84753 8	0.96408 8	0.86014 5	0.93231 2	0.99004 9
Adj. R-squared	0.39640 6	0.64748 2	0.88380 9	0.56607 1	0.89779 0	0.60195 0	0.80735 0	0.97167 9
Sum sq. resids	52.1931 3	61.5856 1	16.2522 6	304.930 8	265.105 3	302.874 0	90.2982 5	311.147 0
S.E. equation	2.00371 1	2.17654 7	1.11811 2	4.84316 1	4.51582 9	4.82680 0	2.63553 0	4.89227 8
F-statistic	2.01248 1	3.83163 0	12.7267 0	3.01114 0	14.5417 0	3.33138 4	7.46075 6	53.8936 4

Log likelihood	-59.94959	-63.09366	-37.78193	-93.48714	-90.82794	-93.35855	-70.36477	-93.87057
Akaike AIC	4.471031	4.636509	3.304312	6.236165	6.096207	6.229397	5.019199	6.256346
Schwarz SC	5.548390	5.713868	4.381672	7.313524	7.173567	7.306757	6.096558	7.333705
Mean dependent	3.836639	20.46531	6.126540	10.58502	-0.246083	5.747082	14.80502	39.99684
S.D. dependent	2.579067	3.665871	3.280187	7.352237	14.12510	7.650515	6.004592	29.07075
Determinant resid covariance (dof adj.)		145723.0						
Determinant resid covariance		27.34048						
Log likelihood		-494.2163						
Akaike information criterion		36.53770						
Schwarz criterion		45.15658						