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EXTERNAL DEBT AND ECONOMIC GROWTH IN SUB-SAHARAN AFRICA: A CROSS-COUNTRY PANEL DATA ANALYSIS

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To My Wife Meazi and My Baby Yididya

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Acronyms

SSA	Sub-Saharan Africa
GDP	Gross Domestic Product
HIPC	Highly Indebted Poor Countries
WDI	World Development Indicators
IMF	International Monetary Fund

1. Introduction

1.1 Background

Africa south of the Sahara desert, often called as Sub-Saharan Africa, is a home for 719 million[1] people of diverse languages and culture. For 30 years ago, the average income in sub-Saharan Africa is believed to have been twice that of both south and East Asia (Commission for Africa, 2005). In those decades after independence, things have been going upside down for the region. The region is now the poorest of all regions. It is a hard and bitter fact that about half of its population earn less than a dollar a day.

Many factors are responsible for the stagnation of the region's economy. These, according to the report of the Commission for Africa (2005), may generally be categorized as political, structural, environmental, technological and human. In this regard, bad governance, conflict, weak investment climate, dependence on primary commodities, poor infrastructure, low agricultural productivity, climate change, fragile environment, poor health/education, pressure of population growth and other reasons related to colonial legacies are some of the specific factors. Another major reason is associated with the region's relationship with the rest of the world which can be characterized in terms of low foreign direct investment (in absolute terms), capital flight, low remittances, high debt service, low aid (in absolute terms), falling share of world trade and brain drain from the region.

Regarding the region's relation with the rest of the world, international trade, aid and external debt have attracted a great deal of attention. It has been argued that international trade has been unfair, aid has been ineffective and external debt service has drained the resources of SSA to the detriment of its growth prospects. Among the world's nations known as highly indebted poor countries, most are found in the region. There has been a growing concern about this indebtedness of Sub-Saharan African countries and a call for debt reduction and cancellation. Despite various promises and actions to reduce its debt, the region is still spending more on debt service payment than it spends on health (ibid,

[1] The figure is as of 2004 , World Development Indicators (2005)

2005). Various promises for debt reduction have been broken, many conditionalities imposed and debt reduction has often been used as a lever to dictate policies (ibid, 2005).

These growing concerns, the efforts for 100% debt cancellation and the recent promise by G8 countries to cancel debt to some countries in the region indicate that external debt is still a hot issue. As indicated above, Sub-Saharan Africa's poor growth performance is likely to be explained by a number of factors including the problem of external debt. But why did these countries fall in to the debt problem? What could the relative contribution of external debt to the stagnating growth be? Is external debt totally harmful or there is a level beyond which it becomes detrimental? How does it affect economic growth? Given the limited number of econometric studies done in relation to this problem of debt in the region, these questions need to be investigated.

1.2 Statement of the Problem

Like other developing countries, countries in SSA were hit by the debt crisis of 1980s and 1990s due to various internal and external factors. Their level of indebtedness has escalated through the 1990s and they have accumulated external debt that is larger than that of other regions. According to World Debt Tables and Global Development Finance (different editions) of the World Bank, total external debt stock of SSA increased from a low level of 6921 million in 1970 to 231, 360 million US dollars in 2003. Total debt service paid to creditors increased from 6678 million in 1980 to 15,235 million US dollars in 2004 (see table 3.2). Total external debt as a ratio of GDP was generally high and increasing. Total external debt stock as a percentage of GDP increased from 64.4 percent in 1984 to 74.8% in 1994 and 68.5% in 1999 (see table 3.1). Since these figures are averages figure for all countries, the absolute and relative measures of indebtedness for highly indebted countries in the region are obviously going to be high and the possible effects be more severe. External debt may not be a big problem if growth is high enough to repay debt as well as finance additional investment demand. In the case of SSA, however, this has not been the case. The growth performance of this Continent has been deteriorating. Statistical evidence (see table 3.1) indicates that the average growth

rate of real per capita GDP for the period 1979-88 and the annual growth rate for the period 1990-1993 was negative. Even during those periods with positive per capita GDP growth, SSA did not perform well to bear the burden of its external debt.

This dwindling economic performance of SSA and the accumulation of large external debt led to a growing concern among Africans and the international community. The growing indebtedness of these countries is often mentioned as a major reason for their poor economic performance.

The so called "Debt Overhang" theories state that high external debt is harmful to economic growth. There is also an assertion that low level of debt could contribute positively to economic growth. Though there seems to be an association between external debt and growth, the relative contribution of external debt and, most importantly, the nature of the relationship is an area that needs investigation.

A number of studies have been conducted either for Latin American countries or for developing countries as a whole. However, the nature or degree of indebtedness and other socio economic factors that could possibly affect the relationship between external debt and growth could vary from region to region. The borrowing and other development policies that should be pursued by Sub-Saharan African countries and the credit polices of bilateral and multilateral lenders should be based on the nature of the relationship between external debt and economic growth. These policies could vary from region to region depending on the nature of the relationship under consideration. It is, therefore, necessary to investigate the quantitative relationship between external debt and economic growth with special emphasis on SSA. Accordingly, this paper investigates the nature and magnitude of the impact of external debt on economic growth using a cross country panel data econometric analysis.

1.3 Research Objective and Research Questions

The objective of the research is to undertake an econometric investigation on the impact of external debt on economic growth in SSA, and identify the transmission mechanisms through which external debt affects economic growth.

The research aims at answering the following specific research questions:

i) What is the nature and magnitude of the impact of external debt on economic growth in SSA? Is there a smooth inverted U-shaped (quadratic) or any other non linear relationship?
ii) If the impact of low debt is different from that of high debt, what is the growth maximizing level of external debt?
iii) What are the main channels through which external debt affects growth?
iv) What lessons and policy implications may we draw from this research in relation to the debt problem in SSA?

1.4 Justification of the Study

Many studies have dealt with the problem of debt in developing countries in general and in SSA in particular. However, only a few studies have used econometric techniques to investigate the quantitative relationship between debt and growth in the region.

Studies by Pattillo, Poirson and Ricci (2002 and 2004) include many developing countries in the world. Their two studies indicate the existence of an inverted U-shaped quadratic relationship between external debt and per capita income growth in developing countries. Furthermore, they estimated the growth maximizing level of external debt. They also identified physical capital accumulation, human capital accumulation and total factor productivity as the transmission mechanisms through which debt affects growth. When it comes to SSA, we find one study by Elbadawi, Ndulu and Ndungu (1997) and another study by Milton A. Iyoha (2000).

The paper by Elbadawi, Ndulu and Ndungu (1997) also indicates the existence of a quadratic relationship. It also estimates the investment function but it does not identify transmission mechanisms other than private investment. The study by Milton Iyoha (2000) does not investigate if the impact of external debt on growth is non linear and it does not identify the transmission mechanisms other than private investment. The study does not estimate the growth maximizing level of debt. Furthermore, it controls for only a few factors that affect economic growth and investment and uses only pooled OLS, which is likely to yield biased and inconsistent estimates as a consequence of an omitted variable (Greene, 2003; Hsiao, 2003). In other words, it fails to take in to account country specific and time specific effects as it does not employ appropriate estimation techniques such as the fixed effects and random effects estimation techniques.

In this study, we investigate if the impact of external debt is non linear by compiling a panel data for 44 Sub-Saharan African countries for the period 1970-2002. Unlike the study by Iyoha (2000), this study takes controls for time specific and country specific effects by employing the fixed effects and random effects estimation techniques. While the studies by Elbadawi et al (1997) and Iyoha (2000) used data that spans only up to the mid 1990s, our data set that covers recent years enables us capture the impacts of recent changes in the trends of indebtedness and economic growth due to reasons such as debt reduction and debt cancellation under initiatives such as the HIPC initiative.

By investigating the above issues that the above two studies on SSA did not address and taking advantage of the benefits of the large data set with time series and cross-sectional dimensions, our study investigates the direct impact of external debt and the channels through which its indirect effect on economic growth takes place. In this way, it makes a little contribution to the empirical literature related to debt and economic growth and draws some implications for debt reduction or cancellation and public policies that may be helpful in solving the debt problem of the region.

1.5 Scope and Limitation

This study is limited to the quantitative estimation of the relationship between external debt and debt service with economic growth in SSA. Though we will provide a brief summary of the factors that led to the accumulation of external debt in the region, we will not go in to the details of these factors that led to this debt crisis. Apart from indicating the implication of the results for debt reduction and debt cancellation, we do not undertake policy simulations or predictions to show the impact of debt reduction on some key variables such as GDP and Investment under different debt reduction scenarios. The omission of these aspects can be considered as the main limitation of this study as their inclusion would have given a better (both qualitative and quantitative) picture of the problem and clearer policy implications.

1.6 Organization of the Paper

This paper proceeds as follows: chapter two summarizes the literature on the origins of the debt problem in developing countries in general and in SSA in particular; revises the theoretical explanations regarding the impact of external debt on economic growth; and summarizes the findings of some empirical studies related to the topic. Chapter three presents the description and justification of different variables used in various regressions; indicates the sources of data for these variables; and presents some stylized facts in relation to debt and growth. Chapter four is concerned with the specification of econometric models and the estimation techniques. Chapter five presents and discusses the main findings of this econometric study. Chapter six summarizes and concludes.

2. Review of Theoretical and Empirical Literature

2.1 Origins of the Debt Problem

This section summarizes the major factors that led to the accumulation of external debt and the subsequent debt crisis in developing countries in general and in Sub-Saharan Africa in particular.

2.1.1 General

The debt crisis that developing countries faced is a result of a number of factors that can be related to policies of debtor countries, international macroeconomic shocks and lending behaviour until 1981 (Sachs, 1989, p.5). The rise of oil prices that occurred at the end of 1973 and soaring interest rates in 1981-82 were major macroeconomic shocks (Cuddington, 1989, p.16). On the one hand, the rise in oil prices led to current account surpluses among many oil exporters that became ready and willing to recycle their petrodollar by lending to developing countries at nominal interest rates that were initially below the growth rate of real exports. On the other hand, oil importing developing countries were facing rising oil import bills and current account deficits. As a result, they had to borrow from abroad to finance their deficits (Kruger, 1991, p.246-247). As is shown in Sachs (1989, p. 7), tight monetary policies by developed countries to control inflation in their economies motivated a sharp rise in interest rate while, as is pointed out in Cuddington (1989, p.16), the annual rate of growth of exports of developing countries declined from a high level of 21.1 percent to 1 percent (due to world wide recession of 1980-83). This led to the escalation of debt service payments (as a ratio of exports) followed by the debt crisis.

The lending behaviour of banks also played a role in giving rise to the crisis. Commercial banks, which were making huge profits from lending abroad, put less emphasis on the risks of cross-boarder lending through the end of 1970s. That is, they expanded loans aggressively without paying attention to the credit worthiness of borrowers or the profitability of projects financed by these loans. In the words of Jeffery Sachs, "few banks, apparently, were concerned with the question of whether the debtor countries

would be willing and able to service their debts if debt servicing had to come out of national resources rather than out of new loans" (Sachs, 1989, p. 8). This lending behaviour of these banks continued and even lending became greater through 1980-81. Following the outbreak of the crisis in 1982, however, this lending behaviour was reversed. They cut back their sovereign lending and worsened the liquidity problem of debtor countries (Cuddington, 1989, p.17). Developing countries started to face net outflow of resources in the form of debt service payments to their creditors.

Sachs (1989) also emphasizes that debtor countries themselves had also contributed to the problem. While some countries such as South Korea and Indonesia quickly responded and adjusted (for example, by cutting deficits and devaluing their currency) to the 1980-82 situations, many others including Brazil, Argentina and Mexico pursued inappropriate fiscal and trade policies accompanied by acceleration of borrowing and excessive government spending High income inequality and severe political instability mainly in Latin American countries were increasing public spending and reducing the ability or the willingness of the governments to raise revenue through taxes and causing them to resort to foreign borrowing to be relieved from such political stresses. Furthermore, they were subsidizing private firms that had heavily borrowed form abroad. In relation to trade policies; Latin American countries were pursuing import protectionist policies. This together with overvalued exchange rates was hampering export earnings and increasing the debt service to exports ratio (Ibid, pp. 11-12).

2.1.2 Sub-Saharan Africa

Like other developing countries, almost all countries in SSA were hit by the debt crisis of the 1980s and they have accumulated huge external debt stock. What makes their case different from Latin American and other Highly Indebted Countries is that much of the Sub-Saharan African debt is owed to multilateral and bilateral creditors such as the World, Bank, IMF and African Development Bank while much of the debt of Latin

American countries was from commercial banks (Greene, 1989, p. 39)[2]. As a result, the Latin American debt problem was regarded as a threat to the international financial system and attracted much attention while the debt problem SSA was regarded as development related and the countries were expected to recover from the problem through time (Abbott, 1993).

Many authors associate the debt problem of the region with government actions of Sub-Saharan African countries; oil price and interest rate shocks; and the decline in external assistance in 1980s. The newly independent states aimed at building their national economies by undertaking various development projects mainly on domestic industry and infrastructure backed by donor support and external debt. Through time, they were accumulating large external debt with the assumption that their development effort will bring growth that would enable them to meet their debt obligations.

While oil price shocks of 1973 increased the import bills of sub-Sahara African countries as well, the prices of many primary commodities exported by these countries (mainly coffee, cocoa, tea, sugar, groundnuts, sisal, phosphate and uranium) were dwindling sharply. However, this fall in export earnings was not accompanied by a decline in public expenditure and deficits. Some courtiers like Zambia, Gabon, Nigeria, and the Republic of Congo used external commercial borrowing to finance their spending. Overvalued exchange rates and subsidies to imported food, fertilizer and petroleum products were increasing the import bill. Furthermore, a decline in domestic savings and outflow of capital due to negative real interest rates is believed to have increased the need for external borrowing to finance projects (Greene, 1989, p. 47- 54).

It can also be argued that the rise in new protectionism by the industrialized countries is one of the major external factors that contributed to the decline in export earnings and development prospects in SSA. As is stated in Abbott (1993), "...the proliferation of non-tariff measures have hurt Sub-Saharan African countries in terms of market access, the

[2] Regarding the structure of external debt stock and the composition of creditors, we have presented some stylized facts in section 3.3.

development of new products and the processing of raw materials domestically". According to Abbott's estimates, the rise in international interest rates has increased the external debt of the region by 8 to 10 billion dollars; the denomination of their debt in terms of dollar increased the debt by 1 to 2 billion dollars (due to weakening of the dollar); and debt rescheduling and refinancing added an extra 1 billion dollar to the debt stock (Abbott, 1993, p. 31).

Other factors include a top heavy and poorly trained man power; weak or non-existent organizational or institutional infrastructure; acute shortage of managerial, administrative personnel and skills, inefficient monetary fiscal and exchange rate policies; insufficient domestic saving and low investment; lack of political will to take decisions; and absence of effective debt management strategy (Ibid, p. 32).

2.2 Theoretical Background

In this section, a brief summary of the theoretical explanations regarding the impact of external debt and debt service payment on economic growth will be presented.

Early growth models emphasize the role of foreign borrowing in supplementing domestic savings that is required to meet investment demand and fuel economic growth. Thirlwall (1978) explains the analysis embodied in the so-called "two-gap" models such as the Harrod-Domar model. The analysis is mainly based on the two gaps: the savings-investment gap and the export-import gap. In the Harrod-Domar model, the relationship between growth (g) and savings is given by the ratio of the marginal propensity to save (s) and the incremental capital-output ratio (c), which is the reciprocal of the productivity of capital (p). That is, $g=s/c$ or $g=sp$. Likewise, the relationship between growth and imports of investment goods is given as $g=im'$, where (i) is the imports ratio and (m') is the incremental output-import ratio. Given (c) and (m'), planners can set a growth target and an increase in economic growth (g) requires an increase in (s) and (i). Let (r) be the the target rate of growth. The saving ratio (s^*) required to achieve this target is thus $s^*=r/p$, and the required imports ratio (i^*) is $i^*=r/m'$. Given this relationship, if domestic savings is not adequate to achieve the required rate of growth, then the economy faces the

savings-investment gap equal to s*-s. If the minimum import requirement to meet the target growth rate is greater than what the country can earn from exports, then there will be the export-import, or foreign exchange, gap equal to i*-i. The implication of the presence of these two gaps to external debt is stated, in the words of Thirlwall (1978), as follows:

> In the absence of foreign borrowing, growth will proceed at the highest rate permitted by the most limiting factor. If the biggest gap is the savings-investment gap, growth is limited by the availability of domestic savings... if the biggest gap is the foreign exchange gap, growth is limited by the availability of foreign exchange... traditionally, the role of foreign borrowing was to supplement domestic saving (Thirlwall, 1978, p. 293)

However, such models have been criticized because of their unrealistic assumptions such as a constant capital-output ratio and an infinite supply of foreign credit (Eaton, 1993).

The possible positive impact of external debt on growth is also explained by Cohen (1991). It argues that in reality, countries are neither in financial autarky nor can borrow as much as they want. Due to the risk of debt repudiation, creditors may impose a credit rationing on a borrowing country. When lenders minimize the fear of the risk of debt repudiation by managing to set a lending strategy (set efficient credit ceilings) that is contingent up on the growth rate of the debtor country (which he calls "efficient credit ceilings"), a larger credit ceiling (i.e. larger external debt) increases the investment and growth rate of the economy (Cohen, 1991, pp. 137-148). Assuming that borrowed funds are associated with productive investment, this suggests that low debt levels are positively associated with growth.

A number of theories have been developed to explain why large external debt is likely to reduce growth. For instance, Alesina and Trabellini (1989) developed a simple dynamic model in which there are two social groups behaving non-cooperatively. This non-cooperation creates uncertainty as to which group will be in control in the future and results in a political turbulence and risk that leads to capital flight and excessive

government borrowing, which in turn slows down growth in developing countries. We also find the "Debt Overhang" theories. Krugman (1988) defines "Debt Overhang" as "a situation where a country's debt exceeds the expected present value of potential future resource transfers". As cited in Agenor (2000), it is argued by Helpman (1989), Krugman (1988), and Sachs (1989) that a country has to repay its debt out of a fraction of the increased output that resulted from increased capital formation (investment). Depending on the extent that investors internalize the effect of debt burden through increased taxes associated with debt servicing, they may expect a low after-tax return on investment. In this way, high external debt that passes a certain level may act as a marginal tax on investment, become a disincentive and reduce the level of private investment and reduce growth (Ibid, 2000).

Agenor (2000, pp. 597-599) uses a kind of debt "Laffer curve" to illustrate the debt overhang situation. The shape of the curve implies that initially an increase in the face value of external debt proportionately increases debt repayment[3]; if the amount of contractual debt (face value of debt) increases further, the probability of default increases; and after a certain threshold, repayment starts to decline, putting the country in a state of "debt overhang." Once the country is in a debt overhang situation, all the effects of a large external debt (beyond the threshold level) will follow.

The scope of the debt overhang effect is further broadened to include effects other than on physical investment. As it is argued in Krugman (1988), debtor countries may take different actions such as exchange rate adjustment, investment, and budget policies, which, in the words of Krugman, can be generally termed as "adjustment efforts". Policy makers in the debtor country may not have the incentive to make such desirable policy changes because of what Krugman described as follows:

> ...Creditors will want a country to make as much adjustment effort as possible, certainly more than the country would want to undertake. Now suppose that the debt burden on a country is as large as the maximum

[3] The implication of proportionate increase in repayment is that at the beginning, an increase in external debt increases the capital stock of the country as a result debt repayment will also increase.

> the country could possibly pay. Then there is in fact no reason for the country to make the adjustment effort, since the reward goes only to is creditors" (Krugman, 1988).

Another way a debt overhang adversely affects investment and growth is by increasing uncertainty. As it is explained by Agenor and Montiel (1996), a large public sector's external debt leads to uncertainty on the side of the private sector as to how this large debt stock will be serviced. If domestic agents expect that this large external debt will be financed through distortionary taxation or reduced levels of productive public expenditure, they will also expect a lower rate of return on domestic private asset accumulation. In the presence of such uncertainty, the private sector is likely to postpone investment and wait until the uncertainty vanishes. This effect may "account for the behaviour of private investment and capital flight in the highly indebted countries during the early 1980s" (Ibid, 1996, p. 462).

A revision by Serven (1997) of the recent literature on investment under uncertainty also indicates that under such uncertainty, investors would refrain from making a high-risk, long-term and irreversible investment and wait to avoid costly mistakes even under moderate uncertainty. Thus, such uncertainty created by debt overhang might also affect the efficiency and productivity of investment by shifting investment to quick-return trading activities that are likely to have less impact on long-term growth.

Debt service payment can have an adverse impact on growth through the fiscal account, which is called the "crowding out" effect. Much of government revenue will be devoted to servicing the debt and this will in turn reduce total investment and private investment to the extent that public investment is complementary to private investment (Diaz-Alejandro 1981; Taylor 1983) and reduce productivity of investment by reducing investment in infrastructure. It also reduces investment in human capital (human capital formation) which, according to endogenous growth theories, is important for growth (as cited by Serieux & Samy, 2001).

Debt service payment can also have an effect on growth through the external account which is known as "the import compression" effect. As is cited by Serieux and Samy (2001), explanation provided by Ndulu (1991) and Moran (1990) shows that countries that have to make their debt service payment in hard currencies must use the foreign exchange earned from exports. To meet this demand by increasing export earnings, either they have to undertake devaluation or impose import restrictions, which in both cases reduces the import of production inputs and capital goods that would have contributed to investment and growth.

2.3 Empirical Studies

In this sub section, we will present a summary of related empirical studies, some of which are specific to SSA. A study by Pattillo, Catherine, Hélène Poirson and Luca Ricci (2002), assessed the impact of external debt on growth using a large panel data of 93 developing countries over 1969-98. Using different methodologies, model specifications and different debt indicators, they found out that doubling debt in a country with average indebtedness would reduce annual per capita growth between half and one percentage point. They also suggested that the level of debt beyond which per capita growth becomes negative corresponds to 160-170 percent of exports or 35-40 percent of GDP. The level of debt beyond which the marginal impact of additional debt becomes negative (the turning point of the debt Laffer curve) is about half of these values. They also indicated that debt reduction for HIPC countries might increase per capita growth by one percentage point. In another study (Pattillo et al, 2004), the above authors indicated that the negative impact of external debt on growth operates through its significant negative effect on the accumulation of physical capital and growth of total factor productivity. Its impact on human capital accumulation was found to be insignificant (Pattillo, et al 2004).

A similar study by Clements, Bhattacharya, and Nguyen (2003) examined the impact of external debt on growth and on the transmission mechanisms of debt in 55 low-income countries covering the period 1970-99. This study suggests the existence of a non-linear relationship. That is, a debt stock exceeding 30-37 percent of GDP and 115-120 percent of exports turns out to have a negative impact on growth. However, this study did not

find statistical evidence that supports the existence of a significant negative impact of debt service on per capita GDP growth. The growth depressing effect of debt was found to work through its effect on the efficiency of resource use rather than through its negative effect on the level of private investment. Furthermore, higher debt service (but not the debt overhang effect of debt stock) was found to have a non linear significant "crowding out" effect on public investment and thus growth. Finally, the authors projected that debt reduction for HIPC countries that would reach completion point by the year 2005 would add 0.8 to 1.1 percent to their per capita GDP growth rates.

We get similar arguments in another study specific to 53 low income and lower middle-income countries by Serieux and Samy (2001). Results of this study suggest that the "crowding out" effect works on the quality rather than the level of investment. However, the "import compression effect" has its effect on the rate of investment and on output. The authors indicated that budgetary and human capital effects were not robust due to limited span of time series data on government revenue and education (1981-96) while the overall data for other variables spans from 1970 to 1999.

Another econometric study by Schclarek (2004) for a number of developing countries and industrial countries indicates that lower total external debt is associated with higher growth rates. This statistically significant relationship was due to public debt rather than private debt. Capital accumulation growth was found to be a significant channel (transmission mechanism) through which external debt affects growth while total factor productivity growth did not have a significant relationship with external debt. It is stated in the paper that the author did not find enough statistical evidence for an inverted U-shape relationship between external debt and growth. This author together with Ramon-Balleste also reach at a similar conclusion in another study made for a panel of 20 Latin American and Caribbean countries with data averaged over each of the seven 5-year periods between 1970 and 2002 (Schclarek and Ramon-Balleste, 2004).

Using panel data for two separate groups of HIPC and non-HIPC countries, a sensitivity and casualty analysis on the relationship between external debt and growth by Abdur R.

Chowdhury (2001) found a statistically significant impact of different debt indicators in both HIPC and non-HIPC groups. Regarding the robustness of the results, the paper states that "the relationship between a debt measure and economic growth is robust to changes in the conditioning set of information included in the regression equations". This study doesn't test if the relationship is non-linear. A cross-country regression analysis by Henric Hansen (2001) also found a significantly negative impact of external debt stock and debt service on economic growth.

Finally, we summarize the findings of the two panel data cross-country studies that are specific to SSA. A cross section regression analysis by Elbadawi et al (1997) finds evidence indicating the existence of a quadratic relationship implied by the debt Laffer curve. The direct effect of debt was through current debt (which was found to stimulate growth); accumulated debt or debt overhang (which was found to have a negative impact also on private investment rates); and debt service payment obligation (serving as a liquidity constraint) that reduced available credit thereby creating a disincentive for investment which adversely affects growth. The indirect negative impact of debt was through its effect on public sector expenditures. This paper indicated that the growth maximizing level of external debt (as a percentage of GDP) is 97 percent.

Similarly, a study by Milton Iyoha (2000) that covers the period 1974-94 found a significant "Debt Overhang" and "crowding out" effects on growth. Policy simulations done in this study indicated that a 75 percent reduction in the debt stock, assumed effective in 1986, would have raised domestic investment by 60 percent and GDP growth by 6 percentage points during 1987-94 periods. The simulation results indicate the importance of debt reduction, preferably through debt forgiveness. However, this paper doesn't test the existence of a non-linear relationship. As a result, the growth maximizing level foreign indebtedness is not indicated.

3. Data, Definition of Variables, Data Sources and Stylized Facts

3.1 The Need for Averaging the Data

To meet the objectives of this study, we initially compiled a large annual dataset on 23 variables for 44 Sub-Saharan African Countries over a 33 years period that ranges from 1970 to 2002[4].

An economy normally passes through the ups and downs of the business cycle and its key macroeconomic variables such as output, income, employment and inflation could fluctuate from year to year. Despite these short-run or cyclical fluctuations, an economy is said to be growing if it is moving along an upward slopping growth path. Use of an annual data for the investigation of the long-run effect of macroeconomic variables such as external debt on economic growth does not help much as it will be subject to such cyclical effects associated with the business cycle and will be prone to autocorrelation problem. To net out the cyclical effects and correct for the autocorrelation problem that we traced while trying to use the annual data, we have transformed our 33-years annual dataset in to a non overlapping three-years dataset (1970-1972, 1973-1975, ..., 2000-2002).

3.2 Definition of variables and data sources

We have identified the variables that we use in the regressions undertaken in this study from various growth and debt theories and other empirical studies. In the following sub-section, we will state the dependent and explanatory variables and indicate the sources of the data for these variables.

[4] The 44 Sub-Saharan African countries included in this study are: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Dem. Republic, Rep. of Congo, Cote d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

1. Real per capita GDP growth (*rgdppcgr*):- to capture economic growth which is net of inflation and takes account of population growth. Data is obtained mainly from WDI (2004) supplemented by World Bank Africa Database (2004) and Easterly's macro time series (World Bank).
2. Initial real per capita GDP in log (*linitial*):- to control for differences in initial conditions and also to check if the convergence hypothesis holds (see Agenor, 2000, p. 446). Data is obtained from WDI (2004) supplemented by World Bank Africa Database (2004).
3. Gross Domestic Investment as a percentage of GDP in log (*linv*):- to control for the impact of physical capital- based on the neoclassical Solow-Swan Growth Model (see Barro and Sala-i-Martin, 1995, p. 17). The data is mainly obtained from WDI (2004) supplemented by World Bank Africa Database 2004, Easterly's macro time series (World Bank), Penn World Tables and World Debt Tables.
4. Population Growth in log (*lpopgr*):- to control for the impact of population growth in SSA. The data is obtained from WDI (2004).
5. Adult Literacy in log (*ladlit*):- to control for the quality of human capital. The data is mainly obtained from WDI (2004) supplemented by World Bank Africa Database (2004).
6. Average Years of Schooling (*scholtot*):- as an indicator of the human capital stock in the economy- based on endogenous growth theories (influential contributors are Lucas 1988, Grossman and Helpman, 1991, Romer 1986) which emphasized accumulation of knowledge, human capital and public policy towards education as an endogenous factor affecting growth (Agenor, 2000, p. 446). Data is obtained from the website of Barro and Lee.
7. Total Debt Service as a percentage of Exports of Goods and Services (*tdsxgs*):- to control for the "crowding out" effects of external debt due to shift of resources towards high debt service payments. Data is compiled from Global Development Finance 2004; World Debt Tables (different editions); Africa Development Indicators (different editions); and World Bank Africa database (2004).
8. Total external Debt as a percentage of GDP in log (*ltedgdp*):- to control for the effect of debt stock. We calculated it by taking debt data from Global

Development Finance (2004) and GDP data from WDI (2004). The figures are the same as the debt as % GDP that we find in Macro time series by William Easterly. Thus we have supplemented the missing values by taking data from Easterly's Macro Time Series (World Bank). The rest is taken from World Bank Africa database (2004).

9. Openness to Trade (*ltrade*):- Exports plus Imports as a percentage of GDP[5]- to capture the degree of openness of an economy- based on conventional trade theories. Example, Sachs and Warner (1995) argued that economies that are more open to trade enjoy higher long-term rates of growth of per capita real income. The data is mainly obtained from WDI (2004) supplemented by Easterly's Macro Time Series (World Bank).
10. Inflation Rate in log (*linflcpi*):- – as an indicator macroeconomic stability based on endogenous growth models- e.g. De Gregorio (1993) suggests that inflation reduces the rate of investment and the efficiency of investment (Agenor 2000). Data is mainly obtained from WDI (2004) supplemented by World Bank Africa Database (2004).
11. Government Budget Balance (*budbal*):- to capture the impact of fiscal policy - based on recent models of endogenous growth which suggested that (not excessive) government spending could directly increase the economy's capital stock through public investment in infrastructure (which could be complementary to private investment) and indirectly by raising the productivity of and accumulation of human capital through spending in education, health and other services. Excessive fiscal deficit may affect growth by lowering aggregate saving, increasing inflation and increasing domestic debt when financed by issuance of liabilities. This may crowd out private investment through reducing availability of credit or increasing interest rate (Agenor 2000). Data is taken from IMF Government Finance Statistics, World Bank Africa Database (2004) and WDI (2004).

[5] We relize that the sum of exports and imports is not a perfect measure of openness. However, we resort to use it as it was difficult to get data on alternative measures of openness.

12. Black Market Premium on Foreign Exchange (*bmprem*)- as a proxy for government distortions of markets (Barro and Sala-i-Martin, 1999, p.434). Data is taken from Africa Dev Indicators, William Easterly's macro time series and World Bank Africa Database (2004).
13. The ratio of M2 to GDP in log (*lm2gdp*):- as a proxy for financial policy[6]. Data is obtained from Easterly Macro time series; IMF Economic Outlook for SSA (2005), WDI (2004), World Bank Africa Database (2004) and part of the data is calculated as money plus quasi money divided by nominal GDP, both from International Financial Statistics of the IMF.
14. Terms of Trade Growth (*totgr*):- as exogenous shock to the economy (Barro and Sala-i-Martin, 1999, p. 435). Data is obtained from WDI (2004).
15. Exports to GDP Ratio in log (*lexpogdp*):- to control for the impact of export earnings on the level of private investment. Data is from WDI (2004) and World Bank Africa Database (2004).
16. Credit to Private Sector in log (*lcreditpriv*):- to control for the impact of credit to the private sector on the level of investment. Data is from WDI (2004).
17. Public Investment in log (*lpubinv*):- to control for the impact of public investment on private investment. Data is compiled from Africa Development Indicators, Easterly's Macro Time Series, Africa Research Program at Harvard, and World Bank Africa Database (2004).
18. Land area in square kilometers in log (*larea*) – as a proxy for resource endowment. Data is from WDI (2004).
19. A dummy variable for oil producers (*oil*):- to control for differences in endowment of oil resources among countries. It assumes a value 1 if the country is oil exporter. We identified oil exporters based on IMF's Economic Outlook for SSA 2005 classification.
20. A dummy variable for land locked countries (*landlock*):- to control for the impact of being landlocked country. It assumes a value 1 if the country is landlocked based on Easterly's Social Indicators and Fixed Factors (World Bank).

[6] Abdur R. Chowdhury (2001) used M2/GDP ratio.

21. Democracy index (*democ*):- to control for the quality of institutions. Source: Polity 4 database: It defines a mature and internally coherent democracy as one in which (a) political participation is fully competitive, (b) executive recruitment is elective, and (c) constraints on the chief executive are substantial.
22. Control of Corruption (*corrupt*):- it is an index of the perception on the control of corruption by a country. Data is obtained from World Bank Governance Indicators (1996-2004).
23. Total Factor Productivity of Physical and Human Capital (*ltfpkh*):- a proxy for the productivity or efficiency of physical and human capital. Data is kindly provided by Susan M. Collins. This data is prepared by Barry Bosworth and Susan M. Collins and used in their paper "The Empirics of Growth: An Update" (2003)[7].

3.3 Some Stylized Facts

For various reasons that we discussed in section 2.1, developing countries in general and Sub-Saharan African countries have been accumulating large external debt. In this section we will show the magnitude of the debt problem, the composition of debt stock and the growth trends in the region with the help of some stylized facts.

According to the World Bank's Global Development Finance database (2004), the total external debt stock of sub-Saharan Africa jumped from 6,921 million in 1970 to 231,360 million US dollars in 2003. Generally, there has been an increasing trend. The ratio of total external debt to GDP is high though there is a declining trend since the year 2000 (see figure 3.1). It decreased from 64.4% in 1984 to 74.8% in 1994 (see table 3.1). Debt service paid by the region has been very high. In absolute terms, it increased from 6678 million in 1980 to 15, 235 million US dollars in 2004 (see table 3.2). Debt service

[7] While constructing the data, they assumed a constant returns to scale production function of the form $Y=AK^{\alpha}(LH)^{1-\alpha}$, where for α is the share of capital (assumed to be equal to 0.35); H is a measure of educational attainment, used to adjust the workforce for quality change. They derived the capital stock through the perpetual inventory system by taking data for initial capital stock from Nehru and Dahreshwar (1993) database. They also allowed for differences in educational attainment by relating human capital, H, to average years of schooling, s, assuming a seven percent return to each year such that $H=(1.07)^{s}$.

payments to exports ratio (TDS/XGS) was 7.4% in 1980, 15.3% in 1998, and 9.8% in 2003.

On the other hand, the growth rate of GDP and per capita GDP has been deteriorating. The statistical appendices of IMF's World Economic Outlook for 1997 and 2004 (see table 3.2) shows that average per capita GDP growth during 1979-88 and annual growth rates during the period1979-1993 was negative. Though there is an improvement in growth performance since 2001, per capita GDP growth during the remaining periods was not satisfactory.

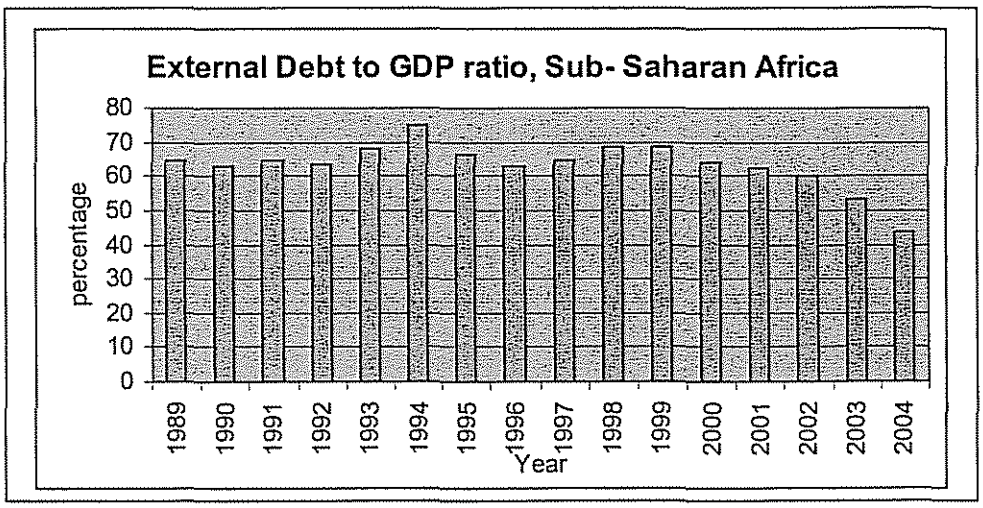
Table 3.1: Debt Indicators and Per capita GDP growth in SSA

Year	EDT/GDP	Debt Service to Exports ratio	Real Per capita GDP growth
1979-88	.....	.....	–0.6
1989	64.4	11.3	0.7
1990	63.2	10	–0.4
1991	64.6	10.6	–1.1
1992	63.5	9.2	–1.7
1993	68.3	8	–1.7
1994	74.8	9.3	0.3
1995	66.4	8.5	0.4
1996	63.2	8.6	2.6
1997	64.9	8.3	0.8
1998	68.4	7.6	0.6
1999	68.5	7	0.5
2000	64	5.6	0.9
2001	62.4	6.6	1.7
2002	60.2	4.4	1.3
2003	53.3	4.1	2.4
2004	43.8	2.7	2.9

Source: prepared by author; data is from IMF World Economic Outlook (1997 and 2004), statistical Appendix

Majority of the world's highly indebted countries and most of the countries included under the IMF-World Bank HIPC package for debt reduction to a sustainable level are found in sub Saharan Africa. Fourteen out of the eighteen countries that are made eligible for debt cancellation after the G8 summit in 2005 are found in Sub-Saharan Africa. This indicates that the debt problem is high in Sub-Saharan Africa. The total external debt to GDP ratio for Sub-Saharan Africa is greater than that of Latin America, Asia and Middle East and Europe during the periods 1989 up to 2004 (Statistical Appendices for IMF World Economic Outlook, 1997 and 2004).

Fig 3.1: Trends in Debt/GDP of SSA



Source of data: World Bank's Global Development Finance 2004

Another dimension of SSA debt is related to its structure and the composition of the creditors. The composition of external debt stock makes the region's debt different from that of Latin American and other Highly Indebted countries. Much of the external debt stock is public and publicly-guaranteed rather than private non-guaranteed debt. A significant portion of the public and publicly-guaranteed external debt is owed to bilateral and multilateral institutions such as the IMF, the World Bank and the African Development Bank while much of the debt of Latin American countries was from commercial banks (Greene, 1989, p. 39).

The stylized facts on table 3.2 (below) indicate that total external debt stock (which, according to World Bank's Classification) is dominated by long-term debt as compared to use of IMF credit and short-term debt. For instance, in the year 2004, the share (from total external debt stock) of long-term debt, use of IMF credit and short-term debt is 84%, 3% and 13%, respectively. In terms of the magnitude, long-term debt has increased from a low level of 6,059 million USD to its highest level of 193,052 million USD in 2003.

Public and Publicly Guaranteed debt takes the largest share of long-term debt while the share of private non-guaranteed is very insignificant. For instance, in 2004, the former accounts for about 90.1% of long-term debt whereas the share of the latter is limited to 9.9%. These evidences also reveal that official creditors, namely Multilateral and Bilateral, take a lion's share from public and publicly guaranteed debt (87.88%). Contrary to this and contrary to the Latin American case, the share of private creditors which include commercial banks was limited to 12.12% of the total public and publicly guaranteed debt.

Table 3.2 : Magnitude of SSA debt and its Composition (US$ million)

Category	1970	1980	1990	1995	1997	1999	2001	2002	2003	2004
Total External Debt Stock	***6921***	***60660***	***176878***	***226483***	***220677***	***214960***	***203187***	***211432***	***231360***	***218405***
Long-term Debt	**6059**	**46483**	**149684**	**175717**	**172441**	**166858**	**165149**	**175440**	**193052**	**182632**
Publiic and Publicly Guaranteed	5751	41916	144408	168600	163619	156466	152736	162955	177429	164588
Official Creditors	4183	25729	108704	133230	130711	128068	128576	138130	152327	144640
Multilateral	869	7597	38149	55104	53538	56012	54386	60927	68854	70544
Bilateral	3314	18132	70555	78126	77173	72056	74190	77204	83473	74096
Private creditors	1567	16387	35703	35370	32908	28398	24160	24824	25102	19948
Bonds	352	637	301	4055	8357	8566	9248	10693	10974	8728
Commercial Banks	128	7371	14012	13814	11604	8837	7278	7071	7795	5405
Other Private	1086	8379	21391	17501	12947	10995	7634	7060	6334	5814
Private Non-Guaranteed	309	4567	5276	7117	8823	10391	12413	12485	15623	18044
Use of IMF Credit	**106**	**3033**	**6612**	**8673**	**7388**	**7124**	**6323**	**7009**	**7244**	**6932**
Short-Term Debt	**..**	**11144**	**20582**	**42093**	**40847**	**40979**	**31715**	**28984**	**31064**	**28841**
Debt Service Paid	**..**	***6678***	***10888***	***13629***	***15864***	***13625***	***12943***	***12971***	***12211***	***15235***

Source: Prepared by author by taking data from World Debt Tables and Global Development Finance 2004 and 2005.

From these facts, we can draw two implications for this study. First, though this study uses total external debt stock (including private non-guaranteed debt) as a measure of indebtedness, the results that we find regarding the impact of external debt on growth will be highly influenced by public and publicly guaranteed debt. The policy implications that we may draw at the end of this study would, thus, mainly reflect how the government should handle the debt problem associated with long-term debt. Second, since the greatest share of long-term debt is owed to official (bilateral and multilateral) creditors rather than private creditors, the alleviation of the debt problem of the region will very much depend up on the measures these creditors take.

4. Methodology

This section deals with the specification of different models and the techniques of estimating these models that help us investigate the impact of external debt on economic growth and on potential transmission mechanisms through which external debt affects economic growth.

4.1 Model Specification

4.1.1 Models for Growth Regressions

Meeting the objectives of this study requires specifying different econometric models. The debt theories that we discussed in section 2.2 and empirical studies (some of which are presented in section 3.3) indicate that the impact of debt is different at low levels and high levels of debt, indicating that the relationship may not be linear. To test these theoretical explanations and arguments against the data we have compiled, we will start our investigation with the linear model, which is specified as follows.

$$\mathbf{Y}_{it} = \alpha_{it} + \beta \mathbf{X}_{it} + \theta \mathbf{D}_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad \ldots\ldots (1)$$

Where: Y_{it} is per capita GDP growth; X_{it} is a vector of control variables (including debt service payments - a flow variable which captures the short-term impacts of indebtedness) taken from theories and empirical growth regressions[8]; D_{it} is external debt stock to GDP ratio (which captures the long-term impact of debt stock on growth); λ_t is an unobserved time specific effect; μ_i is an unobserved country specific time-invariant effect; and ε_{it} is an error term that varies through time and across countries. The subscripts (i) and (t) denote the country and time dimensions, respectively.

We are interested in the relative magnitude of debt rather than on its absolute amount. It makes sense (and is also a common practice) to express debt stock relative to (as a percentage of) GDP and debt service payments relative to exports of goods and services.

[8] The explanatory variables contained in X_{it} are generally explained in section 3.2. However, the specific sets of variables to be included in each regression are stated in the sections where we present the results of our findings.

Though the theories do not explicitly indicate that the kind of non-linear impact of external debt stock on economic growth is a an inverted U-shaped quadratic type, we have seen (in section 2.3) that the empirical studies by Elbadawi et al (1997) and Pattillo et al (2002, 2004) claim that there is such a quadratic impact. To test if this holds, we add the square of our debt indicator (D^2_{it}) to equation (1) and specify our growth regression as follows:

$$\mathbf{Y_{it}} = \alpha_{it} + \beta \mathbf{X_{it}} + \theta \mathbf{D_{it}} + \delta \mathbf{D^2_{it}} + \mu_i + \varepsilon_{it} \quad \ldots\ldots (2)$$

The relationship is said to be quadratic (inverted U-shaped) if the coefficient on D_{it} is positive and that on D^2_{it} is negative. On top of that, both coefficients must be statistically significant.

Empirical studies indicate that the impact of external debt stock could be neither linear nor quadratic. In such a case, another possibility to investigate the nature of the relationship is to divide the debt stock data in to quintiles or deciles, allow it have different slopes across these debt stock quintiles or deciles and explore if the impact of debt stock varies across these quintiles or deciles. This will be done by specifying a model with debt dummies as follows:

$$Y_{it} = \alpha_{it} + \beta X_{it} + \lambda_2 d_2 + \lambda_3 d_3 + \lambda_4 d_4 + \lambda_5 d_5 + \lambda_t + \mu_i + \varepsilon_{it} \quad \ldots\ldots (3)$$

Where: d2-d5 are dummies representing the 2nd to 5th quintiles of debt stock. Due to possible limitation of the data, we prefer to use the quintiles rather than the deciles. Their coefficients indicate the effect of that quintile with respect to zero or low debt (implying the first quintile whose dummy, d_1, is omitted). The sign and magnitude of the coefficient of the dummies may give an indication of whether or not there is a different impact of external debt stock across the debt quintiles.

This model with dummies for the debt quintiles may also help us identify the range of debt stock beyond which the marginal impact of external debt becomes negative. One weakness of this model is that it doesn't allow all explanatory variables (other than debt stock) to have different slopes (different impacts) for low debt and high debt. In reality,

these explanatory variables (or determinants of growth) including debt service payment could have different impact for low and high level of debt over time or across countries.

Due to this reason and the presence of a theoretical support and empirical evidence[9] for the different impact of low debt and high debt, we will finally investigate the impact of external debt on growth by estimating the linear model (equation 1) for two separate data sets representing low level of debt stock and high debt stock. As we don't have any theoretical base to categorize a level of debt as high and low, the division of the total debt stock data in to low debt and high debt will be based on the results of the regression with debt dummies.

4.1.2 Models for the Transmission Mechanisms

To investigate the indirect impact of external debt on growth, we will do regressions of potential transmission mechanisms on debt stock, debt service and other control variables. We will investigate the nature of the relationship using the linear model, the quadratic model and the model with debt dummies. These models, which are similar to those we specified for the growth regressions, are specified as follows:

$$\mathbf{T}_{it} = \alpha_{it} + \beta \mathbf{X}_{it} + \theta \mathbf{D}_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad \ldots\ldots (4)$$

$$\mathbf{T}_{it} = \alpha_{it} + \beta \mathbf{X}_{it} + \theta \mathbf{D}_{it} + \delta \mathbf{D}^2_{it} + \mu_i + \varepsilon_{it} \quad \ldots\ldots (5)$$

$$\mathbf{T}_{it} = \alpha_{it} + \beta \mathbf{X}_{it} + \lambda_2 d_2 + \lambda_3 d_3 + \lambda_4 d_4 + \lambda_5 d_5 + \lambda_t + \mu_i + \varepsilon_{it} \quad \ldots\ldots (6)$$

The dependent variable (T_{it}) is a transmission mechanism. Based on the theoretical explanations that we summarized in section 2.2 and empirical studies related to this topic, we have identified the level of private investment (as a percentage of GDP), human capital and total factor productivity as potential channels through which external debt affects economic growth. While every thing else is the same as what was explained

[9] In section 3.3, we saw that studies by Clements, Bhattacharya and Nguyen (2003) and by Schclarek (2004) have found a non-linear relationship (a positive impact of low debt stock and a negative impact of high debt stock) though the relationship is not a quadratic one.

during the specification of the models for growth regressions, X_{it} in this case is a vector of control variables which affect a transmission mechanism. The control variables that are included in X_{it} will be different depending on the type of the transmission mechanisms. The types of variables that will be included in this vector are explained in the section that discusses the estimation results.

4.2 Estimation Methodology

One way of estimating equations (1) up to (6) is the use of pooled OLS (Ordinary Least Squares) estimation technique. This will be under the restrictive assumptions that the intercept values for each country and the slope coefficients of the explanatory variables are all identical for each country, which might not be the case when it comes to panel data (Gujarati, 2003). In the presence of a correlation between unobserved country-specific effects (μ_i) with one or more of the explanatory variables, estimation of equation (1) by Ordinary Least Squares (OLS) using pooled country-year observation yields biased and inconsistent estimates as a consequence of an omitted variable (Greene, 2003; Cheng Hsiao, 2003). OLS results could also be biased when there is measurement error in any of the explanatory variables. Furthermore, there may be a reverse causation between the dependent variable and the explanatory variables. Thus we need estimation methods other than OLS[10].

One possibility of estimation in the presence of unobserved time-invariant country-specific effects (μ_i) is by taking the first differences of individual observations over time. Let us take equation (1) as an example and first difference it as follows:

$$\mathbf{Y_{it} - Yi_{(t-1)}} = \beta(\mathbf{X_{it} - Xi_{(t-1)}}) + \theta\ (\mathbf{D_{it} - Di_{(t-1)}}) + \mu_i + \varepsilon_{it} - \varepsilon_{i(t-1)} \quad \text{.....(7)}$$

[10] One way of addressing the problem of endogeneity bias is to use instrumental variable (IV) estimation that can be done using the two-stage least squares (2SLS) technique. Pattillo et al (2002) have used this technique by using as instruments the lagged values of the endogenous regressors and the contemporaneous values of the other regressors. Even in IV estimation, the presence of country effects is not accounted for and results may be affected by an omitted variables bias. Due to these reasons, we will not make use of these two estimation techniques.

If there is omission of variables that might be correlated with X_{it} and D_{it} from the model, the first difference of X_{it} and D_{it} will also be correlated with the first difference of ε_{ct}. Thus the OLS estimator of β_1 and β_2 obtained by running the first differenced model will be biased and inconsistent in the presence of an omitted variable problem, which is likely to happen as it might be difficult or impossible to exhaust all the explanatory variables (Deininger and Olinto, 2004). Furthermore, since the first difference of time invariant explanatory variables (such as the dummy variables for oil producers, landlocked countries and land area) is zero, this model would not enable us to estimate the coefficients of such variables. It also confines us to limited time-series variation and loss of degrees of freedom. Finally, first differencing would not be helpful in cases where some countries have data only for one year (if the data is annual) or one period (if the data is an average of years divided in periods).

An alternative method called the fixed effects (or within) transformation is explained in Wooldridge (2002). This method works under certain assumptions[11]. To do the transformation, first we need to average equation (1), for instance, as follows:

$$\bar{Y}_{it} = \beta \bar{X}_{it} + \theta \bar{D}_{it} + \mu_i + \bar{\varepsilon}_{it} \quad \text{.....(8)}$$

Subtracting equation (8) from (1), we get the fixed effects model (with time-demeaned data) from which μ_i has disappeared:

$$\mathbf{Y}_{it} - \bar{Y}_{it} = \beta(\mathbf{X}_{it} - \bar{X}_{it}) + \theta\ (\mathbf{D}_{it} - \bar{D}_{it}) + \varepsilon_{it} - \bar{\varepsilon}_{it} \quad \text{..... (9)}$$

The fixed effects estimation assumes that the idiosyncratic error term ε_{it} should be uncorrelated with each explanatory variable across all time periods while it allows for an

[11] As stated in Wooldridge (2002, pp. 481-4850), the fixed effects estimation is based on the following assumptions: We have a random sample in the cross-sectional dimension; E(ε_{ct} /Yit,Xit, μ_c)=0; Each explanatory variable changes overtime (for at least some C) and there is perfect linear relationship among the explanatory variables; Var(ε_{ct}/Yit, Xit, μ_c)= Var(ε_{ct})= σ_ε^2 ; the idiosyncratic errors are correlated; the error terms are identically distributed as normal. These assumptions are the same for the random effects estimation except that the error terms are uncorrelated.

arbitrary correlation between μ_i and one or more of the explanatory variables. The error terms are also assumed not to be serially correlated over time (Wooldridge, 2002). Equation (9) in this case is based on the assumption that the (slope) coefficients of the regressors do not vary across countries while the intercept varies across countries.

If we assume that μ_i is uncorrelated with each explanatory variables in all time period, then equation (9) becomes the Random effects model. If we re-specify equation (9) such that a composite error term $V_{it} = \mu_i + \varepsilon_{it}$ becomes the error term, we have serially correlated[12] V_{it} across time, requiring the use of GLS (instead of OLS) to solve the correlation problem. The transformed (GLS) random effects equation is of the type provided below (see Ibid, 2002, p. 470). Defining λ as: $\lambda = 1 - [\sigma_\mu^2 / \sigma_\mu^2 + T\sigma_\varepsilon^2]$, we obtain the transformed random effect equation, which allows for explanatory variables that are constant over time, with quasi-demeaned data on each variable.

$$\mathbf{Y}_{it} - \lambda \bar{Y}_{it} = \alpha_{it}(1-\lambda) + \beta(\mathbf{X}_{it} - \lambda \bar{X}_{it}) + \theta(\mathbf{D}_{it} - \lambda \bar{D}_{it}) + \varepsilon_{it} - \lambda \bar{\varepsilon}_{it} \quad \text{.....(8)}$$

According to Wooldridge (2002), λ is never known but can be estimated so that it will be replaced in the formula by $\hat{\lambda}$. The GLS estimator that uses the latter is called the Random Effects Estimator. If $\hat{\lambda}$ is close to zero, random effects estimates become close to the pooled OLS estimates. On the other hand, if it is close to one, its estimates are close to the Fixed Effects Estimates (Ibid, 2002). If the assumption that the error term is not correlated with the explanatory variables holds, then the random effects model is consistent and efficient. The fixed effects estimates are also consistent as the model introduces the fixed effects and breaks down the correlation but not efficient as it throws

[12] Corr(Vit, Vis) = $\sigma_\mu^2 / (\sigma_\mu^2 + \sigma_\varepsilon^2), t \neq s$

in the fixed effects which were not necessary. If the assumption does not hold, then the fixed effects model yields consistent and efficient estimates[13].

[13] As is explained in Dollar and Kraay (2004), and Pattillo, et al (2002), another estimation technique called System GMM has an advantage over the other estimation methods as it combines information in both the levels and changes of data. It requires the estimation of equations (1) and (7) as a system, where "the first differences are instrumented by lagged levels of the dependent and independent variables and levels instrumented by the first differences of the regressors" (Pattillo, et al, 2002). It yields unbiased estimates by addressing the endogeneity issue and maintains the cross-country dimension which could be wiped out by first differencing (differenced GMM method) or taking differences with respect to country means (fixed effects method). However, these instruments are valid only if they are not correlated with the fixed effects (Ibid, 2002). Despite these advantages of the system GMM, we will estimate our models using the fixed effects and random effects estimation techniques due to limitation of time and space.

5. Estimation Results and Discussion

In section 2, we have provided a brief summary of the origins of the debt crisis and the reasons for the accumulation of external debt in the developing world in general and SSA in particular. We have also summarized various theoretical explanations regarding the impact of external debt on growth. The implication of these theories is that large external debt could be bad for growth while the contribution of low external debt could be positive. The stylized facts that we presented in section 3.3 indicated that periods of escalating debt were characterized by declining growth performance in SSA. The correlation matrix (see Annex 1) also suggests an inverse association between external debt stock as well as debt service payment with real per capita GDP growth. It also suggests a negative correlation of debt service with private investment and total factor productivity.

In this section we will try to find out if these suggestions by the theory and the correlation matrix hold after controlling for various factors. Our presentation and discussion of the results begins with the growth regressions followed by the regressions for the transmission mechanisms. For reasons explained in section 3.1, we will use the dataset averaged over three years rather than the annual one. The statistical package used in estimating the models is STATA intercooled 8.

5.1 Results of Growth Regressions

The discussion that follows is based on the results for the growth regressions of equations (1) up to (6) that we specified in section 4.1. These models will be estimated under different sets of explanatory variables and estimation methods: namely the Fixed Effects and Random Effects.

5.1.1 Results of Growth Regressions for the Linear Model

The estimation results of the linear model specified in equation 1 (section 4.1.1) are displayed in annex 3. The dependent variable is real per capita GDP growth. The linear model is estimated under four different sets of explanatory variables displayed in the four

columns of annex 3. The first set augments the endogenous growth models with human capital. It consists of initial per capita GDP (*linitial*), investment to GDP ratio (*linv*), population growth (*lpopgr*), adult literacy (*ladlit*), total external debt stock to GDP ratio (*tedgdp*) (all are in logs) and total debt service payment to exports ratio (*tdsxgs*). The second set adds to the first set different indicators of policy, macroeconomic stability, market distortion and external shock. These are openness (*ltrade*), inflation (*linfcpi*), budget balance, M2 to GDP ratio (*lm2gdp*), and terms of trade growth (*totgr*). The third set adds to the second set some fixed factors. These are area (*larea*), a dummy variable for oil exporters (*oil*), and a dummy variable for landlocked countries (*landlock*)[14]. The fourth set adds to the third set two indicators of institutional quality- indexes for democracy and corruption[15]. The same sets are used under all estimation techniques[16].

As can be seen from annex 3, the fixed effects coefficients for debt service to exports ratio is not statistically significant in all specifications. There is only a weaker statistical significance (at 10%) in the second, third and fourth columns of the random effects. External debt stock as a ratio of GDP is significant only in the first columns of the fixed effects (at 5%) and the first (at 1%) as well as the third column (but only at 10 %) of the random effects. The hausman specification test supports the random effects in the case of specification 1 and 3 while it is in favour of the fixed effects in the case of specification two (column 2)[17].

The results displayed in annex 3 do not indicate a strong empirical evidence that supports a linear "debt overhang effect" of external debt stock on per capita GDP growth. The coefficients of debt/GDP ratio (*tedgdp*) are sensitive to changes in the sets of explanatory variables included in equation 1. We have found some statistical evidence for the "crowding out effect" of debt service payments. However, the effect is not found to be

[14] All variable codes that begin with the letter 'l' are in logarithm.

[15] When we tried to include other variables such as rule of law, political right, civil liberties, revolution and guerrilla warfare, STATA (intercooled) doesn't give results for the regressions. This could be due to a very high correlation of these variables with democracy, corruption and among themselves.

[16] In all sets, a time dummy is included to control for unobserved time specific effects.

[17] Large P-value for the hausamn test supports the acceptance of the null hypothesis H0: difference in coefficients not systematic. Acceptance of this makes the random effects preferable (consistent and efficient).

strong as the coefficient of debt service variable (*tdsxgs)* is significant only at 10% level of significance.

5.1.2 Results of growth regressions for the quadratic model

As part of our effort to investigate the existence of a non-linear relationship, we have estimated the quadratic model of equation 2 (see section 3.1) to see if the non-linear relationship between external debt and growth is a kind of relationship captured by the smooth inverted U-shaped curve of the type shown as annex 15. We have used the same specifications (variable sets) as the ones we used under the four columns of annex 3 except that we have now added the square of our measures of debt stock.

Estimation results of the quadratic model displayed as annex 4 indicate no evidence for the existence of a smooth inverted U-shaped debt Laffer curve. For such an inverted-U type quadratic relationship to exist, the coefficient of the debt variable should be positive and statistically significant and that of its squared value should be negative and statistically significant. However, the coefficients of the debt stock variable and its square do not satisfy these requirements of an inverted-U type quadratic relationship.

5.1.3 Results of Growth Regressions with Debt Dummies

In the above sub-section, we have found no evidence for a smooth quadratic relationship between external debt and growth. We now resort to the exploration of the nature of the impact of external debt on economic growth using the model with debt dummies. In other words, we will investigate if the impact of debt varies across the debt quintiles. This model also helps us identify the range of debt stock beyond which the marginal impact of external debt becomes negative. This will be achieved by estimating equation (3) under the same sets of explanatory variables and estimation techniques that we used in annex 3.

One unique feature of this regression with dummy variables is that it allows for any difference in the behaviour of debt in the five quintiles rather than imposing a linear

model to the entire data. On the contrary, it forces the other explanatory variables to have the same slope regardless of the level of indebtedness. Given this advantage and limitations, we have ranked the data for debt stock as a percentage of GDP in an ascending order and determined the boundaries of the quintiles (d1, d2, ..., d5) for debt stock/GDP ratio by dividing the entire data by five. The upper and lower bounds of the debt quintiles are presented in the following table (table 5.1).

Table 5.1: Debt Quintiles for debt as a percentage of GDP.

Quintile	**Lower bound**	**Upper bound**
Quintile 1 (d1)	0, inclusive	25.12395, inclusive
Quintile 2 (d2)	25.12395	45.04119, inclusive
Quintile 3 (d3)	45.04119	77.96031, inclusive
Quintile 4 (d4)	77.96031	120.7725, inclusive
Quintile 5 (d5)	120.7725	1491.658, inclusive

Source: author's own categorization

As the results displayed under annex 5 indicate, the coefficients for the debt stock dummies representing the quintiles show some statistical significance only under the first specification (column 1) of both the fixed effects and random effects. This significance disappears when we control for more variables in the subsequent specifications (columns 2, 3 and 4). This may suggest that the long-term effect of debt stock on economic growth may vary depending on existing policies and other socio-economic and fixed factors, which in turn are likely to have a different impact on a certain country (over time) or across different countries (at a given time) depending on the level of indebtedness. However, as it was indicated in the methodology, this model doe not allow these other factors to have a different impact (different slopes) depending on the level of indebtedness. Perhaps, that is why their inclusion as control variables has made the coefficients of the debt dummies insignificant.

Another finding displayed by the regression results under annex 5 is that the short-term impact of external debt, which is reflected by the amount of resources flowing out of

Sub-Saharan African countries in the form of debt service payments, has had a significant negative impact on economic growth. The coefficients are statistically significant (see random effects) in the second, third and fourth columns (where we have included more control variables) at 5%, 5% and 10% level of significance, respectively. The decrease in statistical significance in the fourth column could be a result of the large decrease in the number of observations due to the inclusion of democracy and corruption indexes, which have limited observations. The magnitude of the coefficients is interpreted as follows: Other factors remaining constant, a one percent increase in the Debt stock to GDP ratio leads, on the average, to a 1.87 %, 2% and 2.04% decrease in per capita GDP growth in the third, fourth and fifth quintiles, respectively. Other factors remaining constant, a one percent increase in debt service to exports ratio has led, on the average, to a 0.5% to 0.8% decrease in per capita GDP growth in the region during the specified period.

Generally, the results regarding the short-term impact of external debt through debt service payments are consistent with the theoretical explanations which state that external debt crowds out economic growth by causing an outflow of public and other resources to foreign creditors in the form of debt service payments, which otherwise would have been spent on growth stimulating activities such as public and private investment. Despite the fact that the coefficients become statistically insignificant when we control for other variables, the results displayed on the first column of annex 5 are also consistent with the explanations of the "debt overhang" theories. The direction and magnitude of the "crowding out" impact of debt service payments as well as the "Debt Overhang" impact of debt stock on some channels such as private investment will be investigated in section 5.2.

Given the limitations of the model with debt dummies, we will depend on the results of the first column of annex 5 to answer our next question: "Beyond what level does the marginal impact of external debt stock on economic growth become negative?" The magnitude and sign of the coefficients for the debt stock dummies point out that the marginal impact of external debt stock (the percentage change in per capita GDP growth

as a result of a one percent change in debt/GDP ratio) becomes negative and statistically significant when the average level of debt stock enters the third quintile and beyond.

Even though this model does not enable us to identify a specific debt threshold beyond which the marginal impact becomes negative, it signifies that when level of debt exceeds the range depicted by the second quintile (i.e. 25% to 45%), other things remaining constant, an additional amount of debt stock relative to GDP leads, on the average, to a fall in the per capita GDP growth. From the point of the view of practicality, it can also be argued that indicating the rage of indebtedness beyond which the marginal impact of external debt becomes negative is more appropriate than pointing out a specific threshold. This is because, countries are likely to have different growth maximizing debt thresholds due to differences in socio-economic conditions and polices. The growth maximizing range of debt that we have indicated above is similar to what has been suggested by Pattillo et al (2002), which is 35% to 40%.

5.1.5 The Impact of Low Debt and High Debt

To refresh our memory of the explanations we had while specifying our econometric models, it was mentioned that debt theories as well as empirical studies indicate that the impact of debt varies depending on the level of indebtedness. Generally, it is argued that low level of debt contributes to economic growth while high level of debt is harmful to economic growth. Furthermore, estimation results of the model with debt dummies have given some indication that high external debt stock imposed a significant negative impact on economic growth when it exceeds the range containing the second quintile. Following this line of argument, we now turn our attention to the investigation of the impact of external debt on growth by dividing the entire dataset in to two sub-samples representing low debt and high debt. Based on the results of the model with debt dummies, we consider the level of debt contained in the first and second quintiles of debt/GDP as low debt and the higher three quintiles as high debt.

Table 5.2 (below) summarizes the results of the linear growth regressions for low debt and high debt as a ratio of GDP. We control for the sets of explanatory variables that are used under the second and third columns of annex 3[18]. Due to the fact that the Hausman specification test result supports the random effects, our interpretation will focus on the results of the random effects estimation. The results displayed on this table reveal that low external debt contributes to economic growth. The coefficient of debt stock/GDP in the first column is statistically significant at 10% and this statistical significance increases to 5% when we control for the fixed factors (*larea, oil* and *landlock*) in the second column. Other things remaining constant, for a debt stock not exceeding the range contained in the second quintile, a one percent addition to the existing debt stock of a representative country leads to a 4% to 5.5% increase in per capita GDP growth.

The above finding is consistent with the theoretical explanations in relation to the positive contribution of external debt. For instance, Cohen (1991) states that low level of external debt is associated with economic growth provided that funds are spent on productive investment. The analysis embodied in the Harrod-Domar model also signifies that foreign borrowing is necessary to fill the savings-investment gap or the foreign exchange gap and meet the targeted rate of growth especially when domestic savings is not high enough to finance investment or imports are above exports. These results are also consistent with the findings of some empirical studies such as Elbadawi et al (1997), Pattillo et al (2002, 2004), Clements et al (2003), and Schclarek (2004).

Regarding the "crowding out" effect of debt service payments, the regression results displayed on table 5.2 indicate that debt service payments contribute negatively towards economic growth even when the level of debt is low. In this low debt range, a one percentage addition to the debt service to exports ratio leads, on the average, to a 0.46% to 0.86% point decrease in per capita GDP growth, ceteris paribus. These estimates for the impact of debt service to exports ratio are similar to the respective estimates of the model with debt dummies.

[18] It was not possible to undertake the regressions under the variable sets of column 4 of annex 3 due to the limited data we have for democracy and corruption indexes.

Table 5.2:- growth regression with low and high debt to GDP ratio

Dependent variable is real per capita GDP growth

	Low Debt				High Debt			
	Fixed Effects		Random Effects		Fixed Effects		Random Effects	
	1	2	1	2	1	2	1	2
linitial	(dropped)	(dropped)	0.52	-0.48	(dropped)	(dropped)	-1.03	-1.34
			0.39	-0.31			-1.11	-1.44
linv	-1.66	-1.66	2.52	2.14	1.79***	1.76***	3.24*	3.19*
	-0.26	-0.26	1.37	1.13	1.71	1.67	3.46	3.37
lpopgr	-2.47	-2.47	-5.54	-6.62***	-1.33	-1.23	-2.01***	-2.17***
	-0.25	-0.25	-1.46	-1.69	-1.01	-0.91	-1.77	-1.91
ladlit	-25.50	-25.50	3.55**	5.27**	-1.70	-2.33	1.20	1.13
	-0.92	-0.92	2.12	2.50	-0.35	-0.47	1.09	1.05
tdsxgs	-0.10	-0.10	-0.46***	-0.86**	-0.02	-0.02	-0.03	-0.03
	-0.13	-0.13	-1.83	-2.19	-0.80	-0.76	-1.21	-1.16
ltedgdp	5.85	5.85	4.02***	5.45**	-2.06**	-2.07**	-1.77*	-2.25*
	1.35	1.35	1.79	2.09	-2.01	-2.01	-2.38	-2.87
ltrade	4.77	4.77	-3.18	-3.96	2.46***	2.43***	2.28**	2.50**
	0.48	0.48	-1.39	-1.53	1.74	1.71	2.18	2.38
linflcpi	0.76	0.76	1.59	1.68	-0.08	-0.09	-0.12	-0.05
	0.33	0.33	1.06	0.99	-0.31	-0.33	-0.49	-0.23
budbal	-0.14	-0.14	0.16	0.04	0.04	0.04	0.04	0.04
	-0.33	-0.33	0.78	0.17	0.89	0.89	1.02	1.05
bmprem	-6.25	-6.25	-4.54	-6.18***	0.00	0.00	0.00	0.00
	-1.03	-1.03	-1.55	-1.89	-1.38	-1.34	-1.32	-1.29
lm2gdp	-8.54	-8.54	-2.98	-5.08	-3.03*	-3.17*	-2.95*	-3.10*
	-1.33	-1.33	-0.97	-1.35	-2.75	-2.81	-3.42	-3.47
totgr	0.02	0.02	0.02	0.02	0.01	0.02	0.00	0.00
	0.24	0.24	0.41	0.41	0.49	0.51	-0.05	-0.13
larea		(dropped)		0.76		-2.34		0.14
				1.26		-0.19		0.49
oil		(dropped)		-3.40		(dropped)		0.44
				-1.01				0.31
landlock		(dropped)		-3.11		0.58		-1.81***
				-0.97		0.09		-1.81
time	0.76	0.76	-0.58	-0.43	0.44	0.47	0.22	0.29
	0.48	0.48	-1.67	-1.01	1.12	1.19	1.20	1.57
_cons	94.27	94.27	2.47	6.51	9.62	40.59	2.24	4.54
	1.32	1.32	0.27	0.56	0.56	0.26	0.33	0.51
No of obs	45	45	45	45	194	194	194	194
Hausman	chi2		6.820	5.970			7.540	9.890
	Prob>chi2		0.869	0.917			0.754	0.703
Wald test	(p-value)		0.203	0.302			0.000	0.000

*, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy

Source: author's computation.

These results are consistent with the predictions of the debt theories which state that debt servicing can have an adverse impact on growth through the fiscal account. That is, much of government will be spent on servicing debt and this will in turn reduce public investment as well as private investment to the extent that public investment is

complementary to private investment. This will not only reduce the level of investment (including investment in human capital) but also its productivity, which is also important for growth. Another channel through which debt service payments damage economic growth is by jeopardizing a country's ability to meet its import demand, which includes the demand for growth enhancing investment goods.

The results for the regressions for high debt are also depicted on table 5.2 (above). The coefficients of our debt stock variable (debt/GDP) are negative and statistically significant (at 1%) in both columns (specifications) of the random effects. The magnitude of external debt stock on economic growth can be interpreted as follows: other things remaining constant, a one percent addition to the existing debt to GDP ratio of a country in this high debt range would reduce per capita GDP growth by 1.77% to 2.25% (see the random effects). These results are also similar to the estimates for the coefficients of the higher debt quintiles that we found using the model with debt dummies.

Once again, the above result provides a supporting empirical evidence for the theoretical explanations regarding the "Debt Overhang" effect of high debt stocks. These theories that we discussed in section 2.2 state that large external debt works against economic growth by serving as a disincentive to investors who expect a low after tax return on investment (expecting that the government will impose higher tax in the future to pay its debt); by hindering governments in developing countries from undertaking desirable policy changes (adjustments); and raising uncertainty among the private sector as to how the debt will be serviced and thus cause them invest on less risky, quick-return trading activities rather than on high-risk, long-term and irreversible investment. To sum up, we have found empirical evidence supporting a non linear impact of external debt stock on economic growth though this impact is not a quadratic one.

5.1.6. Impact of Other Control Variables

Once again, we focus on the results displayed in annexes 3, 4 and 5 to have a quick look at the impact of the remaining control variables. The level of Investment is found to have

a statistically significant positive impact on economic growth in all econometric models (linear, quadratic, dummy variable, low debt and high debt). This finding holds the same for population growth and monetary expansion (relative to GDP) except that the impacts in this case are negative. Volume of trade (relative to GDP) and democracy[19] have statistically significant positive impact while corruption has statistically negative impact on economic growth in all models except the linear models for low debt and high debt.

Black market premium (an indicator of market distortion) has a statistically significant negative impact on the linear models for low debt and high debt while being oil producer and a landlocked country has the same negative impact but limited to the model with low debt only. Human capital formation (captured by adult literacy) has a statistically significant positive impact when the level of debt is low. This is because at low levels of debt some of the money obtained by loan may go to finance spending on education which is found to have a positive impact on growth while such spending on education is likely to dwindle at times of high indebtedness where there is an outflow of resource in the form of debt service payments.

Before we proceed to the analysis regarding the channels (transmission mechanisms) through which external debt affects growth, we would like underline the findings regarding the positive impacts of the level of investment and human capital formation on growth as these variables are part of the potential transmission mechanisms. Given this positive impact of these two variables on growth, if we find in the analysis (in the following sub-section) that external debt has a significant negative impact on these potential channels, then this will confirm the theoretical explanation that the indirect impact of external debt is, among other factors, through these two channels.

5.2 Results of regressions for Transmission Mechanisms

We now turn to the second phase of this study where we investigate how the indirect impact of external debt on growth works. We did regressions of some potential

[19] The Lowess smoother attaches as annex 16 also suggests a positive relationship between democracy and per capita GDP growth.

transmission mechanisms (the level of private investment, the level of human capital, and total factor productivity).

5.2.1 Impact of Debt on the level of investment

In this section, we discuss the findings of the regressions with the linear model; the quadratic model; and the model with dummy variables for the quintiles of debt[20]. The results for the linear model that is fitted to the entire dataset (see annex 6) provide evidence supporting the crowding out effect of debt service payment on private investment. On the contrary, debt stock did not have such a linear negative impact on private investment. Instead, the coefficients are found to be positive and statistically significant.

In this study, we do not find empirical evidence indicating the existence of an inverted U-shaped quadratic impact of external debt on private investment see (annex 7). Though the coefficient for debt service/exports ratio is still witnessing the "crowding out" effect, the coefficients for debt/GDP and its squared value do not satisfy the criteria for a quadratic relationship.

We also estimated the specifications with dummy variables and we have reported the results under annex 8. Similar to what has been found using the linear and quadratic models, debt service/exports ratio has a statistically significant negative impact on private investment (though at 10% in this case). When the estimation is with fixed effects, we find a strong positive impact of debt in the second and third quintiles. For the random effects, we find such significant positive relationship only for the second quintile. The hausman specification test result supports the random effects. This evidence for such positive impact of debt on investment especially at this low quintile indicates that private

[20] We have used similar sets of variables that we used in the growth regressions except that we have now controlled also for the impact of export earnings (as a percentage of export), credit to private sector and public investment (as a percentage of GDP) and dropped trade to GDP to avoid multicollinearity with exports/GDP ratio.

investment is one of the channels through which low level of debt contributes positively to economic growth.

Winding up our assessment of the impact of external debt on private investment, we found that debt service payment is detrimental to private investment. Surprisingly, the magnitudes of the coefficients for debt service/exports ratio are more or less similar in all models. They vary between 0.08 % and 0.12%. That is, a one percent increase in debt to exports ratio decreases private investment, on the average, by 0.08 to 0.12 %, ceteris paribus. Regarding debt stock, there are two main findings. On the one hand, the level of investment is not one of the channels through which large external debt stock adversely affects economic growth. On the other hand, as the results of the model with debt dummies indicate, the level of private investment is one of the channels through which the positive impact of low level of debt on economic growth takes place.

5.2.2 Impact on the level of Human Capital

When we use human capital accumulation as a dependent variable[21] (see annex 9), results of the linear model provide no statistical evidence that indicates a negative impact of debt service payments on human capital formation. Unlike these results, external debt stock is found to have a significant negative impact on human capital formation regardless of the estimation method, specification and the debt indicator used.

We find no empirical evidence supporting a quadratic impact (captured by an inverted U-shaped curve) of external debt stock as a percentage of GDP (see annex 10). In this quadratic specification, we find no evidence for the "crowding out" effect of debt service payments. In the regressions with debt dummies (annex 11), we find a significant negative impact of external debt/GDP ratio on human capital (average years of schooling) in all debt quintiles (see random effects which are supported by the hausman test results) though this is not the case with debt service/exports ratio.

[21] The explanatory variables are exactly the same as the ones we used in the growth regressions.

Summarizing the results, we may conclude that the "crowding out" effect of external debt is not through human capital formation as the effect of debt service/exports ratio was not statistically significant in all models and specifications. As opposed to this, the level of human capital formation is one of the channels through which accumulation of external debt tock imposes a negative impact on economic growth.

5.2.3 Impact on Total Factor Productivity

One of the theoretical explanations on the impact of external debt on growth was that debt stock could affect growth indirectly by directing investment in to less productive and quick-return type of investment. As we explained elsewhere in this paper, we use total factor productivity as an indicator of the efficiency or productivity of physical and human capital[22]. In this sub section, we examine the impact of external debt on the efficiency or productivity of investment and human capital rather than their level by using total factor productivity as one of the dependent variables.

As usual, we begin with the linear model. The regression results of this model (see annex 12) do not indicate the existence of an empirical evidence for the short-term "crowding out" impact of debt service payments on the productivity of investment. However, it provides an evidence for the "Debt Overhang" impact of external debt stock as the coefficients of debt stock/GDP ratio are statistically significant at 10 % in the first specification of the random effects and at 5% in the second specification, where we control for more variables.

The regression results with the quadratic specification (presented in annex 20) do not provide evidence that indicates the existence of an inverted U-shaped relationship between external debt and growth. Debt service payment is also with no statistically

[22] Other empirical studies including the one by Pattillo et al (2004), Bosworth and Collins (2003) have used total factor productivity to capture the productivity of physical and human capital.

significant effect. The coefficients for debt variable and its square are all negative in almost all cases[23].

The results of the regressions with debt dummies (displayed in annex 11) provide evidence for the negative impact of external debt/GDP in third, fourth and fifth debt quintiles of the fixed effects (the fixed effects is supported by hausman test results). This together with our finding in section 5.2.1 (regarding the impact of debt on investment) suggests that low external debt may not impose a significant adverse impact on total factor productivity (the productivity of investment) while the impact of high debt accumulation is on the efficiency (productivity) of resource use rather than the level of private investment[24]. As the theory suggests, investors feeling uncertain about the future will resort to short-gestating and quick return investment rather than on long-gestating investment that adds more value to the growth process.

5.3 The Overall Picture

Winding up our discussion of the overall findings of this study regarding the direct impact of external debt on economic growth and its indirect impact through some potential channels, we have found an evidence for a non linear impact of external debt and growth. Other things remaining constant, low level of debt is found to have a positive impact on growth while high level of debt is associated with declining growth rates. Generally, this is consistent with various theoretical explanations including the debt overhang theories that we revised in section 2.2. However, the nature of relationship is not quadratic. This finding is against that of Pattilo et al (2002) and Elbadawi et al (1997) who claimed to have found a non-linear but quadratic. On the other hand, our finding is similar to the study by Alfredo Schclarek (2004) which finds no enough statistical

[23] There is one case (column 2 of random effects for debt to GDP) where the debt coefficient has positive coefficient and its square has statistically significant (at 10%) negative coefficient. Since the coefficient for the former is not statistically significant, we have no evidence for such a quadratic type of relationship.

[24] Clements and Nguyen (2003) als found that the growth depressing effect of external debt stock works through its effect on the efficiency of resource use rather than through its negative effect the level of private investment.

evidence for a quadratic type relationship. The growth maximizing level of debt identified by this study (25 % to 45% of GDP) is similar to the one identified by Pattillo et al (2002). The magnitudes of the coefficients for our debt variable are higher than that indicated by these authors. This seems reasonable as the indebtedness in Sub-Saharan Africa is more severe than any other region. The fact that their sample consists of 93 countries from all over the world possibly adds something to the difference in the empirical findings.

Most importantly, our finding regarding the non quadratic nature of non-linearity and the magnitude of the growth maximizing level of debt is also different from the study by Elbadawi et al (1997), which reports a quadratic impact of external debt on Sub-Saharan Africa's economic growth. This difference could possibly arise from difference in the countries included in the sample, the time period covered and most importantly the constant revision of the databases for various variables including the measures of indebtedness. Whatever the case may be, our sample includes almost all Sub-Saharan African countries, covers a larger time span, controls for short-term cyclical effects, and uses the most recent versions of the databases[25].

Our findings are also different from that of Milton Iyoha (2000), who did similar study for the region, in the sense that Iyoha's study (which covers the period 1974-94) has found a significant debt overhang (capturing the effect of stock of debt) and crowding out effects (capturing the impact of debt service payments) on growth by estimating a linear model for the entire data while we have found an evidence for a different effect of debt at lower and higher levels of indebtedness. Iyoha's study not only fails to consider the non linearity in the nature of the relationship between external debt and growth, but also ignores the possibility of country specific and time specific effects. This is because it employs only Ordinary Least Squares (OLS) estimation technique[26] and no estimation is made for the fixed effects and/or the random effects.

[25] The study by Elbadawi et al (1997) includes only 37 countries and covers the period 1960-1994.
[26] Due to the econometric problems associated with the use of country or time specific effects, these OLS estimates and policy simulations that depend on them may not be accurate.

6. Summary and Conclusion

In this paper, we aimed at examining the nature of the impact of external debt on economic growth in 44 Sub-Saharan African countries using an unbalanced dataset that ranges from 1970 to 2002. Instead of using the annual data, which was subject to a serious autocorrelation problem, we calculated an average of three non overlapping years to control for this autocorrelation and to net out the effects of short-run (cyclical) fluctuations as we are interested in the long-run relationship. We examined this relationship under various models, specifications (sets of control variables) and estimation techniques, namely the fixed effects and random effects.

Generally we faced a problem of missing values for various variables and countries. Perhaps because of the inaccuracy in the measurement of variables inherent to the nature of surveys and reporting systems in developing countries, we observe (in the data set) differences in the values for the same variable (at a given year) across different data sources or different editions of the same source (due to revisions in subsequent years). Despite these possible common problems, we have tired to make use of this available data to investigate the general picture of the nature of the impact of changes in the level of external debt on economic growth and estimate the magnitude of its impact. Furthermore, we have investigated the impact of external debt on some potential transmission mechanisms through which the indirect impact of external debt on economic growth takes place. Due to the possible problems associated with the nature of the data, the estimation results (magnitudes of coefficients) of the various regressions should be seen as rough estimates which shed more light on the general picture.

In the growth regressions for the linear model that we fitted to the entire dataset, we did not find a robust impact of external debt while there is weak empirical evidence (at 10% level of significance) for the linear impact of debt service payment on real per capita GDP growth. Estimation results of the quadratic model indicate no evidence for the existence of a smooth inverted U-shaped debt Laffer curve. As the results of the regressions with the model with debt dummies indicate, external debt stock is found to

have a statistically significant negative impact on economic growth especially at higher debt levels contained by the third, fourth and fifth quintiles. We have also indicated that the growth maximizing level of debt stock ranges from 25% to 45% of GDP. Under these regressions with debt dummies, debt service is also found to have significantly and negatively affected economic growth especially when our debt indicator is expressed as a percentage of GDP.

Referring to the theoretical explanations and the findings of other empirical studies, we estimated the linear model for low levels of debt (included in the first and second quintile) and high levels of debt separately. We found a significant positive impact of low level of external debt on economic growth. Other things remaining constant, for a debt stock not exceeding the range contained in the second quintile, a one percent addition to the existing debt stock of a representative country leads to a 4% to 5.5% increase in per capita GDP growth. This supports the theoretical explanation that lower level of debt could fuel economic growth. It could, for instance, provide an additional source of funds to finance investment in infrastructure, schooling, health, etc. Our findings related to the growth regressions also indicate a significant negative impact of debt service payments at low levels of debt/GDP ratio. In this low debt range, a one percentage addition to the debt service to exports ratio leads, on the average, to a 0.46% to 0.86% point decrease in per capita GDP growth, ceteris paribus.

Estimation of the linear model with high debt levels (the third quintile and above) indicates a significant negative impact of debt to GDP ratio on economic growth. In terms of magnitude, a one percent addition to the existing debt to GDP ratio of a country with average indebtedness would reduce per capita GDP growth by 1.77% to 2.25% (see the random effects).

The overall picture is that low level of debt had contributed to growth while high level of debt has been detrimental to growth during 1970-2002 in Sub-Saharan Africa. When the dependent variable is private investment (as a percentage of GDP), we have found no evidence for quadratic relationship between private investment and external debt stock.

Estimation results of the regressions with debt dummies and the linear model do not provide evidence for a debt overhang effect of debt stock on private investment. On the contrary, we have found empirical evidence (in both the linear and quadratic models) supporting the theoretical explanations for the "crowding out" effects of debt service payments on private investment.

The indirect impact of external debt on growth was exhibited through its statistically significant negative impact on human capital. The coefficients of this transmission mechanism were significant and negative in the linear model and the model with debt dummies (but not in the quadratic model). However, debt service payments did not have significant negative impact on human capital formation.

Finally, we find a statistically significant linear impact of debt stock on total factor productivity while the coefficients of our variable for debt service payment are statistically insignificant. This suggests that the indirect impact of external debt on growth is through the productivity (efficiency) rather than the level of private investment.

In a nut shell, our empirical investigation has found results that indicate a non-linear effect of external debt on economic growth though the nature of non-linearity is not the one implied by a smooth inverted U-shaped debt Laffer curve. However, we believe that the quadratic type of non linearity will not have policy implications different from that of ours. Our findings imply that if countries manage to keep their level of debt less than a certain threshold, they will enjoy higher growth rates. We believe that the growth maximizing debt threshold indicated in this study as well as in other empirical studies should be taken as a rough indicator that give an overall insight in to the nature of the relationship between our variables of interest rather than a specific threshold that should be targeted by each country.

Our findings have confirmed the widespread argument that large external debt has hindered economic growth in Sub-Saharan Africa. Though this study has not estimated the magnitude of the quantitative impact of debt reduction scenarios on economic growth,

its findings provide additional empirical evidence to the importance of debt reduction and debt cancellation for Sub-Saharan African countries by bilateral and multilateral creditors (as much of the region's debt is owed to these creditors rather than private banks). This signifies the importance of initiatives and decisions (such as the recent decision by G8 countries following the effort made by Tony Blair's Commission for Africa) to reduce or cancel Sub-Saharan African debt include the HIPC initiative and towards debt reduction and cancellation in the region.

In addition to oil price and interest rate shocks and the decline in external assistance in 1980s, the debt problem of SSA is often associated with government actions and internal conditions of Sub-Saharan African countries themselves. These include a top heavy and poorly trained man power; weak or non-existent organizational or institutional infrastructure; acute shortage of managerial, administrative personnel and skills, inefficient monetary fiscal and exchange rate policies; insufficient domestic saving and low investment; lack of political will to take decisions; and absence of effective debt management strategy (Abbott, 1993 p.32). The implication of our findings in relation to these origins of the debt problem and the additional fact that long-term debt in SSA is dominated by public and publicly-guaranteed debt is that these countries should align their public policies towards maintaining a sustainable level of indebtedness. They should also work on improving the quality of their man power, governance and control corruption as these indicators of the quality of institutions (which are found to have a significant relationship with growth) are often mentioned as justifications for the reluctance on the side of bilateral and multilateral lenders to cancel debt for Sub-Saharan African countries and extend aid to the region. Countries in SSA not only need debt cancellation but also financial and technical assistance to overcome the bottlenecks that has been affecting the effectiveness of aid and development policies as well as the efficient utilization of funds obtained through external borrowing.

Following any debt reduction or cancellation for these countries, bilateral and multilateral lenders (whose lending policies were part of the origins of the debt crisis) should extend new loans in such a way that these countries do not fall back to the debt trap. On top of

that developed countries and multilateral institutions should arrange other mechanisms (such as development cooperation and fairer trade) to help developing countries in the region meet their need and right to development. Without such holistic and coordinated action, debt reduction and debt cancellation efforts will not have a long lasting effect on the growth prospects of the region.

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Annexes

Annex 1: Pair wise correlation matrix for some variables of interest

	rgdppcgr	tdsxgs	ltedgdp	ltedxgs	privinv	scholtot	ltfpkh
rgdppcgr	1.000						
tdsxgs	-0.2113* (0.000)	1.000					
ltedgdp	-0.1494* (0.0017)	0.4930* (0.000)	1.000				
ltedxgs	-0.1979* (0.000)	0.5917* (0.000)	0.7835* (0.000)	1.000			
privinv	0.3989* (0.000)	-0.2086* (0.000)	0.0395 (0.4069)	-0.2474* (0.000)	1.000		
scholtot	0.0903 (0.1713)	0.0358 (0.5886)	0.075 (0.2552)	-0.2300* (0.0005)	0.3792* (0.000)	1.000	
ltfpkh	0.2117* (0.0032)	-0.2218* (0.0016)	-0.2175* (0.0024)	-0.3719* (0.000)	0.5395* (0.000)	0.1776* (0.0408)	1.000

Coefficents with * are significant at 5%. The values in parentheses indicate the level of significance.

Source: author's computation. Source: author's computation

Annex 2: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Real percapita GDP growth	453	.8334875	5.450248	-28.97162	48.87545
Initial income (log)	480	6.051163	.8042982	4.739332	8.318761
Investment/GDP (log)	486	2.85169	.5435346	.4255127	4.477353
Population growth (log)	486	.9174505	.3609272	-1.500735	2.334574
Adult Literancy (log)	418	3.673435	.5735943	1.782523	4.492413
Debt service/Exports	453	15.02453	12.39551	0	82.96137
Debt/GDP (log)	460	4.021372	1.024197	-.856967	7.307643
Debt/Exports (log)	450	5.355432	1.169327	1.290151	8.131941
(Exports + Imports)/GDP (log)	457	4.061778	.590557	-.1281421	5.434639
Inflation, consumer prices (log)	364	2.352586	1.359863	-4.786396	9.022281
Government Budget Balance	424	-4.797909	6.613193	-47.35533	31.28141
Black Market Premium	401	7.04e+08	1.41e+10	.06	2.82e+11
M2/GDP (log)	439	3.092286	.5553918	.0081425	6.413659
Terms of trade growth	437	-1.185149	11.74309	-117.9192	31.45194
Area (log)	495	11.93999	2.162724	6.109248	14.98551
Oil	495	.2	.4004047	0	1
Landlocked	495	.3414141	.4746638	0	1
Democracy Index	468	-3.809117	17.36919	-88	10
Corruption Index	121	-.6120248	.5703711	-1.98	.91
Private Investment/GDP	470	11.32799	8.427197	-.296573	85.5998
Avg. yrs of Schooling	248	2.449792	1.437457	.283	6.279
Total Factor Productivity (log)	209	.0085823	.2674834	-.777781	.6758077
Exports/GDP (log)	456	3.137345	.6636457	1.156876	4.593114
Credit to Private Sector (log)|	420	2.553895	.7907667	-.3992259	4.936702
Public Investment/GDP (log)|	465	1.991548	.7010611	-2.183865	3.8

Source: author's computation

Annex 3 **Linear growth Regression, with debt to GDP ratio**

Dependent variable is real per capita GDP growth

	Fixed Effects				Random Effects			
	1	2	3	4	1	2	3	4
Linitial	-3.115	(dropped)	(dropped)	(dropped)	-0.805***	-0.738	-1.093	-0.917
	(-0.74)				(-1.7)	(-1.11)	(-1.57)	(-0.51)
Linv	4.15*	1.527***	1.507***	-6.584	4.305*	3.262*	3.071*	4.801**
	(7.06)	(1.69)	(1.66)	(-1.5)	(8.48)	(4.00)	(3.75)	(2.47)
Lpopgr	-1.89***	-1.102	-1.0067	-11.796**	-1.465***	-2.387**	-2.404**	-5.374***
	(-1.87)	(-0.86)	(-0.77)	(-2.39)	(-1.83)	(-2.23)	(-2.22)	(-1.94)
Ladlit	3.332	-1.831	-2.216	-29.788	0.999	1.221	1.190	0.270
	(1.5)	(-0.51)	(-0.61)	(-1.1)	(1.61)	(1.42)	(1.35)	(0.1)
tdsxgs	-0.030	-0.044	-0.043	-0.105	-0.029	-0.05***	-0.047***	-0.076***
	(-1.25)	(-1.61)	(-1.56)	(-1.8)	(-1.38)	(-1.92)	(-1.85)	(-1.67)
Ltedgdp	-1.071**	-0.214	-0.1843	0.140	-1.039*	0.499	-0.876***	-2.346
	(-2.34)	(-0.33)	(-0.28)	(0.03)	(-2.91)	(-1.18)	(-1.66)	(-1.32)
Ltrade		2.04	2.01117	-1.192		1.561***	1.798**	1.725
		(1.63)	(1.6)	(-0.18)		(1.81)	(1.99)	(0.73)
Linflcpi		-0.154	-0.164	-1.600		-0.147	-0.088	-0.320
		(-0.63)	(-0.66)	(-1.76)		(-0.65)	(-0.38)	(-0.48)
Budbal		0.044	0.044	-0.278		0.041	0.041	-0.234
		(0.97)	(0.96)	(-1.31)		(0.94)	(0.94)	(-1.27)
bmprem		0.00	0.00	0.000***		0.000	0.000	0.000
		(-1.35)	(-1.31)	(2.22)		(-1.41)	(-1.38)	(-1.4)
lm2gdp		-3.497*	-3.600*	-0.492		-3.020*	-3.142*	-3.935***
		(-3.49)	(-3.55)	(-0.17)		(-3.88)	(-3.84)	(-1.99)
Totgr		0.023	0.024	0.055		0.002	0.004	-0.025
		(0.92)	(0.94)	(0.74)		(0.09)	(0.17)	(-0.38)
Larea			-3.7882	(dropped)			0.015001	-0.442
			(-0.29)				(0.06)	(-0.79)
oil			(dropped)	(dropped)			0.865182	2.522
							(0.72)	(0.82)
Landlock			0.18738	(dropped)			-1.37651	-1.438
			(0.03)				(-1.55)	(-0.6)
Democ				0.153*				0.102**
				(3.41)				(2.4)
Corrupt				-5.372*				-4.144*
				(-3.44)				(-2.89)
_cons	2.909	8.816	56.375	166.02	-4.532	0.697	3.834	30.073
	(0.11)	(0.71)	(0.35)	(1.6)	(-1.35)	(0.15)	(0.61)	(1.14)
No. of Obs	370	239	239	59	370	239	239	59
Hausman	Chi2				5.71	21.8	-8.62	5.31
	P-value				0.5742	0.0259		0.9676
Wald test (p-value)					0.000	0.000	0.000	0.000
					14	19.67	13	22.36

The values in parentheses are the t-ratios. *, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy.

Source: author's computation.

Annex 4: Quadratic growth regression with debt to GDP ratio

Dependent variable is real per capita GDP growth

	Fixed Effects				Random Effects			
	1	2	3	4	1	2	3	4
linitial	-3.127 (-0.74)	(dropped)	(dropped)	(dropped)	-0.81*** (-1.69)	-0.739 (-1.13)	-1.133 (-1.64)	-1.008 (-0.55)
linv	4.156* (6.92)	1.217 (1.33)	1.151 (1.25)	-6.547 (-1.41)	4.303* (8.39)	3.271* (4.02)	3.045* (3.72)	4.860** (2.47)
lpopgr	-1.889*** (-1.86)	-1.022 (-0.80)	-0.896 (-0.69)	-11.811** (-2.27)	-1.466 (-1.82)	-2.498** (-2.33)	-2.535 (-2.34)	-5.403*** (-1.93)
ladlit	3.339 (1.50)	-1.595 (-0.45)	-2.110 (-0.58)	-28.916 (-0.97)	1.010 (1.61)	1.135 (1.32)	1.085 (1.23)	0.277 (0.277)
tdsxgs	-0.030 (-1.38)	-0.057** (-2.04)	-0.058** (-2.05)	-0.103 (-1.56)	-0.029 (-1.38)	-0.050** (-1.99)	-0.049*** (-1.95)	-0.077 (-1.66)
tedgdp	0.000 (0.04)	-0.026*** (-1.79)	-0.029*** (-1.95)	-0.004 (-0.10)	0.000 (0.01)	-0.009 (-0.99)	-0.012 (-1.28)	0.010 (0.41)
ltedgdp2	-0.544*** (-1.78)	0.479 (1.05)	0.568 (1.22)	0.366 (0.09)	-0.521** (-2.04)	-0.018 (-0.05)	-0.094 (-0.25)	-1.679 (-1.08)
ltrade		2.328*** (1.86)	2.322*** (1.85)	-1.167 (-0.17)		1.588*** (1.85)	1.891** (2.09)	1.564 (0.65)
linflcpi		-0.003 (-0.01)	-0.002 (-0.01)	-1.576 (-1.59)		-0.092 (-0.40)	-0.012 (-0.05)	-0.393 (-0.56)
budbal		0.060 (1.30)	0.061 (1.33)	-0.272 (-1.18)		0.042 (0.98)	0.043 (0.99)	-0.242 (-1.29)
bmprem		0.000 (-1.50)	0.000 (-1.47)	0.000*** (2.04)		0.000 (-1.48)	0.000 (-1.47)	0.000 (-1.32)
lm2gdp		-3.929* (-3.83)	-4.126* (-3.96)	-0.391 (-0.12)		-3.130* (-3.98)	-3.331* (-4.02)	-3.965** (-1.99)
totgr		0.024 (0.94)	0.025 (0.98)	0.059 (0.68)		0.004 (0.14)	0.006 (0.25)	-0.031 (-0.46)
larea			-6.607 (-0.51)	(dropped)			0.024 (0.10)	-0.456 (-0.81)
oil			(dropped)	(dropped)			0.825 (0.69)	2.719 (0.86)
landlock			-0.416 (-0.06)	(dropped)			-1.548*** (-1.73)	-1.472 (-0.61)
democ				0.151** (2.98)				0.109** (2.36)
corrup				-5.317** (-3.05)				-4.208* (-2.85)
_cons	2.981 (0.11)	6.104 (0.49)	88.558 (0.55)	160.112 (1.28)	-4.519 (-1.32)	-0.248 (-0.05)	2.876 (0.45)	34.929 (1.17)
No.of obs	370	239	239	59	370	239	239	59
Hausman	chi2				5.44	67.63	93.06	-0.7
	Prob>chi2				0.7093	0.000	0.000	
Wald test (p-value)					0.000	0.000	0.000	0.000

The values in parentheses are the t-ratios. *, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy.

Source: author's computation.

Annex 5: Growth Regressions with dummies for debt/GDP

Dependent variable is real per capita GDP growth

	Fixed Effects				Random Effects			
	1	2	3	4	1	2	3	4
linitial	-3.40 (-0.80)	(dropped)	(dropped)	(dropped)	-0.90*** (-1.93)	-0.73 (-1.19)	-1.15*** (-1.76)	0.08 (0.04)
linv	4.102* (6.92)	1.47 (1.59)	1.43 (1.53)	-4.78 (-1.14)	4.214* (8.36)	3.298* (4.00)	3.03* (3.64)	4.68* (2.38)
lpopgr	-2.04** (-1.99)	-1.15 (-0.89)	-1.05 (-0.79)	-11.81 (-2.97)	-1.58** (-1.98)	-2.54** (-2.42)	-2.64** (-2.48)	-5.67 (-1.85)
ladlit	3.33 (1.47)	-2.37 (-0.65)	-2.77 (-0.75)	-28.62 (-1.10)	1.003*** (1.66)	1.17 (1.47)	1.15 (1.41)	0.27 (0.10)
tdsxgs	-0.03 (-1.45)	-0.05 (-1.64)	-0.05 (-1.65)	-0.08 (-1.30)	-0.03 (-1.64)	-0.05** (-2.11)	-0.05** (-2.07)	-0.08*** (-1.77)
ltrade		2.07 (1.63)	2.05 (1.61)	-3.48 (-0.65)		1.386*** (1.67)	1.75** (1.98)	2.05 (0.83)
linflcpi		-0.20 (-0.79)	-0.20 (-0.76)	-1.41 (-1.60)		-0.21 (-0.89)	-0.14 (-0.61)	-0.68 (-1.04)
budbal		0.04 (0.95)	0.04 (0.96)	-0.11 (-0.37)		0.04 (0.97)	0.04 (0.98)	-0.27 (-1.30)
bmprem		0.00 (-1.22)	0.00 (-1.21)	0.000*** (1.86)		0.00 (-1.32)	0.00 (-1.27)	0.00 (-1.15)
lm2gdp		-3.61* (-3.50)	-3.74* (-3.57)	-1.11 (-0.40)		-2.96* (-3.86)	-3.21* (-3.95)	-3.71 (-1.84)
totgr		0.03 (1.01)	0.03 (1.03)	0.05 (0.71)		0.00 (0.06)	0.01 (0.20)	-0.02 (-0.30)
larea			-4.59 (-0.35)	(dropped)			0.03 (0.16)	-0.50 (-0.78)
oil			(dropped)	(dropped)			0.71 (0.65)	2.24 (0.70)
landlock			-0.29 (-0.04)	(dropped)			-1.47*** (-1.77)	-1.84 (-0.71)
democ				0.120*** (2.23)				0.116* (2.74)
Corrupt				-5.11 (-3.61)				-4.49 (-3.14)
dg2	-0.81 (-1.09)	0.31 (0.35)	0.38 (0.42)	(dropped)	-0.70 (-1.03)	0.03 (0.04)	-0.06 (-0.07)	-4.94 (-0.65)
dg3	-1.87** (-2.05)	0.13 (0.12)	0.28 (0.24)	-4.04 (-0.84)	-1.87*** (-2.40)	-0.36 (-0.35)	-0.78 (-0.74)	0.30 (0.06)
dg4	-2.00*** (-1.85)	-0.09 (-0.06)	0.04 (0.03)	-2.16 (-1.22)	-2.22* (-2.57)	-1.36 (-1.19)	-2.07 (-1.72)	-3.98 (-0.74)
dg5	-2.04*** (-1.66)	0.40 (0.25)	0.38 (0.24)	(dropped)	-2.03** (-2.10)	-0.76 (-0.62)	-1.67 (-1.27)	-2.44 (-0.44)
_cons	2.33 (0.09)	10.38 (0.79)	68.05 (0.41)	164.78 (1.76)	-6.18 (-1.93)	-0.34 (-0.08)	2.35 (0.41)	16.09 (0.61)
No.of Obs	370	239	239	59	370	239	239	59
Hausman	chi2				9.760	-86.570	-54.440	14.020
	Prob>chi2				0.462			0.449
Wald test (p-value)					0.000	0.000	0.000	0.000

The values in parentheses are the t-ratios. *, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy

Source: author's computation.

Annex 6: Linear impact of debt (as a ratio of GDP) on private investment

Dependent variable is private investment as a percentage of GDP

	Fixed Effects		Random Effects	
	1	2	1	2
linitial	(dropped)	(dropped)	-1.16	-1.38
			(-0.58)	(-0.67)
lexpogdp	1.06	1.02	3.65*	2.93**
	(0.80)	(0.76)	(2.80)	(2.24)
lcreditpriv	-0.62	-0.70	0.82	0.77
	(-0.53)	(-0.59)	(0.69)	(0.65)
lpubinv	0.48	0.53	-0.61	-0.47
	(0.54)	(0.59)	(-0.63)	(-0.49)
lpopgr	0.46	0.40	-1.21	-1.18
	(0.28)	(0.24)	(-0.67)	(-0.66)
ladlit	-18.07*	-18.64*	2.94	1.85
	(-3.61)	(-3.66)	(1.24)	(0.75)
tdsxgs	-0.09**	-0.09**	-0.11**	-0.11**
	(-2.13)	(-2.14)	(-2.52)	(-2.43)
ltedgdp	2.96*	3.04*	1.63***	1.57***
	(3.30)	(3.37)	(1.79)	(1.75)
linflcpi	-0.02	-0.03	-0.02	0.07
	(-0.05)	(-0.10)	(-0.06)	(0.20)
budbal	0.01	0.01	0.00	0.01
	(0.09)	(0.09)	(0.05)	(0.09)
bmprem	0.00***	0.00***	0.00	0.00
	(-1.70)	(-1.66)	(-1.36)	(-1.43)
lm2gdp	2.22	2.09	0.33	0.81
	(1.41)	(1.32)	(0.19)	(0.48)
totgr	0.01	0.01	-0.02	-0.01
	(0.27)	(0.31)	(-0.50)	(-0.40)
larea		-14.75		-0.86
		(-0.89)		(-1.31)
oil		(dropped)		9.00*
				(2.58)
landlock		-5.44		0.07
		(-0.60)		(0.03)
_cons	51.50*	234.53	-6.96	7.31
	(3.09)	(1.14)	(-0.57)	(0.45)
Obs	228	228	228	228
Hausman chi2			39.87	19.99
Prob>			0.0001	0.1304

The values in parentheses are the t-ratios. *, ** and *** denote significance at 1%, 5% and 10%, respectively. All regressions include a time dummy

Source: Author's calculations

Annex 7: Quadratic regression of private investment on debt

Dependent variable is private investment as a percentage of GDP

	Fixed Effects		Random Effects	
	1	2	1	2
Debt service	-0.09**	-0.09**	-0.12*	-0.11**
	(-2.17)	(-2.18)	(-2.59)	(-2.49)
Debt to GDP	-0.01	-0.02	-0.02	-0.02
	(-0.55)	(-0.74)	(-1.20)	(-1.20)
log(Debt to GDP)2	1.73*	1.87*	1.36**	1.32**
	(2.71)	(2.86)	(2.11)	(2.09)
No. of Obs.	228	228	228	228
Hausman	chi2		38.49	24.6
	Prob>chi2		0.000	0.056

The values in parentheses are the t-ratios.*, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy and other explanatory variables listed in annex 6.

Source: Author's calculations

Annex 8: Dummy variable regressions of private investment on debt

Dependent variable is private investmant as a percentage of GDP

	Fixed	Effects	Random	Effects
	1	2	1	2
tdsxgs	-0.06	-0.06	-0.09***	-0.08***
	(-1.45)	(-1.49)	(-1.94)	(-1.85)
Quintile 2	4.38*	4.51*	3.55*	3.46*
	(3.63)	(3.71)	(2.72)	(2.70)
Quintile 3	3.28**	3.56**	2.33	2.08
	(2.14)	(2.29)	(1.43)	(1.30)
Quintile 4	3.27***	3.48***	0.81	0.66
	(1.72)	(1.81)	(0.42)	(0.34)
Quintile 5	3.55	3.52	1.42	1.11
	(1.62)	(1.60)	(0.64)	(0.51)
Constant	50.73*	228.87	-2.33	11.79
	(2.92)	(1.10)	(-0.19)	(0.73)
No of obs.	228	228	228	228
Hausman	chi2		28.270	40.580
	Prob>chi2		0.049	0.002

The values in parentheses are the t-ratios. *, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy and other explanatory variables listed in annex 6.

Source: Author's calculations

Annex 9: Linear impact of debt /GDP on Human Capital Accumulation.

Dependent variable is average years of schooling for total population above age 15

	Fixed Effects		Random Effects	
	1	2	1	2
Debt service	0.003	0.003	0.004	0.004
	(0.92)	(0.92)	(1.12)	(1.07)
Debt to GDP	-0.217**	-0.217**	-0.317*	-0.324*
	(-2.42)	(-2.42)	(-3.60)	(-3.67)
No of Obs.	154	154	154	154
Hausman	Chi2		11.41	18.52
	Prob>chi2		0.3267	0.0468

The values in parentheses are the t-ratios.*, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy and other explanatory variables listed in the second and third columns of annex 3.

Source: Author's computations

Annex 10: Quadratic regression of human capital accumulation on debt

Dependent variable is average years of schooling for total population above age 15

	Fixed Effects		Random Effects	
	1	2	1	2
Debt service	0.004	0.004	0.004	0.004
	(0.98)	(0.98)	(1.10)	(1.04)
Debt to GDP	0.001	0.001	0.000	0.000
	(0.33)	(0.33)	(-0.04)	(-0.06)
log(Debt to GDP)2	-0.125***	-0.125***	-0.153**	-0.158**
	(-1.90)	(-1.90)	(-2.36)	(-2.44)
No of Observations	154	154	154	154
Hausman	Chi2		25.24	20.54
	Prob>chi2		0.000	0.000

The values in parentheses are the t-ratios.*, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy and other explanatory variables listed in annex 3.

Source: Author's calculations

Annex 11: Dummy variable regressions of Human Capital on debt

Dependent variable is average years of schooling for total population above age 15

	Fixed	Effects	Random Effects	
	1	2	1	2
tdsxgs	0.000	0.000	0.002	0.001
	(0.11)	(0.11)	(0.46)	(0.35)
Quintile 2	-0.310*	-0.310*	-0.382*	-0.387*
	(-2.69)	(-2.69)	(-3.07)	(-3.17)
Quintile 3	-0.136	-0.136	-0.272***	-0.280***
	(-0.89)	(-0.89)	(-1.70)	(-1.78)
Quintile 4	-0.409**	-0.409**	-0.694*	-0.701*
	(-2.22)	(-2.22)	(-3.87)	(-3.94)
Quintile 5	-0.644*	-0.644*	-0.799*	-0.844*
	(-2.64)	(-2.64)	(-3.44)	(-3.59)
_cons	7.117*	7.117*	-7.813*	-6.832*
	(3.45)	(3.45)	(-5.86)	(-3.54)
No. of Obs.	154	154	154	154
Hausman	chi2		16.160	21.980
	Prob>chi2		0.241	0.056

The values in parentheses are the t-ratios.*, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy and other explanatory variables listed in annex 3.

Source: Author's calculations

Annex 12: Linear impact of debt /GDP) on Total Factor Productivity (TFP)

Dependent variable is total factor productivity (in log)

	Fixed	Effects	Random Effects	
	1	2	1	2
Debt service	0.000	0.000	0.000	-0.001
	(-0.37)	(-0.40)	(-0.46)	(-0.54)
Debt to GDP	-0.062**	-0.064**	-0.057***	-0.064**
	(-2.04)	(-2.09)	(-1.95)	(-2.25)
No of observations	127	127	127	127
Hausman	chi2		235.4	14.74
	Prob>chi2		0.0000	0.3238

The values in parentheses are the t-ratios.*, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy and other explanatory variables listed in annex 3.

Source: Author's calculations

Annex 13: Quadratic regression of TFP on debt

Dependent variable is total factor productivity (in log)

	Fixed Effects		Random Effects	
	1	2	1	2
Debt service	0.000	0.000	0.000	-0.001
	(-0.43)	(-0.40)	(-0.43)	(-0.53)
Debt to GDP	0.000	0.000	0.000	0.000
	(-0.40)	(-0.06)	(0.14)	(0.01)
log(Debt to GDP)2	-0.025	-0.031	-0.030	-0.033***
	(-1.24)	(-1.47)	(-1.45)	(-1.66)
No of Obs.	127	127	127	127
Hausman	chi2(12)		9.17	26.09
	Prob>chi2		0.6887	0.0104

The values in parentheses are the t-ratios.*, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy and other explanatory variables listed in annex 3.

Source: Author's calculations

Annex 14: Dummy variable regressions of TFP on debt

Dependent variable is total factor productivity (in log)

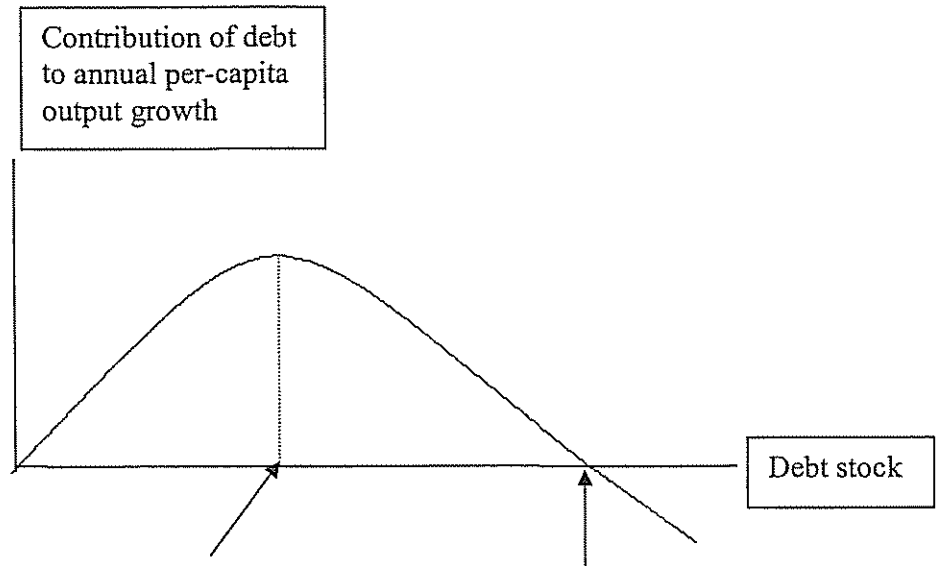
	Fixed Effects		Random Effects	
	1	2	1	2
tdsxgs	0.000	0.000	0.000	0.000
	(-0.31)	(-0.27)	(-0.38)	(-0.15)
Quintile 2	-0.016	-0.024	-0.002	0.080
	(-0.37)	(-0.56)	(-0.06)	(1.29)
Quintile 3	-0.094***	-0.108**	-0.075	0.052
	(-1.81)	(-2.05)	(-1.36)	(0.68)
Quintile 4	-0.136**	-0.149**	-0.120***	0.018
	(-2.16)	(-2.34)	(-1.82)	(0.20)
Quintile 5	-0.128***	-0.128***	-0.087	0.087
	(-1.87)	(-1.87)	(-1.25)	(0.99)
_cons	0.841	-2.520	-0.960*	-3.071*
	(1.52)	(-0.50)	(-2.97)	(-8.02)
No of obs.	127	127	127	127
Hausman	chi2		99.650	112.110
	Prob>chi2		0.000	0.000

The values in parentheses are the t-ratios.*, ** and *** denote significance at 1%, 5% and 10%, respectively

All regressions include a time dummy and other explanatory variables listed in annex 3.

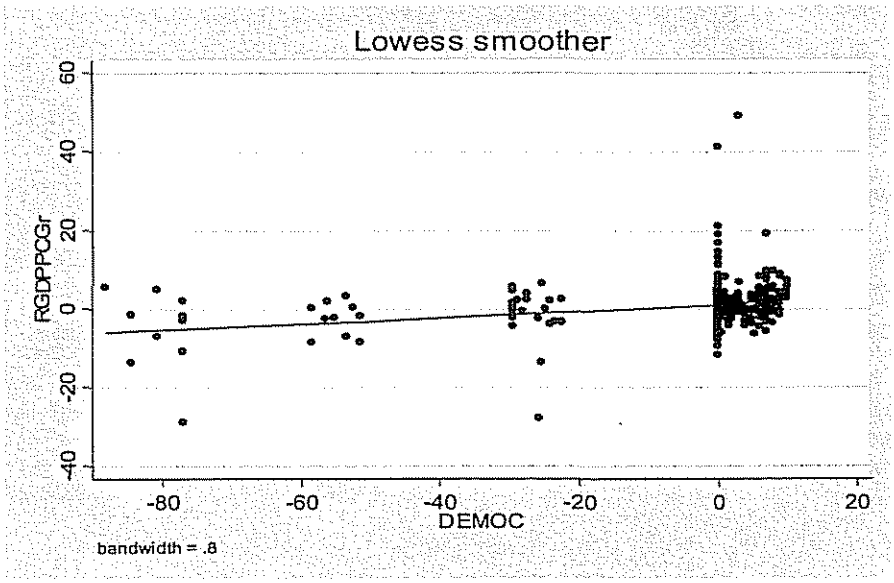
Source: Author's calculations

Annex 15: Inverted U-Shaped (Quadratic type) Debt Laffer Curve



Source: adopted from Pattillo et al (2002)

Annex 16: Lowess Smoother for democracy and per capita GDP growth



Source: Author's own graphing using the dataset for the regressions.