THE IMPACT OF EXTERNAL DEBT ON ECONOMIC GROWTH IN SUB SAHARAN AFRICA: A PANEL DATA ANALYSIS

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DECLARATION

I, **John Bosco Oryema**, hereby declare that this dissertation is my original work, except where it is acknowledged and has never been published and/or submitted for any other degree award to any other university before.

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DEDICATION

This research is dedicated to my mother **Mrs. Filder Labong** and to the memory of my late father **Mr. Timothy Acellam** who was enthusiastic to see me through school.

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List of Acronyms

2SLS	Two Stage Least Squares
ADF	Augmented Dickey Fuller
AfDB	African Development Bank
AR	Autoregressive
EDGDPR	External Debt stock to GDP ratio
EDSGDPR	External Debt Service to GDP ratio
FE	Fixed Effect Model
GDP	Gross Domestic Product
GMM	Generalized Methods of Moments
HIPC	Highly Indebted Poor Counties Initiatives
IMF	International Monetary Fund
IV	Instrumental Variables
MDGS	Millennium Development Goals
MDRI	Multilateral Debt Relief Initiative
NGOs	Non Governmental Organizations.
OLS	Ordinary Least Squares
RE	Random Effect Model
SSA	Sub Saharan Africa
UNCTAD	United Nations Conference on Trade and Development

Abstract

The effects of external debt on economic growth have been a subject of debate in the academic and policy circles. The debates arouse from poor economic performance in many developing countries amidst accumulation of external debt. However, there are competing hypotheses about the effect of external debt on economic growth as it can boost or reduce growth. This study examined the impact of external debt on economic growth in SSA over the period 1990-2005. A theoretical framework was built based on a neoclassical growth model. The main data source used is the World Development Indicator 2008 CD ROM published by the World Bank. Panel data estimation techniques were applied and results shows that external debt stock to GDP ratio had statistically significant negative effect on economic growth meanwhile the external debt service to GDP ratio was statistically insignificant. It is concluded that debt overhang was the main channel through which external debt negatively affected economic growth in SSA between 1990 and 2005. This is contrary to common view that external debt servicing led to decline in economic growth in Sub Saharan Africa. In terms of policy implications, it is recommended that SSA countries should reduce on taking huge loans in order to avoid debt overhang effect. The negative and statistically significant coefficient of INSTITUTION-a variable measuring political and civil liberties indicates that the governments in Sub Saharan Africa should improve on civil and political freedom in order to boost investor's confidence on the enforcement of private property rights.

CHAPTER ONE: INTRODUCTION

1.0 Background

Following the debt crisis that hit developing countries in the 1970s and 1980s, there are debates in the academia, international policy and lobby circles about the relationship between external debt and economic growth. Some analysts argue that external debt lead to economic growth since the borrowed funds supplement domestic capital and therefore increasing the productive capacity of the debtor countries (Eaton; 1992, Pattillo et al. 2002, Baldacci et al. 2003). This implies that regions which are in the early stages of development like Sub Saharan Africa (SSA), could borrow from external sources to supplement the inadequate capital stock and invest in ventures with rates of return greater than the cost of the loans. In this way, economic growth would be enhanced since borrowed resources would generate proceeds sufficient service the debts and warrant positive growth rates.

But other analysts argue that external debt negatively affect economic growth. This is on the hypothesis that external debt servicing crowds out government expenditure on public investments in human capital and infrastructure and thus reducing economic growth (Friedman; 1978, Krueger; 1987). Civil society organisations, through the Jubilee Debt Campaign opined that external debt servicing reduced developing countries' budget allocations for water, health, agriculture and roads among others and consequently reducing human and physical capital accumulation necessary for economic growth. Clements et al. (2003), argued that the crowding-out effect of external debt arise from higher debt service that raises the government's interest bill and the budget deficit, hence reducing public savings. The budget deficit may necessitate domestic borrowing by the governments which could lead to increase in interest rates or competition for credit available for the private investment and thus crowding out investments and dampening economic growth.

The debt overhang effect is another hypothesis advanced to explain how external debt negatively affects economic growth (Krugman; 1988, Sachs; 1989, Alesina et al. 1989). Debt overhang is a situation in which large debt stock create expectations that the debt would be serviced through heavy and perhaps distortionary taxes. Consequently if a country's debt level is expected to exceed its repayment ability, the expected costs of debt service would discourage further domestic and foreign investments and subsequently resulting into lower economic growth.

Information available shows that external debt stock escalated in the 1980s and early 1990s, reaching a peak of about $340 billion (UNCTAD; 2004). By 1996, SSA's debt stock was 67 percent of GDP and 243 percent of export earnings whereas debt servicing was taking about 15 percent of export earnings (UNCTAD; 2004). On the other hand,between 1980 and 2005, SSA's total expenditure on education was only 4.5 percent of GDP meanwhile debt servicing was 18.5 percent of GDP for the period 1995-2004 (AfDB, 2008) and this could have affected economic growth. Arguably, the economic growth rates in many SSA countries have not been impressive especially in the 1970s through the 1990s (Ahmed and Suardi, 2007). Artadi and Sala-i-Martin (2003) found that the GDP per capita growth rate for SSA became negative 0.5 percent in the late 1970s, zero between 1980 and 1985 and negative 1.5 percent in the first half of the 1990s and yet over the same period the rest of the world experienced average growth rate of about 2 percent. The concerns over the poor performance of SSA economies and other developing countries which were highly indebted resulted into many Paris Club arrangements for debt relief. The external debt obligation for SSA changed significantly following Highly Indebted Poor Countries (HIPC) and Multilateral Debt Relief Initiative (MDRI). If external debt burden was the main cause of the poor performance, growth would have been enhanced by the debt cancellations.

But it is not known priori if external debts led to the economic downturn in SSA. This is because external debts may lead to increase in growth if rates returns are greater than the cost of borrowing or it may dampen growth if rate of return is less than the cost of borrowing as shown in the conceptual framework. Empirical evidence also shows the controversial effect of external debt on economic growth as indicated in findings of Eaton (1993), Baldacci et al. (2003), Pattillo et al. (2004), among others.

1.1 Problem Statement

The per capita GDP growth rates of many SSA economies were poor especially in the 1990s. The World Bank (2002) observed that as average income grow, extreme poverty declines but the progress in SSA has been slow and consequently the number of poor people nearly doubled, from 200 million in 1981 to 380 million in 2005 (World Bank 2008). On the other hand SSA has accumulated huge external debt which it has to service. The resources that could have been used to provide health services, education and other social services could be diverted to pay debts. According to UNCTAD (2004), between 1972 and 2002 SSA accumulated US $ 294 billion in debt and paid a total of US$ 268 billion in debt-service. But by 2002 SSA still had to pay US$ 210 billion in debt service. However, it is not certain whether the external debt led to slow growth in SSA given that there are competing hypotheses about the effect of external debt on economic growth as it can boost or reduce growth.

1.2 Research Question

The research question for the study is: What is the impact of external debt on economic growth in Sub-Saharan Africa?

1.3 Aim of the Study

The aim of this study is to assess the impact of external debt on economic growth in SSA

1.4 Objectives of the Study

a) To review the trend of external debt and economic growth in SSA.

b) To examine the impact of external debt on economic growth in SSA.

1.5 Hypothesis:

External debt has a negative effect on growth in Sub Saharan Africa

1.4 Significance of the Study

This study contributes to empirical literature and application of panel data techniques suitable for analyzing external debt-growth relationships. This is through the use of techniques like the Generalized Methods of Moments (GMM) that are robust in addressing endogeneity and persistence of dependent variable problems which are common in growth models and yet it is often ignored by studies which applied Ordinary Least squares (OLS) method. It also contributes analytical framework for tracing the channels through which external debt may influence economic growth. On economic policy issues, this study contributes to empirical debate on debt management so that SSA may contract external loans insofar as it promotes growth.

1.5 Scope of the study

Theoretically the study was guided by the crowding-out effect of external debt and debt overhang effect hypotheses in the context of neoclassical growth model. The geographical coverage consists of 42 SSA countries which had consistent time series data for the period 1990- 2005.

CHAPTER TWO: EXTERNAL DEBT-GROWTH TREND IN SSA

2.1 Origin of the External Debt Crisis of SSA

The debt crisis of Sub-Saharan Africa evolved from a number of factors, some of which were external while others were internal. One major external cause of the debt crisis was the oil price shocks of the 1970s. There were unprecedented increases in world oil prices in the periods 1973 to 1974 and 1979 to 1980 (Krueger, 1987). These led to deficits in trade balances of many SSA countries which relied on imported oil. The fiscal deficits necessitated huge external borrowing which became unmanageable as revealed by the accumulation of arrears. For example in 1987, outstanding debt from the region as a whole was around 375 per cent of 1987 exports (Rimmer, 1990) and for the period 1997 -2000, SSA's principal arrears to GDP ratio was 12.2 percent (UNCTAD, 2004) .

Concomitantly, the oil price shocks transpired with the sharp rise in world interest rates. This exacerbated the debt crisis as SSA countries borrowed external funds at high interest rates which made debt servicing more complicated. According to UNCTAD (2004), between 1972 and 2002 SSA accumulated US $ 294 billion in debt and paid a total of US$ 268 billion in debt-service and by 2002 SSA still had to pay US$ 210 billion in debt service. This indicates the contribution of high interest rates to the debt crisis in SSA.

The recession of 1981-1982 depressed the demand for the key commodity exports of SSA countries like coffee, cotton, cocoa and copper among other primary products. This widened the trade and fiscal deficits. According to Greene (1989), the fall of revenue from commodities was not followed by commensurate, expenditure reduction. Consequently SSA countries resorted to heavy external borrowing to finance the fiscal and external imbalances (Locke and Ahmadi-Esfahani, 1998).

Other external factors which led to the debt crisis include the imprudent lending of petrodollars at non-concessional lending terms by multilateral banks like AfDB and the World Bank (Brooks et al. 1998). The imprudent lending was motivated by the need to dispose the huge petrodollar surpluses to developing countries given that the recession was affecting the developed countries.

In addition to the external factors, a number of internal factors within SSA also led to or worsened the external debt problem. These include poor external debt management policies by debtor countries and the investment of borrowed funds in over ambitious projects that did not yield returns sufficient to service the debt. This is perhaps one of the most serious problems in SSA as it is characterized by institutional weaknesses, corrupt dictatorial governments, mismanagement and wars (Oxfam, 1999). Poor fiscal policies characterized by excessive government expenditure also lead to huge borrowing. This arouse from gigantic development programs such as infrastructural projects in Gabon, Nigeria and the Republic of the Congo meanwhile some countries like Zambia used external commercial borrowing to maintain government consumption amidst the deteriorating export earnings (Greene ,1989). Another internal factor which exacerbated the debt crisis was the inflexible exchange rate system and overvaluation of the local currencies by most SSA countries. Overvalued currencies encouraged imports while discouraging exports and therefore Balance of Payment problems. The external and fiscal deficits led to monetary expansion in many countries and consequently high inflation rates tagged along. Since most exchange rates were pegged to the US dollar, many currencies became overvalued making exports more expensive and uncompetitive in the world market and thus limiting foreign exchange earnings. Overall, external debt crisis in SSA emanated from both internal and external factors, some of which were discussed above.

2.2 Trend of External Debt

The majority of the heavily indebted countries were from SSA and most of debts were contracted from multilateral financial institutions and governments of industrialized nations in the West. A substantial proportion of the loans were directly contracted by governments (public and publicly guaranteed private sector loans) from multilateral banks and foreign governments, making the debt more of "official" than "commercial bank" debt. UNCTAD (2004) observes that by 1995, more than three quarters of Africa's publicly guaranteed debt were "official". Consequently debt servicing became a big burden as arrears were increasing. For instance in 1995, accumulated arrears on principal repayments had exceeded $41 billion (UNCTAD, 2004). Table 1 shows the evolution of external debt indicators for the period 1970-2002.

Table 1. External Debt Trend in SSA

PERIOD	TOTAL DEBT (MILLIONS US $)	DEBT/GDP RATIO	DEBT/EXPORT RATIO	PRINCIPAL ARREARS/GDP RATIO
1970-1979	21 859	17.7	66	0.5
1980-1989	104 676	44	159	2.5
1990-1996	202 821	67.6	243.2	10.9
1997-2000	221 539	67.4	226.3	12.2
2000-2002	208 334	63.7	184.2	7.5

Source: UNCTAD (2004)

From Table 1, the debt stock in SSA worsened in the 1980s through the 1990s. The debt to export ratio was so high that it would be difficult for the countries to service the debt using exports earnings. Notably, arrears on principal also accumulated as the countries could not afford to service the debt. On the other hand UNCTAD (2004) noted that between 1970 and 2002 the GDP per capita declined by 14 percent. This indicates that the debt crisis could have influence economic growth in SSA. The next section explores the trend of economic growth in SSA.

2.3 GDP Growth Trend in SSA

In the 1960's SSA made good economic progress as many countries registered average GDP growth rate of about 5 percent per annum between 1965 and 1973 (ILO, 1996). Between 1973 and 1980, the region experienced declining but positive GDP growth rate of 3.4 percent in spite of the external shocks (lyoha, 1999). But the 1980s was a turbulent period marked by poor performance as average GDP growth rate deeply plummeted to 2.1 percent in 1980, 1.7 percent (1980-1991), 0.6 percent for the period 1991-1993 (Iyoha, 1999). Table 2 shows the trend of growth for the period 1990-1999.

Table 2. GDP Growth rate in SSA, 1990-1999

Year	1990	'91	'92	'93	'94	'95	'96	'97	'98	'99
GDP Growth Rate	2.5	1.8	-0.3	0.0	0.9	4.3	5.3	3.8	3.2	2.7

Source: World Development Report 2001

Table 2 shows that growth has been declining in the first half of the 1990s and making some improvements thereafter. Table 3 below shows the sub-regional performance of the five sub-regional classification of Africa by AfDB (the first four make up SSA).

Table 3. Real GDP Growth Rates by Sub-Regions

	1990-1999	2000-2005	2006	2007
AfDB Geographical Sub-Regions				
Central Africa	0.6	6.2	3.4	4.1
Eastern Africa	-1.3	2.4	4.8	4.8
Southern Africa	4	2.8	7.2	4.9
Western Africa	4.4	4.2	3.8	4.2
Northern Africa	4.4	4	6.8	7.1

Source: AfDB (2008): Selected Statistics on African Economies

From Table 3, we note that the period 2000 to 2005 registered better average growth rates in all the sub-regions. Considering the Central, Eastern, Sothern and Western Africa sub regions, Eastern Africa had the worst performance as it recorded negative average growth rate in the 1990s. This could be due to bad governance, poor infrastructures, corruption and limited investment opportunities, among others.

Western and Southern Africa performed relatively better, perhaps due to the presence of strong economies like South Africa and major oil exporters like Nigeria, Angola, Gabon, Cameroon, Equatorial Guinea in the two sub regions. While countries like Botswana and Ghana are exporters of valuable minerals and besides, many countries in SSA received debt relief through HIPC and MDRI. It also plausible that the debt relief could have freed resources which were invested in social and economic infrastructure resulting into economic growth.

But structurally, SSA economy is still heavily dependent on agriculture despite the contributions of other sectors. The average agricultural GDP growth rate in SSA in the 1990s was 2.8 percent. But agricultural productivity still relies on poor technology and nature. Between 1993 to 1998 good weather conditions in most of Sub-Saharan Africa boosted agricultural growth, averaging 3.9 percent per annum (UNCTAD, 1999). This perhaps explains the improved growth rates recorded in the 1990s given that the region is predominantly agrarian

Overall, African Development Bank (2008) observed that the recent economic performance of SSA has improved with the aggregate GDP growth rate reaching 5.7 percent in 2007, compared to only 1.3percent in the early 1990's. The noticeable improvement was quite widespread across countries, with fewer countries recording negative growth and an increasing number of countries recording GDP growth rates above 5% in 2006 and 2007. This was attributed to rising global demand for primary products like minerals and oil. Moreover, many countries pursued improved macroeconomic policies resulting in consolidation of fiscal balances and lower inflation rates.

It also is conceivable that the large debt stock of the 1970s through the mid 1990s was responsible for the low growth experienced at that time. This was probable since debt overhang and crowding-out effects could have impinged on public investment in both physical and social infrastructure. Similarly, domestic and foreign private investors could have been afraid of policy distortions due external imbalances.

2.4 Debt Relief and Debt-Growth Nexus in SSA

Given the poor performance of developing countries and the spiralling external debt problem, the international community came up with a number of measures to address the problem. The Paris Club arrangement involved rescheduling small amounts of debt at market interest rates under the "Toronto terms"[1] and "London terms''[2] . But these interventions failed to improve the economic growth rates in many developing countries particularly in SSA. This necessitated other measures like the "Naples Terms"[3] which offered deeper relief, but most developing countries were ineligible since it considered only non Official Development Assistance (ODA) credit yet a substantial proportion of SSA's debts were multilateral. Similarly, the International Development Association (IDA) Debt Reduction Facility did not help SSA countries since it provided funds to buy commercial debt only and thus leaving the "official debt" which was the main problem. The various interventions also failed to stimulate growth due to other exogenous factors like poor export performance, inadequate economic reforms and factors constraining the ability of poor economies to realise their growth potential in addition to multilateral debt service demands. The attempts by the international community to relief poor countries from the multilateral debt burden were not realized.

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[1] In October 1988, Paris Club creditors agreed to implement a new treatment on the debt of the poorest countries. The treatment called "Toronto terms" involved 33.33% cancellation of claims and the outstanding part being rescheduled at the appropriate market rate with a 14-year repayment period including an 8-year grace period, among other terms.

[2] This raised the level of debt cancellation from the 33.33% as defined in Toronto terms to 50%

[3] For the poorest and most indebted countries, the level of cancellation is at least 50% and can be raised to 67% of eligible non-ODA credits.

Besides the various Paris Club arrangements, in 1980s and early 1990s, the IMF and the World Bank prescribed the Structural Adjustment Programmes (SAPs) which involved policy changes and conditionalities for getting new loans or for obtaining lower interest rates on existing loans from the IMF and the World Bank. The conditionalities were to ensure that the money lent would also be spent in accordance with the overall goals of the loans.

SAPs conditionalities required liberalization and deregulation of the economies, privatization of state enterprises, fiscal and public service reforms among others. The conditions were resisted by many developing countries as they viewed it as an impingement on political and national sovereignty. The half-hearted response from developing countries to SAPs was perhaps ignited by NGOs advocacy campaigns which portrayed the IMF and World Bank structural adjustment programs as factors escalating poverty rather than reducing it (Keck and Sikkink, 1999).The poor or partial implementation of SAPs yielded poor results and more blames on the Western world and the Brettonwoods Institutions for "re-colonising" Africa (Rimmer, 1990).

Generally, the Paris Club arrangements brought some debt relief for SSA countries but it was the HIPC (1996) and the Enhanced HIPC Initiative (1999) that brought substantial reduction of external debt. The HIPC initiative was designed to provide exceptional assistance to eligible countries following sound economic policies to help them reduce the countries' external debt burden to sustainable levels. The initiatives involved reduction in the net present value (NPV) of the future claims on the indebted country. Eligibility of countries for HIPC was conditioned on unsustainable debt burden beyond the available debt relief mechanisms such as Naples terms and the countries were to implement reforms and sound policies through IMF and World Bank supported programs.

The enhanced HIPC was followed by the Multilateral Debt Relief Initiative (MDRI) which took effect in 2006 .MDRI was launched in 2005 with an objective of cancelling 100 percent of all debt owed by SSA countries to the IMF, World Bank and AfDB. This was a result of campaigns of the Africa Commission and the Gleneagles summit of 2005. The initiative was meant to help poor countries achieve the MDGs as total cancellation of the debts would allow for more allocation of resources into poverty reduction strategies. Under MDRI, US $ 1.8 billion of SSA's debt was cancelled by the African Development Bank in 2006.

Considering the relationship between debt relief and economic growth in SSA, the debate on whether debt relief enhances growth remains unresolved. Debt relief could promote growth if the funds meant for debt servicing are invested in productive social and economic infrastructures. However, debt relief may induce governments to take huge amount of new loans with the expectation that debts will always be forgiven. This may result into a cycle of new loans, defaults, debt overhang effect and low economic growth.

According to the IMF (2001) and the World Bank (2006), the highest average debt relief between 1990 and 2000 was offered to Ethiopia (US $ 1.9 Billion), Tanzania (US $ 3 Billion) and Mozambique (US $ 600 Million). In the subsequent years Ethiopia's and Mozambique's real GDP per capita growth rates declined in spite of getting the largest relief, where as Tanzania's GDP per capital growth improved from a negative during the relief decade to a positive in subsequent years. Therefore it is not certain that debt relief would lead to enhanced economic growth rates. This could be due to the influence of other exogenous factors like macroeconomic and political stability, among others.

CHAPTER THREE: LITERATURE REVIEW

3.0 Introduction

The rate at which economies grow has remained a focal point of theoretical and empirical discourse since growth influences a country's ability to improve the welfare of its citizenry. It is therefore not a coincident that relationship between external debt and economic growth has attracted a lot of empirical research due to the dismal performance of many developing countries amidst the debt crises of the 1970s and 1980s and the subsequent HIPC and MDRI. In this chapter, we review related literature and the review is divided into theoretical and empirical components to bring out the controversies as advanced in theory and empirical research.

3.1 Theoretical Literature Review

According to the Harrod-Domar growth model, GDP growth rate is proportional to the rate of investment or output growth should be equal to investment divided by the incremental capital output ratio (ICOR). The model posits that, for any desirable growth rate the required investment can be estimated by multiplying the target rate with the ICOR. This would indicate the gap between the available financing for investment and the required investment. The financing gap could be filled with foreign capital such as external loans which would subsequently become external debt. Therefore rational levels of external borrowing by open economies can augment economic growth through capital accumulation. Theoretical discourse on the effect of external debt on growth generates contradictory conclusions with some concluding negative effects while others indicate positive or insignificant effects. Eaton (1993), on the basis of endogenous growth models concluded that if economies are open and have access to the world capital market, borrowing can lead to economic growth. The study noted that "the rate of growth depends only on the technological parameters and the world interest rate and access to the world capital market can raise the growth rate if domestic taste parameters are such that positive growth is feasible with borrowing but infeasible under autarky" (Eaton; 1992 p; 29). Thus external debt may help to promote economic growth by supplementing domestic savings and speeding up capital accumulation. Greene (1989) noted that many SSA countries borrowed from overseas to finance projects designed to improve domestic industry and infrastructure on the assumption that the economies would grow over time and would allow the debt service obligations arising from the projects to be met. Thus borrowing from abroad may lead to economic growth.

Similarly, from Keynesian macroeconomic perspective, external borrowing could lead to increase in the government spending which stimulates the domestic demand, investments and economic growth (Baldacci et al; 2003*)*. In this way external debt would "crowd-in" investments and positively influence economic growth. From classical economic theory Pattillo et al. (2002, 2004) noted that some optimal level of external borrowing by a poor country should enhance economic growth, through increase in capital accumulation necessary in productive sectors or economic infrastructures.

It is argued that economies in the early stages of development tend to be constrained by small stock of capital and yet the rates of return on investments are usually high and borrowing from abroad would lead to growth provided the cost of borrowing are lower than the rate of returns. The inadequate capital stock in developing countries is attributed to low income and savings. The savings-investment gap could be supplemented by foreign resources like loans. If borrowed funds are put in productive investments and all other factors are favourable, economic growth would be enhanced such that debt repayments will be easily met without imposing burdens (Pattillo et al, 2004). Given that the countries in SSA are in early stages of development with relatively low capital accumulation, external borrowing may lead to increased investments and growth if rates of return are higher than the interest to be paid on the loans.

However, external debt could negatively affect economic growth through crowding-out effect as theorized in the neoclassical macroeconomic framework. The crowding-out effect are in terms of the burden of external debt servicing which reduces resources necessary for public investments in human capital and physical infrastructure and thus reducing the potential economic growth. This strand of argument is advanced by authors like Friedman (1978) and Krueger (1987), among others. Similarly, civil society organisations like Oxfam (1999) argued that heavily indebted low income countries had been servicing debt by squeezing imports and investments and consequently forgoing consumption and output growth. Clements et al. (2003) observed that the crowding-out effect of external debt also arise from higher debt service which increase interest cost and the budget deficit, hence reducing public savings. This could lead to increase in interest rates or competition for credit available and thus crowding out private investments and dampening economic growth.

The debt overhang hypothesis is another theoretical perspective used to explain the negative effect of external debts on economic growth. Krugman (1988), Sachs (1989), Alesina and Tebellini (1989) defined debt-overhang as a situation in which large debt stock create expectations that debt would be serviced through heavy and perhaps distortionary taxes. This implies that if a country's debt level is expected to exceed its repayment ability, the expected costs of debt-service will discourage domestic and foreign investment resulting into lower economic growth. Clements et al. (2003), also pointed out that debt overhang leads to uncertainty about government policies in order to meet its fiscal obligations. As a result potential investors would prefer to wait as they study government actions in the presence of huge debt obligations. This could make new investments to be concentrated in short term projects with assured and quick returns rather than to risky long term projects necessary for long term economic growth.

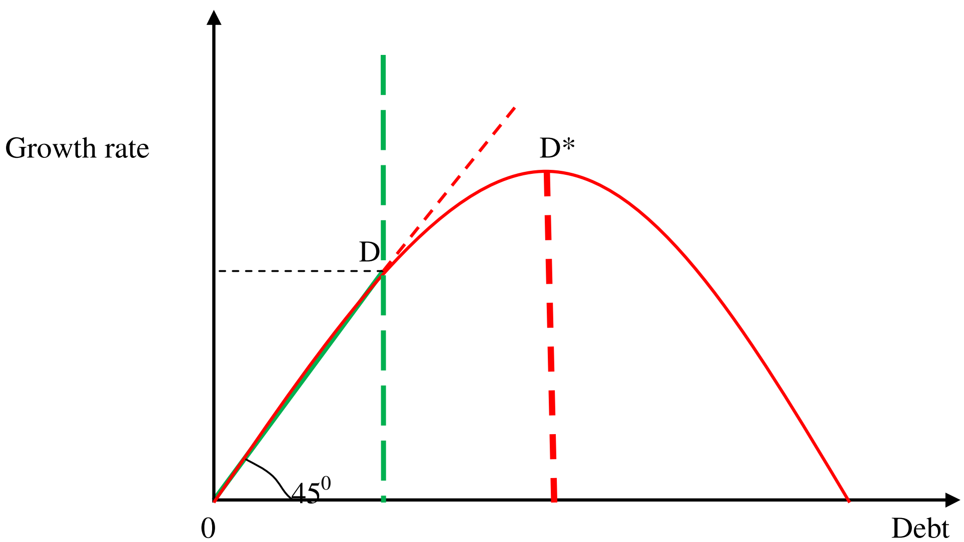
3.2 Non Linear versus Linear effect of External debt on growth

The above review of theoretical literature suggests that external debt would either increase or decrease economic growth in a monotonic way, which is not always the case. From the first part of theoretical review, we noted that rational levels of debt could have a positive effect on growth. This is in agreement with neoclassical economics which allows for capital mobility, and the option to borrow and lend from foreign sources. Poor countries would borrow and invest in viable projects given that the marginal product of capital tends to be high in the initial stages of growth relative to the world interest rate (Eaton; 1993, Barro and Sala-i-Martin; 1995). But high level of external debt could lead to a decline in economic growth. This is through the debt-overhang hypothesis which posits that external debt burden provides a disincentive to domestic investment thus dampening economic growth since any additional foreign exchange earnings would have to be taxed in order to pay foreign creditors. This suggests that external debt can help to increase growth but beyond some level, it becomes counterproductive.

Cohen (1993) illustrated the relationship between the face value of debt and investment as a "Growth-debt Laffer Curve" which indicates that as outstanding debt increases beyond an optimal level, the expected repayment falls as well as investments. Krugman (1988) argued that the incentives for domestic firms to invest at home could also be distorted since expected returns from investment projects would be heavily taxed in order to raise revenue for debt servicing. In anticipation of this undesirable outcome, investors would reduce on big undertakings and consequently jeopardizing long term economic growth rate of the debtor country. The “Debt Laffer curve”, is represented by an “inverted U” relationship between the level of debt stock and expected net present value (NPV) of debt service payments.

Assuming a one to one correspondence between investment and economic growth the growth- debt Laffer curve can be illustrated as in Figure 1.

Figure 1. *Growth-Debt “Laffer Curve” Relationship*



Source: Author’s reformulation of Krugman’s (1988) Illustration

Debt overhang in this context would imply that a country is to the right of the peak of the curve in Figure 1. The upward-sloping part of the curve implies that an increase in the face value of debt would lead to an increase in the expected debt repayment up to that threshold level. Meanwhile the downward sloping part of the curve indicates that an increase in debt reduces expectations about debt repayment and if debt is to be paid taxes would have to be raised in order to obtain the required revenue. Although the debt overhang model do not show the effects on economic growth explicitly but by implication , large debt stocks lower growth partly by reducing the incentive to invest. The line 0D shows that the slope is increasing but after point D the slope of the curve increases but at a decreasing rate. This indicates that external debt may help to enhance growth and as debt increases beyond some optimal level growth rate will increase at a rate less than the increase in debt. Beyond point *D**, increase in debt stock would negatively affect economic growth. This is because domestic and foreign investors could expect heavy taxes to be levied in future as way of raising revenue to meet debt obligations. This lowers capital accumulation and growth. This review shows that the impact of external debt on economic growth may be non-linear although it is studied in linear setting for ease of analysis.

3.3 Empirical Literature Review

Empirical literature on the relationship between external debt and economic growth also turn out to be controversial as some findings indicate that it promotes growth meanwhile some concludes otherwise. External debt could lead to economic growth if the acquisition of foreign loans augment physical capital and human capital stock through public investment in infrastructure, education and health. Warner (1992) used pooled panel regression with data spanning from 1961 to 1989 and debt crisis dummy variable was included to capture the impact of external debt on heavily indebted countries' economic growth. The findings shows that the coefficient for debt crises was positive and significant rather than the negative sign predicted by some studies. Warner (1992) argued that the debt crisis did not depress investment as the borrowed funds were used in public investments and thus encouraging economic growth. But the pooled OLS regressions used have weakness since the method ignores country specific effects and this study used a more robust dynamic GMM estimation.

Chowdhury (1994) examined the cause-effect relationship between external debts and decline in economic growth. Logarithmic transformed time series data on GNP were used in the regression and causality test was carried out. The result indicates that there was a positive relationship between economic growth and external debt in Bangladesh, Indonesia and South

Korea for the period 1970-1988. Similarly, Amoateng et al. (1996) used Granger Causality test to determine the relationship between external debt and GDP growth rates of 35 developing countries with data ranging from 1971 to 1990 and the findings indicate that there was positive causality between foreign debt and GDP growth rate. Hansen (2001) also examined the impact of aid and external debt on growth and investment and the findings shows that external debt positively influenced investment and GDP per capita growth rates. Hansen(2001) concluded that the impact was through investment and this implies that if external loans were put in productive venture, the increased investment will lead to further growth. This corroborated the findings of Khan and Kumar (1997) whose finding showed that public investment expenditures funded from external debt have positive and significant effect on economic growth. This in accord with Aschauer (1989) who noted that public capital creation positively influences output and productivity growth. Thus external debt used to finance productive ventures would lead to growth keeping other factors constant.

Azeiman et al. (2007) using endogenous growth model and system GMM concluded that public sector borrowing to finance public capital goods may allow the economy to reach a long-run optimal growth path faster. But the study also warned that if borrowed funds are used to finance recurrent expenditures economic growth would decline. This should be expected since recurrent expenditures do not generate long term benefits since it is used to finance government consumption. The strength of the study is the use of the GMM estimator which is more robust when dependent variable is highly persistent (Arellano and Bond;1991). This study used both the first differenced and system GMM estimation given their relative strength.

The preceding strand of literature considered external debt as a capital inflow with a positive effect on investment and thus economic growth. However, the impact depends on how the borrowed funds are used and whether the rates of return on the projects are greater than the cost of borrowed capital. But most of studies reviewed so far used pooled time series data from different countries has limitations as they the ignored the spatial properties of the data and this could make the findings to be biased and inconsistent . This study attempted to address the problems by applying dynamic panel data analysis which more robust.

A number of studies examined how an external debt crowds-out investments and therefore growth. Freidman (1978) found that that financing fiscal deficits can have crowding out or crowding in effects. The crowding-out effect of external debt arises from the fact that many heavily indebted poor countries diverted resources to service debt obligations, particularly debt owed to multinational institutions like the World Bank and IMF, which cannot be easily rescheduled. Alesina and Tebellini (1989) examined the simultaneous occurrence of large accumulation of external debt, private capital outflow and relatively low domestic capital formation in developing countries using a dynamic model for a small open economy. The model shows that political uncertainty over re-election provide incentives for the incumbent governments to accumulate external debt and the uncertainty over the fiscal policies of future governments generates private capital flight and small domestic investment which dampen economic growth.

In a similar study Pettersson-Lidbom (2001) used data from Swedish local government debt and found out that a right-wing government accumulates more debt during their term in office if they anticipated electoral loss meanwhile a left-wing government accumulates less debt the higher the probability of its defeat. In the 1970s up to the 1990s, most of the governments in SSA were mainly military juntas or dictatorships. The political uncertainties they faced could have led them to acquire and misuse external loans as they anticipated change of government. For this reason the Freedom House indicator for civil liberties is used to mimic the influence of political and institutional capabilities on economic growth in SSA as it could influence how much debt a country can take notwithstanding how the loan would be used.

Cohen (1990), regressed investment as a percent of GDP on many variables including the debt to export ratio and found out that the debt to export ratio had a negative effect on investment and therefore economic growth. This is similar to the empirical conclusions of Sachs (1989) and Krugman (1989). But some researchers argue that debt burden reduces economic growth due to the negative impact on the productivity of labour. Geiger (1990) studied the effect of debt burden on capital flows and GNP growth rate using data from nine highly indebted Latin American countries for the period1974 to 1986. The debt burden was measured by the ratio of debt service to GDP. The findings from the OLS and distributed lag model regressions indicate that there was a statistically significant negative relationship between debt and economic growth. The reduction in labour and capital productivity was the main channel of the negative effect of debt on economic growth. Similarly, Greene et al. (1991) and Savvides (1992) concluded that external debt reduces private investment and consequently low economic growth.

Fosu (1996) examined the relationship between economic growth and external debt in SSA countries using data spanning from1970 to 1986 and employed a cross country OLS regression. The finding of the study showed that, on average a highly indebted country faces about one percentage reductions in GDP growth rate annually. Similarly, Oxfam (1999) argued that high external debt service is one of impediments to achieving basic needs in developing countries. This in turn results into poor human capital accumulation, poor labour productivity and low economic growth. As noted earlier OLS regressions are not robust in the presence of country specific effects and hence the need for dynamic panel data.

Mbire and Atingi (1997) used OLS method and found that debt servicing was one of the major causes of low economic growth in Uganda in 19980's and 1990's. They noted that debt-export ratio was over 1000 percent between 1990 and 1993 and that any increase in the foreign interest rate would have worsened the situation. Iyoha (1999) used 2SLS method and found that the large stock of external debt and heavy debt service payments had negatively affected investments and growth in SSA. The simulated prediction showed that a 20 percent debt stock reduction would, on average increase investment by 18 percent and GDP growth by one percent during the period considered in the study (1987-1994). On the other hand, Were (2001), used time series data for the period 1970-95 and an error correction model (ECM) to study the impact of external debt on economic growth in Kenya. The findings showed that external debt accumulation had a negative impact on private investments and economic growth in Kenya.

The preceding literature shows that external debt negatively affected economic growth through crowding-out of investments. However, it can argue that the misuse of the borrowed funds could be the source of crowding-out effect especially if borrowed funds are used to meet recurrent expenditure. Koeda (2008) argued that the lower a country's initial income, the more it would borrow big loans so as to raise both investment and consumption in the short run and thus becomes more likely to be trapped in the low steady state of growth. This could have been the situation in SSA.

Clements et al. (2003) used both Fixed Effects (FE) and dynamic GMM estimation and found that a significant reduction in the stock of external debt for poor HPIC countries would directly increase per capita GDP growth rates. Similarly, Pattillo et al. (2004) noted that the negative impact of external debt on growth operated through negative impact on physical capital accumulation. A common feature of Clements et al (2003) and Pattillo et al (2002) is the inverted U curve relationship between external debt and economic growth. They found that at lower levels, external debt promotes economic growth but beyond the "optimum" level, external debt reduces economic growth. This is the external debt-growth Laffer curve discussed earlier. Given the strengths of GMM, this study replicated its use with data from SSA.

The findings of Dessy and Vencatachellum (2007) indicate that debt relief provided to SSA countries between 1989 and 2003 had a positive impact on the share of a country's resources allocated either to public education or health in countries with good institutions. But Currie (2005), argued that most countries in the early stages of economic development experienced debt crises because the loans were not productively used. From this perspective, it is important for countries to establish strong institutions to manage projects funded from borrowed resources. For this reason this study included a proxy for institutions to show its importance in the growth process. From a managerial perspective Vamvakidis (2007) argued that external borrowing may lead to delay in economic reforms. Using a panel data from developing and emerging economies, the finding showed that external borrowing by private sector reduces economic growth. The premise was that external financing acted like a short run solution while postponing the required reform necessary to lift the country from economic downturn.

3.4 Empirical Review of Literature on Debt Overhang Effect

A number of other studies examined the effect of external debt on investments and economic growth through the debt overhang hypothesis. Krugman (1988) and Sachs (1989) argued that debt overhang occurred because accumulated debt acted as a tax on future output and consequently discouraging investment in the private sector and fiscal policy reforms on the part of governments. It is plausible that if future debt is expected be greater than a country's ability to repay, then the expected debt service would take a greater proportion of future output through taxation.

Sachs (1989) found that the debt overhang led to international credit rationing while Rodrik (1989) noted that investment declined because of fiscal policy uncertainty given that heavy investments are irreversible. It is plausible that the disincentive effect of the debt overhang could negatively affect private saving and investment, even if all external debt is held by the government. This is because the government would have little incentive to initiate policies to promote domestic capital formation or to reduce current consumption in exchange for higher future economic growth when it expects that the benefits from such policies would go to creditors in the form of higher debt payments.

Fosu (1999) investigated the impact of external debt stock on economic growth in SSA for the 1980 -1990 period. The study aimed at testing debt overhang hypothesis and the findings showed that when debt stock was included in the growth equation, the coefficient was negative. This is similar to the findings of Sawada (1994) who applied a cointegration analysis to examine the effect of external debt on growth in highly indebted countries. The finding indicates that heavily indebted countries had debt overhang problems.

Deshpande (1997) applied OLS estimation on pooled data ranging between1971 and 1991 for 13 highly indebted countries. From the 13 countries Ivory Coast, Kenya and Zambia are from SSA. The actual amount of paid debt was used as the measure of debt overhang. The study noted that for any increase in proportion of output/exports used for debt payment, investors would be less willing to invest in such countries. Recently, Presbitero (2008) used a panel of 114 developing countries and the results show that the debt-growth relationship depends on institutions and policies and the debt overhang was evident in countries with poor institutions. This is similar to the findings of Cordella et al. (2005) who concluded that the debt overhang takes effect when the debt stock-to-GDP ratio is about 0.2. It is noted that countries with good policies tend to have higher debt overhang thresholds than countries with bad policies. This could be an issue in SSA given its institutional problems characterized by poor governance.

Overall, most of the literature reviewed conclude that external debt lead to decline in economic growth through crowding-out effect or debt overhang effect. This is because external debt servicing drains the debtor countries off resources that could be invested to promote growth meanwhile high external debt discourages inward FDI as investors would be uncertain about future fiscal policy. Furthermore domestic businesses would postpone long term investments due to uncertainty about future fiscal policies and thereby reducing economic growth. But a number of studies also concluded that external debt positively influenced economic growth. It is also noted that most studies used pooled cross country data or single country studies. This study employed panel data methods which are more robust than time series or cross sectional techniques.

CHAPTER FOUR: METHODOLOGY

4.1 Analytical Framework

A neoclassical growth model is used to analyze the impact of external public debt on economic growth in addition to other factors. To explicitly model the impact of external debt on growth , we used ideas from Lucas (1988), Otani and Villanueva (1989), Romer (1990), Dellas and Galor (1992) .Assuming an open economy in which goods are produced using two factors of production; Capital (K) and Labour (L) via a neoclassical production function such that:

$$Y = F(KL) \tag{1}$$

The production function is assumed to posses the desirable properties of being continuous and twice differentiable, with positive but diminishing marginal products:

$$\frac{\partial Y}{\partial K} > 0, \frac{\partial^2 Y}{\partial K^2} < 0 \quad and \quad \frac{\partial Y}{\partial L} > 0, \frac{\partial^2 Y}{\partial L^2} < 0 \tag{2}$$

The Inada (1963) conditions are also assumed to be satisfied such that:

$$\lim_{K \to 0} \frac{\partial Y}{\partial K} = \infty, \lim_{K \to \infty} \frac{\partial Y}{\partial K} = 0 \quad and \quad \lim_{L \to 0} \frac{\partial Y}{\partial L} = \infty, \lim_{L \to \infty} \frac{\partial Y}{\partial L} = 0 \tag{3}$$

The production function is assumed to be linearly homogenous of degree one so that it can written as $Y = Lf(k)$ and in per capita form: $y = f(k\ 1) = f(k)$ (4)

Where $y = YL^{-1}$ *and* $k = KL^{-1}$

It is also assumed that Firms maximize profits in a competitive market. Therefore equilibrium the marginal product of capital equals to the price of capital r and marginal product of labour equals to the real wage w.

$$\frac{\partial Y}{\partial K} = f'(k) = r$$

$$\frac{\partial Y}{\partial L} = f(k) - f'(k)k = w \tag{5}$$

Labour force L is assumed to be exogenously determined such that at any time t, $L_t = L_0 e^{nt}$ where $n = \frac{\dot{L}}{L}$ is the labour force growth rate. Given that a fixed proportion of output s is saved such that national savings $S = s.F(KL)$ and savings is equal to investment (S=I). From saving-investment relation the growth of capital stock would be equal to the savings less depreciation of capital stock (depreciation rate δ is assumed to be constant).

Thus $\frac{dK}{dt} = \dot{K} = I - \delta K = s.F(KL) - \delta K$ (6)

Writing (6) in per capita form, the growth in capital stock is given by $\frac{\dot{K}}{L} = \frac{s.F(KL)}{L} - \delta \frac{K}{L}$

$$\frac{\dot{K}}{L} = s.f(k) - \delta k \tag{7}$$

To make all terms to be in per capita form, the capital labour ratio K/L is differentiated with respect to time using quotient rule and we obtain

$$\frac{d\left(K/L\right)}{dt} = \frac{L\frac{dK}{dt} - K\frac{dL}{dt}}{L^2} = \frac{L\frac{dK}{dt}}{L^2} - \frac{K\frac{dL}{dt}}{L^2} = \frac{L\dot{K}}{L^2} - \frac{K\dot{L}}{L^2} = \frac{\dot{K}}{L} - \frac{\dot{L}}{L}\frac{K}{L}$$

$$\therefore \; \frac{d\left(K/L\right)}{dt} \equiv \dot{k} = \frac{\dot{K}}{L} - nk \;\; \Leftrightarrow \;\; \frac{\dot{K}}{L} = \dot{k} + nk \tag{8}$$

Substituting (8) into (7) yields the dynamic path of capital labour ratio:

$$\dot{k} = s.f(k) - \delta k - nk = s.f(k) - (\delta + n)k \tag{9}$$

In the steady state, $\dot{k} = 0$ implying that $s.f(\bar{k}) = (\delta + n)\bar{k}$ so that:

$$\bar{k} = s.f(\bar{k})(\delta + n)^{-1} \tag{10}$$

From the above mechanics of the Solow's 1956 growth model, savings, depreciation and labour force growth rates influence the level of capital labour ratio which in turn influences per capita output and hence economic growth.

For poor countries, the capital labour ratio $\bar{k}$ may be due to low savings. If there is access to international financial markets, loans could be obtained from abroad in order to boost investments and economic growth. This would be achievable if foreign interest rate is less than the marginal product of capital in the domestic economy. That is if $r^f \le f'(k)$ where r^f is foreign interest rate.

It is plausible that the gross investment after acquisition of foreign loans would increase such that the new level of investment would be; $I = S + eB^f = s.F(LK) + eB^f$ (11)

Where B^f is foreign borrowing, e is the nominal exchange rate. The purchase of K is financed by domestic savings and foreign borrowing B^f.

The acquisition of foreign finances and their proper utilization would increase the country's productive capacity by increasing both private and public physical capital K and human capital accumulation H assuming that borrowed funds were used to improve education and health services. This could augment the Solow–Swan Growth model such that output

$Y^D = F(KLH)$ (12)

Where Y^D is the National Income with debt augmenting growth

But the government would impose taxes which would be used to service external public debts and publicly guaranteed private sector loans. Thus new savings level $\tilde{S}$ would be the sum of savings by firms S_p, Households, S_h and by the government S_g, given increased taxation to finance debt servicing.

Where $S_p = s_p\left((1-\tau_p)\phi_p Y^D - r^f eB_p^f\right)$ (13)

τ_p is tax rates levied on firms ϕ_p is share of firms in total output and B_p^f is the external debt incurred by firms.

Households' savings $S_h = s_h(1-\tau_h)\phi_h Y^D$ (14)

Where τ_h is the income tax rate on households' income and ϕ_h is the share of households in total output.

Government savings $S_g = s_g.\left((1-C_g-H_g-K_g)[(\tau_p\phi_p+\tau_h\phi_h)Y^D+ntr]-r^f eB^{fg}\right)$

(15)

Where C_g is government spending on goods and services, H_g is government spending on health meanwhile K_g is government expenditure on capital goods and B^{fg} is government externally acquired loan. The national income in the subsequent period in the presence of debt servicing would be:

$$Y = Y^D - r^f eB^f \quad (16)$$

Total national savings given the new tax rates would be $\breve{S}=S_p+S_h+S_g = \breve{s}.\left(Y^D - r^f eB^f\right)$ (17)

Where $\breve{s} = (s_p + s_h + s_g) \mid \tau$ and then putting (17) into equation (7) to determine the growth of capital per labour unit. $\frac{\dot{K}}{L} = \breve{s}.\left(\frac{F(KLH)}{L} - \frac{r^f eB^f}{L}\right) - \delta k$ (18)

$$\frac{\dot{K}}{L} = \left[\breve{s}.\left(f(kh) - r^f d^f\right)\right] - \delta k \quad (19)$$

Where $h = H / L$ and $d^f = \frac{eB^f}{L}$ - the external debt per capita. Substituting (19) into (8) through (9) yields the new path of capital labour ratio

$$\dot{k} = \breve{s}.\left(f(kh) - r^f d^f\right) - (n+\delta)k \quad (20)$$

Then at the steady state when $\dot{k}$=0, $\hat{k} = \breve{s}.\left(f(kh) - r^f d^f\right)(n+\delta)^{-1}$ (21)

Therefore in the new setting with external debt servicing, the steady state growth rate of capital labour ratio would be $\frac{\dot{k}}{k} = \frac{\breve{s}.\left(f(kh) - r^f d^f\right)}{k} - (n+\delta)$ (22)

Since at the steady state all variables grow at constant rates , $\dot{k}/k$ is constant given the assumption that $s, n \text{ and } \delta$ are constant. The per capita GDP would also grow at a constant rate since the ratio$\left(f(kh) - r^f d^f\right)k^{-1}$ is constant by assumption of steady state.

Comparing $f(kh) - r^f d^f$ in (21) and $f(\bar{k})$ in (10), different outcomes could be attained given the deviation between per capita output and per capita debt service. The following propositions are conceivable.

Proposition 1*: The GDP per capita could grow at higher rate in the presence of foreign borrowing and debt servicing.*

Proof**:** If $f(kh) - r^f d^f > f(\bar{k})$ then $\hat{k} > \bar{k}$ and therefore the economy would grow at a faster rate with foreign borrowing and subsequent debt servicing.

Proposition 2: *The GDP per capita growth could fall in the presence of foreign borrowing and debt servicing.*

Proof: If $f(kh) - r^f d^f < f(\bar{k})$ then $\hat{k} < \bar{k}$ and the economic growth would decline in the presence of external debt and debt servicing.

Proposition 3: *The GDP per capita growth may remain unchanged in the presence of foreign borrowing and debt servicing.*

Proof : If $f(kh) - r^f d^f = f(\bar{k})$ then $\hat{k} = \bar{k}$ and the growth of the economy would not be affected by foreign debt servicing and GDP per capita would remain unchanged given that capital labour ratio would remain unchanged.

Proposition 4***:*** *Even if the government would not increase the tax rates; increase in the external debt stock may cause uncertainty about future fiscal policies. This would be the debt overhang effect which would discourage investments and economic growth.*

From the propositions, external debt may crowd in, crowd out or be neutral to capital accumulation and economic growth. We now link up the growth of capital per labour unit with growth in GDP per capita. From equation (16) the GDP after payment of debt would $Y = Y^D - r^f eB^f$ from which we can obtain the GDP per capita;

$$\frac{Y}{L} = \frac{Y^D}{L} - \frac{r^f eB^f}{L} \equiv y = f(kh) - r^f d^f \tag{23}$$

Differentiating $y = f(kh) - r^f d^f$ with respect to time yields

$$\dot{y} = f_k \dot{k} + f_h \dot{h} - r^f \dot{d}^f - \dot{r}^f d^f \tag{24}$$

Substituting the expression of $\dot{k}$ in (20) into (24) yields

$$\dot{y} = f_k \left[\breve{s}.\left(f(kh) - r^f d^f \right) - (n+\delta)k \right] + f_h \dot{h} - r^f \dot{d}^f - \dot{r}^f d^f \tag{25}$$

Dividing (25) through by y to obtain the GDP per capita growth rate

$$\frac{\dot{y}}{y} = \frac{f_k}{y} \left[\breve{s}.\left(f(kh) - r^f d^f \right) - (n+\delta)k \right] + \frac{f_h \dot{h}}{y} - \frac{r^f \dot{d}^f}{y} - \frac{\dot{r}^f d^f}{y} \tag{26}$$

Equation (26) implies that GDP per capita growth rate is a positive function of the productivity capital (f_k), the domestic savings ($\breve{s}$) and the human capital productivity (f_h).

But debt stock (d^f), debt servicing with changing interest ($\dot{r}^f d^f$), changing debt stock with interest remaining unchanged ($r^f \dot{d}^f$), labour force growth rate (*n)*, depreciation rate (δ), real interest rate (r^f) negatively affect per capita GDP growth rate. However, data on some variables like interest rates were not consistently available for many of the countries included in sample. Secondly economic growth is influenced by other factors like macroeconomic and institutional strength which are not explicitly included in the derivation. Consequently equation (27) provides a modified version of equation (26) for estimation purposes and it now contains inflation, openness and institutions, in addition L, K, H, and debt indicators.

4.2.0 Estimation Framework

Many studies on external debt–investment–growth relation used OLS and time series methodologies on cross country or single country data. However , most cross country and OLS regressions tend to yield biased results due to heterogeneity since observations a given variable may vary with time and across countries (Baltagi, 2005, Cameroon and Trivedi; 2006). This study employed panel data methods because it can deal with the problem of heterogeneity and yet it is more informative, more efficient, increases the degrees of freedom and capable of dealing with endogeneity problems common in growth models (Baltagi, 2005).

From equation (26), the following growth equation is specified for estimation purposes.

$$g_{it} = \beta_0 + \beta_1 K_{it} + \beta_2 L_{it} + \beta_3 H_{it} + \beta_4 EDSGDPR_{it} + \beta_5 INFL_{it} + \beta_6 OPENNESS_{it} + \beta_7 INST_{it} + \varepsilon_{it} \quad (27)$$

Where g_{it} the GDP per capita growth rate of a country in a given year and the data was obtained from World Development Indicators (WDI) 2008. K is the gross capital formation as a percentage of GDP and its coefficient is expected to be positive. It is used as a proxy for capital as there are no consistent data series for capital stock for most of the countries in the sample and the data was obtained from WDI 2008. L is the total labour force and it is ratio of the population aged 15-64 years to the total population and it was extracted from Selected Statistics on African Economies (2008). It indicates the proportion of population deemed to be economically active and it is expected to yield a positive coefficient since the marginal product of labour is assumed to be positive. *H* is the level human capital accumulation and Gross Secondary School enrolment ratio is used as a proxy. The data was obtained from Selected Statistics on African Economies (2008). Its coefficient is expected to be positive as derived in the model. EDSGDPR is the external debt service to GDP ratio expressed in percentage and the sign of the coefficient is unknown a priori. It can either be positive or negative depending on whether crowding-in or crowding-out is dominant respectively. External debt to GDP ratio (EDGDPR) is used to investigate debt overhang effect. The coefficient of EDGDPR is expected to be negative if external debts adversely affect growth through the overhang effect but it can be positive if the threshold of debt overhang was not reached by SSA. *INFL* is the inflation rate and it is meant to capture macroeconomic stability and the coefficient is expected to be negative as it dampens economic growth.

Other variables include *OPEN,* which is the degree of openness of the economy to international trade and it promotes growth and the reverse is true. Studies like Sachs and Warner (1995), Dollar and Kray (2001)) concluded that openness has a general positive impact on growth and thus need to be included in the model since most SSA economies are open. It is measured as a ratio of trade (exports plus imports) to GDP and the data was obtained from WDI (2008). *INST* is the governments' institutional efficiencies in terms of democratic principles and rule of law which are important in promoting efficient production. It is measured on a discrete scale of 1 to 7 with 1 signifying highest freedom and 7 showing least freedom and the data is obtained from Freedom House[4] and the coefficient is expected to be negative.

[4] URL : http://www.freedomhouse.org/template.cfm?page=5 (Accessed on 15/ 04/2009)

4.2.1 Estimation of the Model

Using a one way error component model in which unobserved individual country heterogeneity exist but the model is homogenous over time, equation (27) would be estimated through Random Effects (FE), Fixed Effects (FE) and Generalized Methods of Moment (GMM). Let y be the dependent variable in equation (27) and x be the vector of explanatory variables as described in the preceding section. In the one-way error component model formulation the equation for estimation would be:

$$y_{it} = \alpha_i + x'_{it}\beta + \varepsilon_{it} \tag{28}$$

Where

$\varepsilon_{it} = \mu_i + v_{it}$

μ_i Are the unobservable country specific effects which should be time invariant. The individual country specific effects denote the unobserved heterogeneity like resource endowments, efficiency of debt utilization among other factors which cannot be easily quantified. v_{it} are the idiosyncratic errors that vary across time and across countries. The composite error term ε_{it} is assumed to be homoscedastic and serially independent both within and between cross-sections and are not contemporaneously correlated. That is $cor(\varepsilon_{it}\varepsilon_{js}) = 0$ when $i \neq j, t \neq s$.

Thus $y_{it} = \alpha + \mu_i + x'_{it}\beta + v_{it}$ (29)

The method for estimating equation depends on the whether the individual specific effects μ_i are correlated with the exogenous variables or not. Secondly the issue of persistence and endogeneity of the dependent variable also played a role in the selection of the estimation technique. The following sub-sections discuss the FE and RE methodologies and the improvement which could be attained when GMM technique is applied.

4.2.2 Random and Fixed Effects Estimators

Traditionally equation (29) would be random effect model if μ_i (the individual specific effects) are randomly distributed across the cross-sections. But μ_i would be fixed effect when it is treated as a parameter to be estimated for each cross-section observation. However, modern panel data econometrics considers the correlation between μ_i with the regressor. Accordingly, μ_i becomes a random effect when there is no correlation between the observed explanatory variables and the individual specific effect $[\,\text{cov}(\mu_i x_{it}) = 0]$. But when there is correlation between the observed explanatory variables and μ_i, the appropriate model would be fixed effect.

To decide between a fixed or random model, both FE and RE were estimated and the Hausman (1978) specification test was conducted in order to determine the appropriate model. The test assumes that the RE is correct a priori with the null hypothesis: $H_0 : \text{cov}(\mu_i x_{it}) = 0$ and the alternative $H_0 : \text{cov}(\mu_i x_{it}) \neq 0$ (i.e. the FE is correct). The Hausman test statistics is constructed from the estimated parameters of the random effect and within estimator of FE.

The Hausman test statistics $H = \left(\hat{\beta}_{re} - \hat{\beta}_w\right)' \left[V(\hat{\beta}_{re}) - V(\hat{\beta}_w)\right]^{-1} \left(\hat{\beta}_{re} - \hat{\beta}_w\right)$ is asymptotically distributed as a chi-square (χ^2) distribution. When a data set fails to meet the asymptotic assumption of the Hausman test, the F test can be used to check for redundancy of fixed effects. The null hypothesis would be $\mu_i = 0 \;\; \forall i = 1......n$ and rejection would imply that fixed effect model is valid and the reverse is true.

4.3.0. Dynamic Panel Estimation

The dependent variable, per capita GDP growth rate (PGDPGR) of one period tend to be related to the previous period's values and this required dynamic panel estimation which yield more efficient and consistent results than the fixed or random effects estimation. Given the effects of lags, equation (29) can be rewritten as: $y_{it} = \alpha + \mu_i + \delta y_{it-1} + x'_{it}\beta + v_{it}$ (30)

Where

$$\mu_i \sim iid(0, \sigma_\mu^2) \; and \; v_{it} \sim iid(0, \sigma_v^2)$$
$$y_{it-1} = \alpha + \mu_i + \delta y_{it-2} + x'_{it-1}\beta + v_{it-1}$$

Since y_{it-1} is correlated with v_{it} in equation (30), OLS and FE estimates would be biased and inconsistent even if the error term v_{it} are not serially correlated. Nickel (1981) noted that the within estimator of the FE model will be biased in dynamic panels and the bias will only diminish as period T tends to infinity. The problems of biasness and inconsistency of the FE within estimator has been dealt with by Anderson and Hsiao (1981), Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) with varying Instrumental Variables (IV) and GMM methodologies. This study employed two GMM techniques; Arellano and Bond (1991) and the system GMM (Blundell and Bond, 1998) estimators since they are more efficient than Anderson and Hsiao (1981) IV estimator.

4.3.1 Difference GMM Estimator

Arellano and Bond (1991) proposed a first difference GMM technique. They improved on the Anderson and Hsiao (1981) IV estimator by adding more instruments and exploiting the orthogonality conditions between lagged values of dependent variable y_{it} and the error term v_{it}. From the Anderson-Hsiao difference equation:

$$y_{it} - y_{it-1} = \delta_i (y_{it-1} - y_{it-2}) + (x_{it} - x_{it-1})' \beta + (v_{it} - v_{it-1}) \qquad (31)$$

The valid instruments could be found at different points t. For instance at $t = 3$, $y_{i3} - y_{i2} = \delta_i (y_{i2} - y_{i1}) + (x_{i3} - x_{i2})' \beta + (v_{i3} - v_{i2})$, the valid instrument would be y_{i1} because it is highly correlated with $(y_{i2} - y_{i1})$ but not correlated with $(v_{i3} - v_{i2})$. At $t = 4$ the valid instrument would be y_{i2} as it would be highly correlated with $(y_{i3} - y_{i2})$ but not correlated with $(v_{i4} - v_{i3})$ and so on. The dependent variable in the difference GMM estimation is $y_{it} - y_{it-1} = (\vartriangle y_{it})$ and the explanatory variables are the x_{it} the instruments $y_{i1}, y_{i2}, ..., y_{iT-2}$. The matrix of instruments for the first difference GMM estimator including the exogenous variables is given as

$$W_i^D = \begin{bmatrix} y_{i1}, x_{i1}', x_{i2}' & 0 & .... & 0 \\ 0 & y_{i1}, y_{i2,} x_{i1}', x_{i2}', x_{i3}' & .... & . \\ . & . & ... & . \\ 0 & . & ... & y_{i1}, ., y_{iT-2}, x_{i1}', .. x_{iT-1} \end{bmatrix}$$

The difference equation $\Delta y_{it} = \delta_i (\Delta y_{it-1}) + \Delta x_{it}' \beta + \Delta v_{it}$ is estimated using GMM.

If the explanatory variables are exogenous or weakly exogenous and there is no autocorrelation in the error term, the Arellano and Bond first difference GMM estimator can be obtained from the if the orthogonality conditions: $E(\Delta v_{it}) y_{i,t-s} = 0 \; \forall s \geq 2 \; and \; t = 3.......T$ and $E(\Delta v_{it}) x_{i,t-s} = 0 \; \forall s \geq 2 \; and \; t = 3.......T$ are satisfied .

4.3.2 System GMM Estimator

Arellano and Bover (1995), Blundell and Bond (1998) and Bond (2002) noted that the first difference-GMM estimator have poor finite sample properties and it is biased downwards particularly when the time dimension (T) is small. This is likely to be an issue in this study since T=16. Consequently the system GMM estimator was also used in the analysis. Blundell and Bond (1998) considered an AR (1) process $y_{it} = y_{it-1} + x'\beta + \mu_i + v_{it}$.

Focusing on the orthogonal condition $E(y_{it}\Delta v_{it}) = 0 \; \forall i = 1...N, t = 3....T$ and putting mild stationary restriction on the AR process, one can use system GMM estimator which uses lagged differences of y_{it} as instruments for equations in levels. This in addition to lagged values of y_{it} used as instruments for equations in first difference GMM estimator. For instance, for the equation $y_{i3} = \alpha + \mu_i + \delta y_{i2} + x'_{i3}\beta + v_{i3}$ the additional instrument would be $y_{i2} - y_{i1} = \Delta y_{i2}$, for $y_{i4} = \alpha + \mu_i + \delta_i y_{i3} + x'_{i4}\beta + v_{i4}$, Δy_{i3} would be additional and so on. The full set of instruments for the T-2 equations is given by the matrix below.

$$W_i^{D*} = \begin{bmatrix} W^D & 0 & ... & 0 \\ 0 & \Delta y_{i2} & ... & . \\ . & . & ... & . \\ 0 & . & ... & \Delta y_{iT-1} \end{bmatrix}$$

Where W^D is the matrix of instruments from the first difference GMM estimator.

The system GMM estimator and it is known to have remarkable efficiency gains over the first-difference GMM provided the condition $E\left(W_i^{D*}\Delta v_i\right) = 0$, $i = 1.......N$ is satisfied. For a comparative analysis of the efficiency gains, the system GMM results are presented alongside the difference GMM in the next chapter.

CHAPTER FIVE: DATA AND RESULTS

5.1.0 Data

The main data source is the World Development Indicators (2008) from which variables such as per capita GDP growth rate (PGDPGR), Capital stock (K), Labour (L), Inflation(INFL), OPENNESS, DEBT STOCK, and DEBT SERVICE were obtained. Other variables like External Debt to GDP ratio (EDGDPR) and External Debt Service to GDP ratio (EDSGDPR) were computed by the author. Explicitly;

$$EDGDPR_{it} = \frac{EXTERNAL\ DEBTSTOCK_{it}}{GDP_{it}} \times 100$$

$$EDSGDPR_{it} = \frac{DEBT\ SERVICE_{it}}{GDP_{it}} \times 100 .$$

Selected Statistics on African Economies (2008) was also used to obtain data on Gross Secondary enrolment (H) meanwhile the Freedom House Indices was used to obtain the level of the level of civil liberties (INST) which is used as proxy for measuring political and civil liberties accorded to residents of country on a discrete scale of 1 to 7 with 1 signifying highest freedom and 7 showing least freedom. All the variables except INST are measured in percentages/ ratios to ensure that the units of measurements are the same. A few data gaps for Labour force were filled by a linear regression based interpolation and extrapolation. Data was collected on 42 SSA countries listed in appendix 1 and covered the period 1990-2005. Even though WDI (2008) had data for 2006, many countries included in the sample had missing data for 2006 and since a balanced panel data is required for the analysis, the period for consideration was up to 2005.

5.1.1 Descriptive Statistics

A panel summary statistics was obtained and it slightly differs from the usual summary statistics as it decomposes the standard deviation, minimum and maximum values into overall, between and within components. The panel data summary is more informative than the usual summary statistics is presented in Table 4.

Table 4. Descriptive Statistics

VARIABLE		MEAN	STD. DEV	MIN	MAX	OBS
PGDPGR	Overall	1.0712	6.831	-46.997	67.102	N=672
	Between		3.367	-5.303	18.853	n=42
	Within		5.965	-47.501	49.320	T=16
Capital	Overall	20.445	11.492	1.763	113.578	N=672
	Between		9.3258	8.311	57.058	n=42
	Within		6.859	-19.67	76.660	T=16
Labour	Overall	45.36	5.404	32.5	60.1	N=672
	Between		5.404	33.118	58.925	n=42
	Within		0.807	42.336	48.536	T=16
Human	Overall	30.522	23.460	4.900	125.572	N=672
Capital	Between		22.128	7.144	114.637	n=42
	Within		8.466	3.635	81.678	T=16
EDSGDPR	Overall	4.261	4.5161	0.039	75.124	N=672
	Between		2.7561	0.834	12.377	n=42
	Within		3.601	-4.825	67.00	T=16
EDGDPR	Overall	102.65	68.708	3.541	467.713	N=672
	Between		61.1	10.835	338.596	n=42
	Within		32.726	-18.883	251.953	T=16
Inflation	Overall	81.486	957.846	-11.686	23773.130	N=672
	Between		345.297	2.556	2163.241	n=42
	Within		894.932	-2077.760	21691.380	T=16
OPENNESS	Overall	72.446	40.495	10.831	275.232	N=672
	Between		37.406	28.811	171.712	n=42
	Within		16.489	-46.238	190.888	T=16
Institution	Overall	4.4271	1.357	1.000	7.000	N=672
	Between		1.164	1.875	7.000	n=42
	Within		0.720	2.115	7.427	T=16

Note: The negative minimum for K, EDSGDPR EDGDPR and OPENNESS within is not a mistake; the within shows the variation of the variables within countries around the global mean i.e. the within minimum = $(x_{it} - \overline{x}_i - \overline{x}_{it})$.(STATA, 2009)

From Table 4, we note that the overall mean Per Capita GDP Growth Rate (PGDPGR), was 1 percent and the within mean (average over period) is 5.965 percent which is close to the AfBD 2008 estimate meanwhile minimum growth rate was negative 46.99 percent for Rwanda in 1994, probably due to the 1994 genocide. The maximum growth rate was 67.10 percent recorded in Equatorial Guinea in 1997, probably due to the discovery and production of oil for exports (IMF, 2001).

Considering the indicators of external debt, the overall mean of external debt service to GDP ratio (EDSGDPR) was 4.264 percent. This is low, perhaps due to debt servicing problems and debt relief due to the HIPC initiative. But the overall external debt stock to GDP ratio (EDGDPR) was 102 percent over the period under consideration. Sudan had the lowest debt service to GDP ratio of 0.04 percent of GDP yet its debt stock to GDP ratio was 207 percent of GDP in 1994. Guinea- Bissau had the highest external debt stock to GDP ratio of 467 percent while its external debt service to GDP ratio was only 5.9 percent of its GDP in 1998. By inspection, the trend cuts across most countries and this indicates that countries were struggling with debt burdens which were difficult to pay.

The overall mean inflation (INFL) was 81.4 percent and the with a maximum of 23,773 percent for the Democratic Republic of Congo in 1994 and this was attributed to widening fiscal deficit (Nachega, 2005). Over all, the region had macroeconomic instability over the period under consideration. The gross domestic investment as a ratio of GDP which is used as proxy for capital stock had an overall mean of 20.45 percent. However, the minimum value was 1.76 for the Democratic Republic of Congo (DRC) in 1993. This could have been due to the hyper inflation experienced at that time. The highest gross domestic investment was recorded in Equatorial Guinea in 1996, the year preceding actual oil production.

5.1.2 Pair wise Correlation Analysis

To further explore the data and discover some pair-wise relationship between the variables, the correlation matrix is presented in Table 5. Most of the variables have the correlations with per capita GDP growth rate PGDPGR of expected signs

Table 5. The Correlation Matrix from some of the Variables

	PGDPGR	Capital	Labour	H	EDGDPR	EDSGDPR
PGDPGR	1.000					
CAPITAL	0.443*	1.000				
LABOUR	-0.216	-0.074	1.000			
H	0.0744	0.209*	-0.0425	1.000		
EDGDPR	-0.1993*	-0.1344*	-0.0006	-0.3681*	1.000	
EDSGDPR	-0.0905* -	-0.028	-0.0317	0.0102	0.2764*	1.000

** Indicates that the correlation coefficient is significant at 5 percent level of significance*

To rule out the influence of multicollinearity, all the correlation coefficients are within acceptable limits.

5.1.3 Panel Unit Root Tests.

Tests for panel units were conducted because most macroeconomic variables are often non stationary and may result into spurious regressions. Levin et al. (2002) considered testing panel unit roots by assuming that persistence parameter are common across the cross-sections in an Augmented Dickey Fuller (ADF) test setting. Considering an autoregressive process for the panel data generating process, $y_{it} = \alpha + \mu_i + \delta_i y_{it-1} + x'_{it}\beta + v_{it}$, if $|\delta_i| < 1$, y_{it} would be weakly stationary and there would be no worry about spurious regressions but if $|\delta_i| = 1$, then there is a unit root. Following the ADF test formulation, we subtract y_{it-1} from both sides and to obtain $\Delta y_{it} = \alpha + \mu_i + (\delta_i - 1) y_{it-1} + x'_{it}\beta + v_{it}$. Augmenting with lagged values of

y_{it} to correct for autocorrelation we obtain an ADF type of model

$$\Delta y_{it} = \alpha + \mu_i + (\delta_i - 1) y_{it-1} + x_{it}'\beta + \sum_{j=1}^{p} \varphi_j \Delta y_{it-j} + v_{it} \qquad (32)$$

Letting $(\delta_i - 1) = \rho_i$, $\Delta y_{it} = \alpha + \mu_i + \rho_i y_{it-1} + x_{it}'\beta + \sum_{j=1}^{p} \varphi_j \Delta y_{it-j} + v_{it}$ (33)

Levin et al. (2002) assumed that $\rho_i = \rho \ \ \forall i = 1........n$. On the other Im et al (2003) assumed that the unit root process vary across cross sections such that $\rho_i \neq \rho, \forall \ i = 1........n$. Both techniques have the same null and alternative hypotheses: $H_0 : \rho = 0$ (there is a unit root) and $H_a : \rho < 0$ (there is no unit root) respectively. Although panel root test can be performed in STATA, it was performed using Eviews 5 because it provides for automatic maximum lag selection. The results are summarized in Table 6.

Table 6. Summary of Panel Unit Root Tests

	Null: Unit root (homogeneous)	**Null: Unit root (heterogeneous)**
Variable	**LLC t*–stat**	**IPS W-stat**
PGDPGR	-13.7607 (0.000)***	-10.6358 (0.000)***
CAPITAL	-7.78266 (0.000)***	-5.03213 (0.000)***
LABOUR	-11.5520 (0.000)***	-5.09178 (0.000)***
HUMAN CAPITAL	0.07739 (0.5308)	2.18423 (0.9855)
EDGDPR	-5.294 (0.000)***	-0.7386 (0.23)
EDSGDPR	-10.7687 (0.000)***	-5.5727 (0.007)***
INFLATION	-11.8445 (0.000)***	-6.38861 (0.000)***
OPENNESS	-6.87488 (0.000)***	-5.31421 (0.000)***
INSTITUTION	-13.825 (0.000)***	-7.22832 (0.000)***

LLC= Levin et al (2002) panel Unit root test
IPS= Im et al (2003) panel Unit root test
The p values are in parentheses and ***, ** and * means rejection of the null hypothesis at one, five and ten percent level of significance respectively.

From the unit root test, rejection of the null under LCC and IPS tests imply that a variable is stationary and therefore *I (0)*. The dependent variable per capita GDP growth rate (PGDPGR) was found to be $I(0)$. This implied that the explanatory variables should be $I(0)$ for regressions to be non spurious. All the explanatory variables were found to be stationary by the decision rule except Human Capital (H). Consequently Human Capital was excluded from the regressions.

5.2 Fixed Effects and Random Effects Results

Given the formulation in equation (29) and (30) fixed effects and random effects panel regressions were conducted and the results are presented in Table 7.

Table 7. Fixed and Random Effects Panel Regressions Results

PGDPGR	1(RE)	2 (FE)	3 (RE)	4 (FE)	5 (RE)	6 (FE)
CAPITAL	0. 2275 (7.9)***	0.1856 (5.21)***	0. 2329 (8.05)***	0.1885 (5.15)***	0.2254 (7.80)***	0.186 (5.21)***
LABOUR	1.459 (1.93)*	0.5807 (0.23)	1.076 (1.47)	0. 1793 (0.07)	1.491 (2.0)**	0.593 (0.23)
LABOUR SQUARED	-0.0159 (1.94)*	-0.0123 (0.45)	-0. 0117 (1.48)	-0.0077 (0.27)	-0.016 (2.0)**	-0.012 (0.45)
EDGDPR	-0.0202 (4.53)***	-0.0396 (5.84)***			-0. 0189 (4.17)***	-0.0399 (5.78)***
EDSGDPR			-0. 113 (1.96)*	-0.052 (0.83)	-0.05 (0.85)	0.0146 (0.23)
INFLATION	-0.00024 (0.99)	-0. 00015 (0.61)	-0. 00033 (1.34)	-0.0002 (0.84)	-0.00025 (1.05)	-0.00014 (0.60)
OPENNESS	0. 0099 (1.07)	0.0335 (2.25)**	0. 012 (1.27)	0. 0332 (2.15)**	0.0115 (1.21)	0.0331 (2.20)**
INSTITUTION	-0. 0531 (0.24)	-0.822 (2.60)***	-0.235 (1.12)	-1.00 (3.10)***	-0.0408 (0.19)	-0.8239 (2.60)**
CONSTANT	-34.9 (1.99)**	2.00 (0.03)	-27.31 (1.62)	7.527 (0.12)	-35.7 (2.07)**	1.72 (0.03)
Wald $\chi^2(7)$	137.45***		123.70***		140.18***	
F (7,624)		15.60***		10.28***		13.64***
N	672	672	672	672	672	672

The absolute values of Z or t statistics are in parentheses. The Z statistics are for the Random Effects Model meanwhile the t statistics are for the Fixed effects model and ***, ** and * indicates that the estimates are significant at one, five and ten percent level of significance respectively. In model 5, the Wald Statistics is taken at $\chi^2(8)$ and in model 6, F statistics is evaluated at F (8,622).

The results were obtained from three sub models which involved controlling for external debt stock to GDP ratio (EDGDPR) or external debt service to GDP ratio (EDSGDPR) then including both variables. This is meant to investigate the separate effects of debt overhang and crowding out effect respectively and then their joint impact on economic growth. On model selection and specification, the data failed to meet the asymptotic assumption of the Hausman (1978) specification test. But the F test for redundancy of fixed effects shows that fixed effects are valid. The Wald statistics for RE are statistically significant at one percent level of significance and this indicates that the models are well specified. A log file with detailed results is contained in appendix 3.

In models 1(RE) and 2(FE) labelled as regression 1 and 2 in the appendix, external debt service to GDP ratio (EDSGDPR) was excluded. This was meant to unravel debt overhang effect of external debt stock to GDP ratio (EDGDPR) while controlling for crowding-out effect of external debt service. In model 1 (RE), CAPITAL, LABOUR, LABOUR SQUARED, external debt stock to GDP ratio (EDGDPR) yielded coefficients which are statistically significant and with the expected signs. Meanwhile from model 2(FE), CAPITAL, external debt stock to GDP ratio (EDGDPR) OPENNESS and INSTITUTION yielded coefficients which are statistically significant. These results implies that capital, labour, external debt to GDP ratio, openness to international trade and civil liberties influenced per capita GDP growth in SSA as hypothesized.

The significant and negative coefficient of external debt stock to GDP ratio (EDGDPR) is of major interest as it relates directly with the aim of the study. It shows that as the external debt stock to GDP ratio increases, the growth in per capita GDP declined by 0.03 percent, keeping other factors constant. The coefficient is significant at one percent level of significance in both the random and fixed effects models. This indicates a debt overhang effect for the period 1990-2005.

The results in models 3 (RE) and 4(FE) were extracted from regressions 4 and 5 contained in appendix 3. The influence of external debt stock to GDP ratio (EDGDPR) was controlled for in order to reveal the crowding-out effect of external debt servicing in the absence of debt overhang effect. In the RE model, the coefficients of capital and external debt service to GDP ratio (EDSGDPR) yielded statistically significant coefficients. In FE model, the coefficients of CAPITAL, OPENNESS and INSTITUTION are statistically significant. The coefficient of external debt service to GDP ratio (EDSGDPR) is not statistically significant from model 4 and weakly significant from model 3. This indicates that external debt servicing had a weak influence on economic growth in SSA over the period considered. This is probable given that the overall mean external debt service to GDP ratio for the region was 4.261 percent of GDP whereas the mean external debt stock to GDP ratio was 102.65 percent as shown in the summary statistics.

The results in Models 5(RE) and 6(FE) were obtained from regression 5 and 6 contained in appendix 3. Model 5(RE) and 6(RE) can be regarded as the unrestricted models as they contain all the variables specified in equation (27). They were used to investigate the contemporaneous impact of both debt overhang and crowding-out effects of external debt. This involved inclusion of both external debt stock to GDP ratio (EDGDPR) and external debt service to GDP ratio (EDSGDPR) in the RE and FE regressions. Both the RE and FE results shows that External debt stock to GDP ratio (EDGDPR) had a negative and statistically significant influence on per capita GDP growth rate (PGDPGR). The result shows that, overall, an increase in external debt stock to GDP ratio was associated with a

0.03 percent decrease in economic growth rate, keeping other factors constant. Meanwhile the coefficient of external debt service to GDP ratio (DSGDPR) was insignificant and this indicates that debt servicing did not significantly affect growth over the period 1990-2005. We note that a variable Labour squared was included in all the models even if it was not in equation (27). It is meant to test one of the assumptions put in equation (2), which indicated diminishing returns of labour. The negative and statistically significant coefficient validated the theoretical assumption of the model.

Overall, the fixed effects and random effects results shows that the model specification is valid given that both F statistics is significant at one percent level of significance. Secondly all the variables had coefficients with the signs expected. However, the data failed to meet the asymptotic assumptions of the Hausman (1978) specification test to decide whether the random effect model would be better than the fixed effect model. Consequently, the F test for the redundancy of fixed effects was used and it shows that the fixed effects model is valid and there is need to purge the fixed effects using GMM techniques.

5.3 GMM Results

To obtain consistent and efficient estimates in the presence of endogeneity between variables, lagged dependent variable, unobserved individual country specific effects, short time dimension(T=16) and a larger country dimension (*N =42*) the difference and system GMM estimation were conducted and the results presented in Table 8. The Arellano and Bond (1991) first difference and the Blundell and Bond (1998) system GMM estimates were obtained through the XTABOND2 technique recommended by Roodman (2006). This is because the technique is flexible and demands for a *dofile (*Appendix2*)* and thus offers better accountability for the results. A full log file is provided as Appendix3 with GMM regressions marked 7 through 12. Specification issues were handled by considering test results of Sargan's test for over-identification restrictions, the F test and Arellano and Bond (AB) test for AR (1) and AR (2) in first differences. Sargan's test has a null hypothesis that the instruments as a group are exogenous. Consequently failure to reject the null hypothesis when the p-value of the Sargan's test statistic is high, the instruments are deemed to be valid. All the tests statistics shows that the econometric specifications of the models are acceptable.

Table 8. Difference and System GMM Results

PGDPGR(D1)	GMM1	GMM2	GMM3	GMM4	GMM5	GMM6
PGDPGR(L1)	-0.1809 (3.47)***	-0. 1627 (2.81)***	-0. 1754 (3.34)***	0.1679 (3.23)***	0.1883 (3.38)***	0.168 (3.17)***
CAPITAL(L1)	0.31405 (7.02)***	0.4313 (7.96)***	0 .314 (6.96)***			
CAPITAL				0.245 (7.13)***	0.272 (6.46)***	0.2459 (6.93)***
LABOUR	-4.00 (0.72)	-6.12 (0.94)	-3.86 (0.69)	1.88 (1.99)**	0.8519 (0.79)	1.877 (1.94)*
LABOUR SQUARED	0.0417 (0.69)	0.062 (0.89)	0.04 (0.66)	-0.019 (1.91)**	-0.0093 (0.8)	-0.0197 (1.87)*
EDGDPR	-0.044 (4.51)***		-0. 046 (4.61)***	-0.01 (2.18)**		-0.01 (2.1)**
EDSGDPR		-0.0574 (0.69)	0 .115 (1.14)		-0.077 (0.95)	0.0015 (0.02)
INFLATION	0. 0002 (0.6)	-6.92e-06 (0.02)	0. 0002 (0.58)	0.0001 (0.38)	0.0003 (0.77)	0.00016 (0.37)
OPENNESS	0.053 (2.46)**	0.0532 (2.04)**	0. 049 (2.23)**	0.005 (0.58)	0.003 (0.26)	0.0057 (0.51)
INSTITUTION	-1.528 (2.56)**	-2.05 (3.03)***	-1.67 (2.73)**	0.325 (1.21)	0.233 (0.72)	0.325 (1.2)
F Statistics	F(7,580) = 12.49	F(7,580) =10.69	F(8,579) = 11.11	F(7,622) =20.93	F(7,622) =16.46	F(8,621) =18.57
Sargan's Test	χ^2 (296) = 299.42	χ^2 (226) = 251.13	χ^2 (295) = 294.98	χ^2 (344) = 313.27	χ^2 (262) = 273.15	χ^2 (343)= 313.22
AB- AR(1) Z =	-9.68	-8.65	-9.62	-12.86	-12.14	-12.85
AB- AR(2) Z =	-1.87	-1.71	-1.85	-2.08	2.19	2.08
N	588	588	588	630	630	630

Absolute t statistics are in parentheses, ***, ** and * indicates that the coefficient is significant at 1%, 5% and 10% level of significance respectively. AB = Arellano and Bond test of autocorrelation in first differences.

Roodman (2006) strongly recommended that researchers must report the number of instruments and the p-values for Sargan Test and they are hereby reported:

GMM1: No of Instruments= 304, p-value for Sargan Test= 0.434 => Instruments are valid

GMM2: No of Instruments= 234, p-value for Sargan Test= 0.121 => Instruments are valid

GMM3: No of Instruments= 304, p-value for Sargan Test= 0.489 => Instruments are valid

GMM4: No of Instruments= 353, p-value for Sargan Test= 0.882 => Instruments are valid

GMM5: No of Instruments= 271, p-value for Sargan Test= 0.305 => Instruments are valid

GMM6: No of Instruments= 253, p-value for Sargan Test= 0.874 => Instruments are valid

Crowding out effect of external debt service to GDP ratio (EDSGDPR) and the debt overhang effect of external debt stock to GDP ratio (EDGDPR) were investigated separately and then jointly. The first three sub models are the Arellano and Bond (1991) first difference GMM results(GMM1, GMM2 and GMM3) meanwhile the last three models are the Blundell and Bond (1998) system GMM results (GMM4, GMM5 and GMM6).

In GMM1 the influence of external service to GDP ratio (EDSGDPR) was controlled for and the results shows that the initial per capita GDP growth rate (PGDPGR), lagged CAPITAL, OPENNESS and INSTITUTION produced coefficients which are statistically significant with the expected signs. Notably the negative and significant coefficient of the debt stock to GDP ratio indicates that the region suffered from the debt overhang effect. Since both per capita GDP growth rate (PGDPGR) and external debt stock to GDP ratio (EDGDPR) are in percentages, the coefficient of negative 0.044 implies that a unit increase in external debt stock to GDP ratio would lead to a 0.04 decrease in per capita GDP growth rate, all else kept constant.

When the impact of external debt stock to GDP ratio (EDGDPR) was controlled for in GMM2, initial per capita GDP growth rate (GDPGR), initial CAPITAL stock, INSTITUTION and OPENNESS yielded statistically significant coefficients with the expected signs. However, the coefficient for external debt service to GDP ratio (EDSGDPR) is not statistically significant and this indicates that external debt servicing had negligible negative impact on per capita GDP growth rate (PGDPGR) in SSA for the period considered.

GMM3 is the unrestricted model as it includes all the variables specified in equation (27) and the results indicates that initial per capita GDP growth rate, initial Capital stock, external debt to GDP ratio (EDGDPR) ,OPENNESS and INSTITUTION yielded statistically significant coefficients with the expected signs. The negative and statistically significant coefficient of EDGDPR shows that the debt overhang effect dominated the crowding-out effect of external debt servicing. Therefore the first difference Arellano and Bond (1991) estimates showed that external debt negatively affected economic growth in SSA through the debt overhang effect.

The system GMM results labelled GMM4, GMM5 and GMM6 were extracted from regressions 10, through 12 as contained in appendix 3. The sub- models resulted from controlling for external debt service to GDP ratio (EDSGDPR) in GMM4, external debt stock to GDP ratio (EDGDPR) in GMM5 and then relaxing all the restrictions in GMM (6). Notable from the results of the three sub models is the positive and statistically significant coefficient of initial per capita GDP growth rate (PGDPGR). This contradicts conditional convergence hypothesis as postulated in the neoclassical growth theory. This is perhaps due the heterogeneity among the 42 countries included in the sample[5].

From GMM4, the coefficients of CAPITAL, Labour, Labour Squared and external debt stock to GDP ratio (EDGDPR) are statistically significant with the expected signs. In GMM 5, only the coefficients of CAPITAL and initial per capita GDP growth rate(PGDPGR) are statistically significant. In GMM (6), the coefficients of CAPITAL, Labour, Labour Squared and external debt stock to GDP ratio (EDGDPR) are statistically significant with the expected

[5] Barro and Sala-i-Martin (2004) pointed out that conditional convergence hypothesis holds if the economies examined are more homogenous. But SSA economies tend to heterogeneous since some countries like South Africa, Botswana, Equatorial Guinea recorded high growth rates in 1990s meanwhile some countries like Sierra Leone, Burundi, Guinea Bissau, among others experience contraction in growth as the WDI (2008) data indicates.

signs. We note that the coefficient of external debt service to GDP ratio (EDSGDPR) is not statistically significant in both GMM (5) and GMM (6) results whereas the coefficient of external debt stock to GDP ratio (EDGDPR) is negative and statistically significant whenever it is included in the model. This indicates that the debt overhang effect had a statistically significant effect on economic growth in SSA over the period 1990-2005. In terms of magnitude the system GMM results shows that a unit increase in the external debt stock to GDP ratio is associated with a 0.01 decrease in economic growth rate, keeping other factors constant.

5.4 Discussion of Results

This study examined the impact of external debt on economic growth in SSA and from the theoretical foundations of crowding-out effect and debt overhang effect. From the RE, FE and the GMM estimations the results indicates that the effect of debt servicing as a ratio of GDP was statistically insignificant even when the influence of external debt stock to GDP ratio was controlled for. This is perhaps due to the various debt relief initiatives implemented during the 1990s and the inability to pay the debt. Moreover the summary statistics shows that the mean external debt service to GDP ratio (EDSGDR) was only 4.261 percent for period 1990-2005. Consequently proposition 2 put in the analytical framework is rejected on the basis of the data analyzed. This is similar to findings of Levine and Rennet (1992). Therefore the view of NGOs like OXFAM (1999) that high external debt service had been the major cause of low economic growth in SSA was not supported by this result.

Debt overhang effect was another hypothesis which guided this study. The debt overhang effect hypothesis links the impact of external debt stock to economic growth rate. In this study, the external debt stock to GDP a ratio (EDGDPR) is used as a measure of the magnitude of external debt. From the RE, FE and GMM regressions, the coefficient is negative and statistically significant at one percent level of significance. The system GMM result shows that a one percent increase in EDGDPR is associated with a 0.01 percent decline in per capita GDP growth rate, keeping other factors constant. Therefore the impact of external debt stock was negative on economic growth in SSA for period 1990-2005. This result supports the hypothesis that high external debt would lead to a decline in economic growth. This result corroborates the findings of Melbourne (1997), Pattillo et al. (2002), Clements et al. (2003), among others.

Considering other factors included in the model, the coefficient of capital measured in terms of the gross capital formation as a percentage of GDP is positive as predicted. This is in agreement with neoclassical growth model and empirically proven in studies like Mankiw et al. (1990), Barro (1991), among many others. In all the GMM models the coefficient of CAPITAL is positive and statistically significant. In the difference GMM, the initial value of CAPITAL was used on the basis that the impact of new investments on GDP occurs with some lags as firms adjust to the new equipments and training of labour to use the new innovations.

The impact of labour force is positive and significant from the system GMM results. Labour force, measured in terms of the economically active population as a ratio of the entire population, positively influenced economic growth as assumed in the analytical framework. Labour squared (L^2) was included so that the assumption of diminishing returns is tested. The negative and significant coefficient of Labour Squared in the system GMM results indicates that as more and more units of labour are added into the economy, per capita GPD growth rate declines. The result indicates that the theoretical assumption of the model is valid.

Given the inbuilt impact of initial per capita GDP growth rate (PGDPGR), the coefficient turned out to be negative and significant in the difference GMM results as expected in neoclassical growth theory. The sign of coefficient of initial per capita GDP growth rate (PGDPGR), indicates whether there is growth convergence in the region or not. In cross-sectional studies, Baumol (1986), DeLong (1988), Barro (1991), Barro and Sala-i-Martin (2004), among others examined how economy's growth rate varies with initial income level. The studies note that if there is convergence then the coefficient of initial income level should be negative. Furthermore, in cross country analyses, regression of future growth rates on initial income levels may be used to test for exogenous growth as opposed to endogenous growth [Barro (1991), Mankiw et al. (1992), Barro (1997)]. Empirically, a negative coefficient is also interpreted as evidence of exogenous growth. The negative coefficient of initial per capita GDP growth rate (PGDPGR) in the difference GMM results implies that there was convergence in per capita of GDP growth rates as well as diminishing returns to capital as assumed in the analytical framework (Barro, 1996; Mankiw et al. 1992). A key assumption in this approach is that cross-country growth is linear and this holds under Solow's (1956) growth model. But the system GMM results shows that there was no convergence in GDP per capita growth rate since the coefficient of initial per capita GDP growth rate (PGDPGR) is positive and statistically significant. Given the strength of system GMM over differenced GMM, the contradiction may be explained by the heterogeneity of growth rate in the 42 countries included in the sample. Barro and Sala-i-Martin (2004) concluded that absolute convergence does not apply to a broad cross section of countries. The positive coefficient implies that there was a tendency for richer countries to grow at a rate faster than poor countries.

The degree of openness to trade (OPENNESS) in the difference GMM results have yielded a statistically significant and positive coefficient as predicted by theory. This implies that openness to trade enhances economic growth through increased exports and import of raw materials or capital equipments necessary in the production processes. Increased exports would lead to economic growth due to increase in foreign exchange earnings. This result is similar to the findings of Sachs and Warner (1995), Dollar and Kray (2001).

From the fixed effects (FE) and difference GMM regressions, the coefficient of INSTITUTION is statistically significant and with the expected negative sign. INSTITUTION is used to measure the level of civil and political liberties. It is meant to reflect the institutional strength in the region. This is because countries with civil and political liberties tend to have good governance and institutions necessary for efficient economic activities. Civil and political liberties also influence the ease of starting and owning businesses. It also influences the enforcement of property rights by institutions like the courts of law and other government agencies. Thus INSTITUTION can affect growth in many ways and countries with poor rankings are associated with unfavourable conditions for investors and consequently jeopardizing economic growth. The coefficient for INSTITUTION is negative, showing that a decline in civil and political liberty negatively affected economic growth in SSA. The summary statistics shows that the overall mean of INSTITUTION is 4.4 and this is poor given that 1 is the best and 7 is the worst. This is similar to the finding of Feld et al. (2003)

The insignificant impact of INFLATION is one aspect of the results that appears to be strange. It was hypothesized that inflation would have a negative impact on per capita GDP growth rate . Many studies like Cohen (1993), Were (2001), Ahmed et al. (2007, among others reported negative and significant impact of inflation on economic growth. The insignificant result could be due to the heterogeneity among the 42 countries included in the regressions. Some countries had relatively low inflation while other countries had very low inflation rates. By inspection (see Appendix 4) a total of 416 observations had inflation rate of less than 10 percent meanwhile only 256 observations had inflation rate greater than 10 percent. Given this data structure, it is plausible for inflation to have insignificant coefficient. This is in accord with Levine and Renelt (1992) who examined how inflation would affect growth in cross-section regressions. Their results showed that inflation was not significant even if it was transformed in many ways. Levine and Zervos (1993) found that inflation was insignificant partly because of number of high-inflation and high-growth outliers. This could be the case in this study given that some countries like Angola experienced very high inflation in the 1990s, meanwhile Gabon experienced deflation, among others. On the other hand Equatorial Guinea had extremely high growth rates meanwhile Guinea Bissau and Sierra Leone had negative growth rates. These mix-ups could have rendered the coefficient of inflation to be statistically insignificant.

From the discussion, it is evident that the effect of external debt stock to GDP ratio was negative and statistically significant in all the FE and GMM regressions. This indicates that the debt overhang effect influenced growth in SSA over the period 1990-2005. Other factors like capital, labour, openness to trade and institutions also influenced growth as predicted by theory. Over all, the results are valid given that specification tests were satisfied. The next chapter provides the conclusion and policy recommendations arising from the results discussed.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.0 Summary of Findings

The major finding of this study is the negative impact of external debt stock on the per capita GDP growth rate in SSA over the period 1990-2005. This is consistent with the debt overhang hypothesis. In contrast, the crowding out effect of external debt servicing was found to be statistically insignificant even if the effect of external debt stock was controlled for. This is perhaps due to low debt servicing after many SSA countries benefited from HIPC and other Paris Club debt relief initiatives.

The impact of openness to trade, capital/ investment, and labour force were found to be positive as expected in neoclassical growth models. From the difference GMM, the negative coefficient of the lagged PGDPGR indicates a tendency of conditional convergence towards the steady state growth rate but the system GMM results rejects the convergence hypothesis, perhaps due to heterogeneity of the countries included in the model. This however remains a controversy within the findings. Another finding is the significant effect of institutional strength and civil liberties on economic growth. The results indicate that lack of civil and political liberties negatively affected economic growth in SSA over the period 1990 to 2005.

6.1 Conclusion

From the findings, we can conclude that   external debt stock negatively affected economic growth in SSA over the period 1990-2005 as hypothesized. This is because the coefficient of the external debt to GDP ratio was negative and statistically significant in all the regressions. Thus the debt overhang hypothesis was corroborated from this study. However, the crowding out effect of external debt servicing was found to be statistically insignificant.

6.2 Policy Recommendations

From the empirical results, it is recommended that SSA countries should exhibit restrain in contracting new external debts since external debt stock was associated with decline in economic growth. The study showed that accumulation of external debt led to debt overhang effect even if some debts were cancelled through HIPC and MRDI. Moreover, debt cancellation is an indication of the debtors' inability to service its obligation and thus limiting opportunities to borrow and put up productive physical and human capital necessary for economic growth. Secondly SSA countries should create political environments that are suitable for economic growth. Given the negative impact of INSTITUTION, SSA countries should initiate reforms on political and civil liberties. This would guarantee free business environment , protection of private property rights and enforcement of contracts.

6.3 Recommendation for Further Studies

This study was not able to trace data on the purposes for which external loans were borrowed by SSA countries. This was due to aggregation of data from WDI (2008). It is recommended that future studies could focus on the use of externally acquired loans and establishing the impact of such loans on economic growth. For instance one can study the impact of externally borrowed funds meant for industrial sector on economic growth. This would bring out the clear impact of borrowed funds on economic growth using some sort of disaggregation.

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APPENDICES

Appendix 1. List of Countries Included in the sample

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, DR Congo,. Republic of Congo, Cote d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan , Swaziland, Togo, Tanzania , Uganda , Zambia ,Zimbabwe

Appendix2. dofile.

```
version 9.1
clear
set matsize 800
capture log close
set mem 200m
log using ratios.log,replace
set more off
use "C:\Users\john\Documents\Dissertation\latest.dta"
tsset id year
rename gdi k
rename  labouractive l
gen l2=l*l
gen edgdpr= (debtstock/gdp)*100
gen edsgdpr= (deb_service/gdp)*100
*\DESCRIPTIVES\*
xtsum pgdpgr k l h  edgdpr  edsgdpr infl  openness  inst
pwcorr pgdpgr k l h edgdpr  edsgdpr infl  openness  inst,star(0.05)
*\RE1\*
xtreg  pgdpgr k l l2 edgdpr infl  openness inst, re i(id)
estimates store random_effects
*\FE1\*
xtreg  pgdpgr k l l2 edgdpr infl  openness inst, fe i(id)
estimates store fixed_effects
hausman random_effects fixed_effects
*\RE2\*
xtreg  pgdpgr k l l2 edsgdpr infl openness inst , re i(id)
estimates store random_effects
*\FE2\*
xtreg  pgdpgr k l l2 edsgdpr infl openness inst , fe i(id)
estimates store fixed_effects
hausman random_effects fixed_effects
*\RE3\*
xtreg  pgdpgr k l l2 edgdpr edsgdpr infl openness inst , re i(id)
estimates store random_effects
*\FE3\*
xtreg  pgdpgr k l l2 edgdpr edsgdpr infl openness inst , fe i(id)
estimates store fixed_effects
hausman random_effects fixed_effects
xtabond2 pgdpgr l.pgdpgr l.k l  l2 edgdpr  infl openness inst,gmm(l3.(pgdpgr k
edgdpr  openness)) nolevel small
xtabond2 pgdpgr l.pgdpgr l.k l  l2 edsgdpr infl openness inst,gmm(l3.(pgdpgr
edsgdpr  openness))nolevel small
xtabond2 pgdpgr l.pgdpgr l.k l l2 edgdpr  edsgdpr infl openness inst,gmm(l.3(pgdpgr
k edgdpr openness))  nolevel small
xtabond2 pgdpgr l.pgdpgr k l l2 edgdpr  infl openness inst,gmm(l3.(pgdpgr k edgdpr
openness))small
xtabond2 pgdpgr l.pgdpgr k l l2  edsgdpr infl openness inst,gmm(l3.(pgdpgr edsgdpr
openness))small
xtabond2 pgdpgr l.pgdpgr k l l2 edgdpr  edsgdpr infl openness inst,gmm(l3.(pgdpgr k
edgdpr openness)) small
sum infl if infl<10
sum infl if infl>10
extremes infl
extremes pgdpgr
```

Appendix 3: log file

```
       log:  C:\data\ratios.log
  log type:  text
 opened on:  29 Jun 2009, 19:03:15

. set more off

. use "C:\Users\john\Documents\Dissertation\latest.dta"

. tsset id year
       panel variable:  id, 1 to 42
        time variable:  year, 1990 to 2005

. rename gdi k

. rename  labouractive l

. gen l2=l*l

. gen edgdpr= (debtstock/gdp)*100

. gen edsgdpr= (deb_service/gdp)*100

. *\DESCRIPTIVES\*
. xtsum pgdpgr k l h  edgdpr  edsgdpr infl  openness  inst

Variable         |      Mean   Std. Dev.       Min        Max |    Observations
-----------------+--------------------------------------------+----------------
pgdpgr   overall |  1.071217   6.831118  -46.99654   67.10155 |     N =     672
         between |              3.36723  -5.303038    18.8528 |     n =      42
         within  |             5.964847   -47.5012   49.31996 |     T =      16
                 |                                            |
k        overall |  20.44572   11.49275   1.763038   113.5779 |     N =     672
         between |             9.325808   8.311396   57.50501 |     n =      42
         within  |             6.859792  -19.67471   76.51856 |     T =      16
                 |                                            |
l        overall |  45.36131   5.404223       32.5       60.1 |     N =     672
         between |             5.404364   33.11875     58.925 |     n =      42
         within  |              .807086   42.33631   48.53631 |     T =      16
                 |                                            |
h        overall |  30.52217   23.46032        4.9   125.5719 |     N =     672
         between |             22.12827    7.14375   114.6374 |     n =      42
         within  |             8.465979   3.634671   81.67842 |     T =      16
                 |                                            |
edgdpr   overall |  102.6476   68.70825   3.541066   467.7134 |     N =     672
         between |             61.10062   10.83474   338.5963 |     n =      42
         within  |             32.72604  -18.88271   251.9526 |     T =      16
                 |                                            |
edsgdpr  overall |  4.261067   4.516073   .0395006   75.12484 |     N =     672
         between |             2.756145   .8340464    12.3769 |     n =      42
         within  |             3.601165  -4.825291   67.00901 |     T =      16
                 |                                            |
infl     overall |  81.48645   957.8457  -11.68611   23773.13 |     N =     672
         between |             345.2971   2.556274   2163.241 |     n =      42
         within  |             894.9322   -2077.76   21691.38 |     T =      16
                 |                                            |
openness overall |  72.44639   40.49478   10.83072   275.2324 |     N =     672
         between |              37.4063   28.81132   171.7116 |     n =      42
         within  |             16.48864  -46.23829   190.8875 |     T =      16
                 |                                            |
inst     overall |  4.427083   1.357447          1          7 |     N =     672
         between |             1.163789      1.875          7 |     n =      42
         within  |             .7200943   2.114583   7.427083 |     T =      16


. pwcorr pgdpgr k l h edgdpr  edsgdpr infl  openness  inst,star(0.05)

             |   pgdpgr        k        l        h   edgdpr  edsgdpr     infl
-------------+---------------------------------------------------------------
      pgdpgr |   1.0000
           k |   0.4430*  1.0000
           l |  -0.0216  -0.0744   1.0000
           h |   0.0744   0.2094* -0.0425   1.0000
      edgdpr |  -0.1993* -0.1344* -0.0006  -0.3681*  1.0000
     edsgdpr |  -0.0905* -0.0282  -0.0317   0.0102   0.2764*  1.0000
        infl |  -0.0772* -0.0559  -0.0305  -0.0282   0.0955* -0.0189   1.0000
    openness |   0.2465*  0.5779* -0.1694*  0.4284* -0.0925*  0.2209* -0.0128
        inst |  -0.0566  -0.0957* -0.0840* -0.3729*  0.2839*  0.0219   0.0818*

             | openness     inst
-------------+------------------
    openness |   1.0000
        inst |  -0.0973*  1.0000
```

Regression 1(RE)

```
. xtreg  pgdpgr k l l2 edgdpr infl  openness inst, re i(id)

Random-effects GLS regression                    Number of obs      =       672
Group variable (i): id                          Number of groups   =        42

R-sq:  within  = 0.1177                         Obs per group: min =        16
       between = 0.5533                                        avg =      16.0
       overall = 0.2179                                        max =        16

Random effects u_i ~ Gaussian                   Wald chi2(7)       =    137.45
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           k |   .2275534   .0288206     7.90   0.000      .171066    .2840408
           l |    1.45978   .7577218     1.93   0.054    -.0253278    2.944887
          l2 |   -.015948   .0082401    -1.94   0.053    -.0320983    .0002023
      edgdpr |  -.0202122   .0044623    -4.53   0.000    -.0289582   -.0114663
        infl |  -.0002436    .000245    -0.99   0.320    -.0007239    .0002366
    openness |   .0099161   .0092915     1.07   0.286    -.0082949     .028127
        inst |  -.0531024   .2195266    -0.24   0.809    -.4833666    .3771618
       _cons |  -34.90704   17.50524    -1.99   0.046    -69.21668   -.5974068
-------------+----------------------------------------------------------------
     sigma_u |  1.4856837
     sigma_e |  5.7101126
         rho |  .06340387   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store random_effects
```

Regression 2(FE)

```
. xtreg  pgdpgr k l l2 edgdpr infl  openness inst, fe i(id)

Fixed-effects (within) regression               Number of obs      =       672
Group variable (i): id                          Number of groups   =        42

R-sq:  within  = 0.1491                         Obs per group: min =        16
       between = 0.2143                                        avg =      16.0
       overall = 0.1170                                        max =        16

                                                F(7,623)           =     15.60
corr(u_i, Xb)  = -0.7168                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           k |   .1856378   .0356414     5.21   0.000     .1156459    .2556297
           l |   .5807184   2.547788     0.23   0.820    -4.422574    5.584011
          l2 |   -.012355   .0276143    -0.45   0.655    -.0665833    .0418733
      edgdpr |  -.0396085   .0067801    -5.84   0.000    -.0529231   -.0262939
        infl |  -.0001509   .0002469    -0.61   0.541    -.0006359     .000334
    openness |   .0335767   .0149473     2.25   0.025     .0042235    .0629298
        inst |  -.8220656   .3159624    -2.60   0.009    -1.442546   -.2015853
       _cons |   2.001005   58.83331     0.03   0.973    -113.5346    117.5366
-------------+----------------------------------------------------------------
     sigma_u |  4.7958426
     sigma_e |  5.7101126
         rho |  .41363012   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(41, 623) =     2.99             Prob > F = 0.0000


. estimates store fixed_effects

. hausman random_effects fixed_effects

Note: the rank of the differenced variance matrix (6) does not equal the number of coefficients being
tested (7); be sure this is what
        you expect, or there may be problems computing the test.  Examine the output of your estimators for
anything unexpected and
        possibly consider scaling your variables so that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |  random_eff~s fixed_effe~s    Difference          S.E.
-------------+----------------------------------------------------------------
           k |     .2275534     .1856378        .0419155               .
           l |      1.45978     .5807184        .8790613               .
          l2 |     -.015948     -.012355       -.003593                .
      edgdpr |    -.0202122    -.0396085        .0193963               .
        infl |    -.0002436    -.0001509       -.0000927               .
    openness |     .0099161     .0335767       -.0236606               .
        inst |    -.0531024    -.8220656        .7689632               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =   -41.05    chi2<0 ==> model fitted on these data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test
```

Regression 3 (RE)

```
. xtreg  pgdpgr k l l2 edsgdpr infl openness inst , re i(id)

Random-effects GLS regression                   Number of obs      =       672
Group variable (i): id                          Number of groups   =        42

R-sq:  within  = 0.0828                         Obs per group: min =        16
       between = 0.6026                                        avg =      16.0
       overall = 0.2061                                        max =        16

Random effects u_i ~ Gaussian                   Wald chi2(7)       =    123.70
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           k |     .23291   .0289403     8.05   0.000     .1761881     .289632
           l |   1.076036   .7301546     1.47   0.141    -.3550403    2.507113
          l2 |  -.0117468   .0079395    -1.48   0.139    -.0273079    .0038144
     edsgdpr |    -.11324   .0579117    -1.96   0.051    -.2267449    .0002649
        infl |  -.0003311   .0002479    -1.34   0.182     -.000817    .0001548
    openness |   .0120574   .0094661     1.27   0.203    -.0064959    .0306106
        inst |  -.2353244   .2100799    -1.12   0.263    -.6470734    .1764246
       _cons |  -27.31013   16.89696    -1.62   0.106    -60.42756    5.807297
-------------+----------------------------------------------------------------
     sigma_u |  1.3636841
     sigma_e |  5.8612077
         rho |  .05135212   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store random_effects
```

Regression 4(FE)

```
. xtreg  pgdpgr k l l2 edsgdpr infl openness inst , fe i(id)

Fixed-effects (within) regression               Number of obs      =       672
Group variable (i): id                          Number of groups   =        42

R-sq:  within  = 0.1035                         Obs per group: min =        16
       between = 0.1975                                        avg =      16.0
       overall = 0.0976                                        max =        16

                                                F(7,623)           =     10.28
corr(u_i, Xb)  = -0.6260                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           k |   .1885828   .0366171     5.15   0.000      .116675    .2604907
           l |   .1793459   2.614755     0.07   0.945    -4.955456    5.314148
          l2 |   -.007752   .0283391    -0.27   0.785    -.0634037    .0478997
     edsgdpr |  -.0524674   .0634239    -0.83   0.408    -.1770178     .072083
        infl |  -.0002139   .0002534    -0.84   0.399    -.0007116    .0002837
    openness |   .0332484   .0154669     2.15   0.032     .0028748     .063622
        inst |  -1.002433   .3228797    -3.10   0.002    -1.636497   -.3683683
       _cons |   7.527272   60.39366     0.12   0.901    -111.0725    126.1271
-------------+----------------------------------------------------------------
     sigma_u |  4.1446725
     sigma_e |  5.8612077
         rho |  .33335186   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(41, 623) =     2.39             Prob > F = 0.0000

. estimates store fixed_effects

. hausman random_effects fixed_effects

Note: the rank of the differenced variance matrix (6) does not equal the number of coefficients being
tested (7); be sure this is what
        you expect, or there may be problems computing the test.  Examine the output of your estimators for
anything unexpected and
        possibly consider scaling your variables so that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |  random_eff~s fixed_effe~s    Difference          S.E.
-------------+----------------------------------------------------------------
           k |      .23291     .1885828        .0443272               .
           l |    1.076036     .1793459        .8966905               .
          l2 |   -.0117468     -.007752       -.0039948               .
     edsgdpr |     -.11324    -.0524674       -.0607726               .
        infl |   -.0003311    -.0002139       -.0001172               .
    openness |    .0120574     .0332484        -.021191               .
        inst |   -.2353244    -1.002433        .7671082               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =   -25.41    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;  see suest for a generalized test
```

Regression 5(RE)

```
. xtreg  pgdpgr k l l2 edgdpr edsgdpr infl openness inst , re i(id)

Random-effects GLS regression                   Number of obs      =       672
Group variable (i): id                          Number of groups   =        42

R-sq:  within  = 0.1157                         Obs per group: min =        16
       between = 0.5691                                        avg =      16.0
       overall = 0.2207                                        max =        16

Random effects u_i ~ Gaussian                   Wald chi2(8)       =    140.18
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           k |   .2254745   .0289079     7.80   0.000     .1688161    .2821328
           l |    1.49192   .7472906     2.00   0.046     .0272569    2.956582
          l2 |   -.016281   .0081261    -2.00   0.045    -.0322078   -.0003542
      edgdpr |  -.0189787   .0045528    -4.17   0.000    -.0279021   -.0100554
     edsgdpr |  -.0503089   .0592134    -0.85   0.396     -.166365    .0657471
        infl |  -.0002567   .0002454    -1.05   0.296    -.0007377    .0002244
    openness |   .0115484   .0095058     1.21   0.224    -.0070826    .0301794
        inst |  -.0408523   .2174665    -0.19   0.851    -.4670789    .3853743
       _cons |   -35.7112   17.26013    -2.07   0.039    -69.54044    -1.88196
-------------+----------------------------------------------------------------
     sigma_u |  1.4253024
     sigma_e |   5.714453
         rho |  .05856714   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store random_effects
```

Regression 6(FE)

```
. xtreg  pgdpgr k l l2 edgdpr edsgdpr infl openness inst , fe i(id)

Fixed-effects (within) regression               Number of obs      =       672
Group variable (i): id                          Number of groups   =        42

R-sq:  within  = 0.1492                         Obs per group: min =        16
       between = 0.2125                                        avg =      16.0
       overall = 0.1164                                        max =        16

                                                F(8,622)           =     13.64
corr(u_i, Xb)  = -0.7170                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           k |   .1860024    .035703     5.21   0.000     .1158893    .2561155
           l |   .5932134   2.550292     0.23   0.816    -4.415012    5.601439
          l2 |  -.0124937   .0276417    -0.45   0.651     -.066776    .0417887
      edgdpr |  -.0399044   .0069037    -5.78   0.000    -.0534618   -.0263469
     edsgdpr |   .0146143   .0629155     0.23   0.816    -.1089382    .1381668
        infl |  -.0001487   .0002473    -0.60   0.548    -.0006344    .0003369
    openness |   .0331338   .0150797     2.20   0.028     .0035205     .062747
        inst |  -.8239464   .3163062    -2.60   0.009    -1.445104    -.202789
       _cons |   1.724464   58.89006     0.03   0.977     -113.923    117.3719
-------------+----------------------------------------------------------------
     sigma_u |  4.8032183
     sigma_e |   5.714453
         rho |  .41400703   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(41, 622) =     2.93             Prob > F = 0.0000

. estimates store fixed_effects

. hausman random_effects fixed_effects

Note: the rank of the differenced variance matrix (7) does not equal the number of coefficients being
tested (8); be sure this is what
        you expect, or there may be problems computing the test.  Examine the output of your estimators for
anything unexpected and
        possibly consider scaling your variables so that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |  random_eff~s fixed_effe~s    Difference          S.E.
-------------+----------------------------------------------------------------
           k |     .2254745     .1860024        .0394721               .
           l |      1.49192     .5932134        .8987061               .
          l2 |     -.016281    -.0124937       -.0037873               .
      edgdpr |    -.0189787    -.0399044        .0209256               .
     edsgdpr |    -.0503089     .0146143       -.0649232               .
        infl |    -.0002567    -.0001487        -.000108               .
    openness |     .0115484     .0331338       -.0215853               .
        inst |    -.0408523    -.8239464        .7830941               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
```

```
                    =   -43.04    chi2<0 ==> model fitted on these
                                  data fails to meet the asymptotic
                                  assumptions of the Hausman test; see suest for a generalized test
```

Regression 7(GMM1)

```
. xtabond2 pgdpgr l.pgdpgr l.k l  l2 edgdpr  infl openness inst,gmm(l3.(pgdpgr k edgdpr  openness)) nolevel
small
Building GMM instruments.....
8 instrument(s) dropped because of collinearity.
Warning: Number of instruments may be large relative to number of observations.
Suggested rule of thumb: keep number of instruments <= number of groups.
Estimating.
Performing specification tests.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       588
Time variable : year                            Number of groups   =        42
Number of instruments = 304                     Obs per group: min =        14
F(7, 580)     =     12.49                                      avg =     14.00
Prob > F      =     0.000                                      max =        14
------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      pgdpgr |
         L1. |  -.1809098   .0520829    -3.47   0.001     -.283204   -.0786157
           k |
         L1. |   .3140556     .04475     7.02   0.000     .2261639    .4019473
           l |  -4.002138    5.59381    -0.72   0.475    -14.98873    6.984454
          l2 |   .0417735   .0605418     0.69   0.490    -.0771344    .1606814
      edgdpr |  -.0444166   .0098546    -4.51   0.000    -.0637717   -.0250615
        infl |   .0002316   .0003862     0.60   0.549    -.0005269    .0009901
    openness |   .0535678   .0217827     2.46   0.014     .0107852    .0963505
        inst |  -1.528868   .5968646    -2.56   0.011    -2.701148    -.356589
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/.).(L3.pgdpgr L3.k L3.edgdpr L3.openness)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -9.68  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.87  Pr > z =  0.062
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(296)  = 299.42  Prob > chi2 =  0.434
  (Not robust, but not weakened by many instruments.)
```

Regression 8(GMM2)

```
. xtabond2 pgdpgr l.pgdpgr l.k l  l2 edsgdpr infl openness inst,gmm(l3.(pgdpgr edsgdpr  openness))nolevel
small
Building GMM instruments....
Warning: Number of instruments may be large relative to number of observations.
Suggested rule of thumb: keep number of instruments <= number of groups.
Estimating.
Performing specification tests.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       588
Time variable : year                            Number of groups   =        42
Number of instruments = 234                     Obs per group: min =        14
F(7, 580)     =     10.69                                      avg =     14.00
Prob > F      =     0.000                                      max =        14
------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      pgdpgr |
         L1. |  -.1627124   .0578706    -2.81   0.005    -.2763739   -.0490509
           k |
         L1. |   .4313541   .0541617     7.96   0.000     .3249772     .537731
           l |  -6.127564   6.520012    -0.94   0.348    -18.93327    6.678147
          l2 |    .062626   .0699892     0.89   0.371    -.0748372    .2000893
     edsgdpr |  -.0574868   .0827938    -0.69   0.488     -.220099    .1051254
        infl |  -6.92e-06   .0004098    -0.02   0.987    -.0008118    .0007979
    openness |   .0532518   .0260689     2.04   0.042     .0020508    .1044527
        inst |  -2.054413   .6790702    -3.03   0.003    -3.388149   -.7206765
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/.).(L3.pgdpgr L3.edsgdpr L3.openness)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -8.65  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.71  Pr > z =  0.087
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(226)  = 251.13  Prob > chi2 =  0.121
  (Not robust, but not weakened by many instruments.)
```

Regression 9(GMM3)

```
. xtabond2 pgdpgr l.pgdpgr l.k l l2 edgdpr  edsgdpr infl openness inst,gmm(l.3(pgdpgr k edgdpr openness))
nolevel small
You need a newer version of Stata to run the fast version of xtabond2.
Type "update executable" at the Stata prompt and follow the instructions the command displays when
finished.
Building GMM instruments.....
8 instrument(s) dropped because of collinearity.
Warning: Number of instruments may be large relative to number of observations.
Suggested rule of thumb: keep number of instruments <= number of groups.
Estimating.
Performing specification tests.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       588
Time variable : year                            Number of groups   =        42
Number of instruments = 304                     Obs per group: min =        14
F(8, 579)     =     11.11                                      avg =     14.00
Prob > F      =     0.000                                      max =        14
------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      pgdpgr |
         L1. |  -.1754904   .0526149    -3.34   0.001    -.2788296   -.0721511
           k |
         L1. |   .3140493    .045023     6.98   0.000     .2256211    .4024776
           l |  -3.865885   5.629201    -0.69   0.493    -14.92203    7.190258
          l2 |    .040118   .0609284     0.66   0.511    -.0795496    .1597857
      edgdpr |  -.0464246   .0100693    -4.61   0.000    -.0662013   -.0266479
     edsgdpr |   .1159778   .1014917     1.14   0.254    -.0833589    .3153144
        infl |   .0002236   .0003886     0.58   0.565    -.0005396    .0009869
    openness |    .049527   .0221991     2.23   0.026     .0059264    .0931275
        inst |  -1.672132   .6134534    -2.73   0.007    -2.876997   -.4672667
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/.).(L3.pgdpgr L3.k L3.edgdpr L3.openness)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -9.62  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.85  Pr > z =  0.064
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(295)  = 294.98  Prob > chi2 =  0.489
  (Not robust, but not weakened by many instruments.)
```

Regression 10 (GMM4)

```
. xtabond2 pgdpgr l.pgdpgr k l l2 edgdpr  infl openness inst,gmm(l3.(pgdpgr k edgdpr  openness))small
Building GMM instruments.....
8 instrument(s) dropped because of collinearity.
Warning: Number of instruments may be large relative to number of observations.
Suggested rule of thumb: keep number of instruments <= number of groups.
Estimating.
Performing specification tests.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       630
Time variable : year                            Number of groups   =        42
Number of instruments = 353                     Obs per group: min =        15
F(7, 622)     =     20.93                                      avg =     15.00
Prob > F      =     0.000                                      max =        15
------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      pgdpgr |
         L1. |   .1679161   .0520481     3.23   0.001     .0657048    .2701274
           k |   .2458135   .0344767     7.13   0.000     .1781088    .3135183
           l |   1.880589   .9446353     1.99   0.047      .025528     3.73565
          l2 |  -.0197497   .0103265    -1.91   0.056    -.0400287    .0005292
      edgdpr |  -.0105308   .0048331    -2.18   0.030     -.020022   -.0010397
        infl |   .0001641   .0004362     0.38   0.707    -.0006925    .0010206
    openness |    .005788   .0100041     0.58   0.563     -.013858    .0254339
        inst |   .3253515   .2707212     1.20   0.230    -.2062867    .8569897
       _cons |  -48.89716   21.58392    -2.27   0.024    -91.28335   -6.510976
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/.).(L3.pgdpgr L3.k L3.edgdpr L3.openness)
Instruments for levels equation
  Standard
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(L3.pgdpgr L3.k L3.edgdpr L3.openness)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -12.86  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   2.08  Pr > z =  0.037
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(344)  = 313.27  Prob > chi2 =  0.882
  (Not robust, but not weakened by many instruments.)
```

Regression10 (GMM 5)

```
. xtabond2 pgdpgr l.pgdpgr k l l2  edsgdpr infl openness inst,gmm(l3.(pgdpgr edsgdpr  openness))small
You need a newer version of Stata to run the fast version of xtabond2.
Type "update executable" at the Stata prompt and follow the instructions the command displays when
finished.
Building GMM instruments....
Warning: Number of instruments may be large relative to number of observations.
Suggested rule of thumb: keep number of instruments <= number of groups.
Estimating.
Performing specification tests.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       630
Time variable : year                            Number of groups   =        42
Number of instruments = 271                     Obs per group: min =        15
F(7, 622)     =     16.46                                      avg =     15.00
Prob > F      =     0.000                                      max =        15
------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      pgdpgr |
         L1. |   .1883987   .0557208     3.38   0.001      .078975    .2978223
           k |    .272771   .0421967     6.46   0.000     .1899056    .3556363
           l |   .8519274   1.084523     0.79   0.432    -1.277843    2.981698
          l2 |  -.0093109      .0117    -0.80   0.426    -.0322873    .0136654
     edsgdpr |   -.077107   .0814488    -0.95   0.344    -.2370551     .082841
        infl |   .0003508    .000458     0.77   0.444    -.0005486    .0012502
    openness |   .0031908   .0122077     0.26   0.794    -.0207824     .027164
        inst |   .2330326   .3226256     0.72   0.470    -.4005348       .8666
       _cons |  -24.77424   25.15683    -0.98   0.325    -74.17685    24.62837
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/.).(L3.pgdpgr L3.edsgdpr L3.openness)
Instruments for levels equation
  Standard
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(L3.pgdpgr L3.edsgdpr L3.openness)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -12.14  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   2.19  Pr > z =  0.028
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(262)  = 273.15  Prob > chi2 =  0.305
  (Not robust, but not weakened by many instruments.)
```

Regression 12(GMM6)

```
. xtabond2 pgdpgr l.pgdpgr k l l2 edgdpr  edsgdpr infl openness inst,gmm(l3.(pgdpgr k edgdpr openness))
small
Building GMM instruments.....
8 instrument(s) dropped because of collinearity.
Warning: Number of instruments may be large relative to number of observations.
Suggested rule of thumb: keep number of instruments <= number of groups.
Estimating.
Performing specification tests.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       630
Time variable : year                            Number of groups   =        42
Number of instruments = 353                     Obs per group: min =        15
F(8, 621)     =     18.57                                      avg =     15.00
Prob > F      =     0.000                                      max =        15
------------------------------------------------------------------------------
      pgdpgr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      pgdpgr |
         L1. |   .1680755   .0529557     3.17   0.002     .0640816    .2720694
           k |    .245951   .0354688     6.93   0.000     .1762976    .3156044
           l |   1.877308   .9655254     1.94   0.052    -.0187822    3.773399
          l2 |  -.0197151   .0105399    -1.87   0.062    -.0404133     .000983
      edgdpr |  -.0105541   .0050322    -2.10   0.036    -.0204362   -.000672
     edsgdpr |   .0015631   .0932729     0.02   0.987    -.1816054    .1847315
        infl |   .0001638    .000437     0.37   0.708    -.0006943    .0010218
    openness |   .0057048   .0111767     0.51   0.610     -.016244    .0276535
        inst |   .3250208   .2716787     1.20   0.232    -.2084995    .8585412
       _cons |  -48.82017    22.0862    -2.21   0.027    -92.19285   -5.447491
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/.).(L3.pgdpgr L3.k L3.edgdpr L3.openness)
Instruments for levels equation
  Standard
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(L3.pgdpgr L3.k L3.edgdpr L3.openness)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -12.85  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   2.08  Pr > z =  0.037
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(343)  = 313.22  Prob > chi2 =  0.874
  (Not robust, but not weakened by many instruments.)
```

Appendix 4: Outliers/ Extreme Values

```
. sum infl if infl<10

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        infl |       416    3.470642    3.878217  -11.68611   9.980025


. sum infl if infl>10

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        infl |       256    208.2621    1545.352   10.00836   23773.13


. extremes infl

  +-------------------+
  | obs:         infl |
  |-------------------|
  | 242.    -11.68611 |
  | 348.    -9.616154 |
  | 243.    -9.542913 |
  | 132.    -8.427934 |
  | 235.    -8.237844 |
  +-------------------+

  +------------------+
  | 162.    2154.437 |
  |   6.    2671.792 |
  | 163.     4129.17 |
  |   7.    4145.107 |
  | 165.    23773.13 |
  +------------------+

. extremes pgdpgr

  +-------------------+
  | obs:       pgdpgr |
  |-------------------|
  | 485.    -46.99654 |
  | 313.    -30.00276 |
  |   4.     -27.0994 |
  | 531.     -19.2321 |
  | 536.    -18.47257 |
  +-------------------+

  +------------------+
  | 143.    29.17903 |
  | 486.     37.4916 |
  | 218.     38.1074 |
  | 220.    58.46995 |
  | 216.    67.10155 |
  +------------------+

.
end of do-file. exit, clear
```