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SCHOOL OF GRADUATE STUDIES

THE ANALYSIS OF BEHAVIOR OF PRIVATE INVESTMENT IN RESPONSE TO FISCAL POLICY CHANGES IN SUB-SAHARAN AFRICA

BY

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A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirement for the Degree of Master of Science in Economics (Economic Policy Analysis)

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DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in any other university. All the resources of materials used in the thesis have been duly acknowledged.

Declared by:

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Addis Ababa, Ethiopia

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ACRONYMS

AIDS – Acquired Immune Deficiency Syndrome

GDP – Gross Domestic Product

HIPC – Highly Indebted Poor Countries

HIV – Human Immune Virus

IMF – International Monetary Fund

UN – United Nations

USD – United States Dollar

WB – World Bank

Abstract

Despite the belief that fiscal policy can influence both economic growth and private investment., attempts like the Structural Adjustment Program and Poverty Reduction Strategic Papers have not yet brought that much promising results in Sub- Saharan Africa. If so, *Can policy makers help enhance the performance of private investment in the region through fiscal policy changes?* In an attempt to answer this question, annual panel data for the period 1986- 2003 for twenty three countries in the region was utilized. The data set depicted the persistence of heterogeneity among the countries. The fixed effects model was applied based on the specification tests. The regression output indicated that private investment is positively responsive to previous period fiscal policy measures, per capita GDP and its growth rate. However, current period fiscal policy measures, domestic credit to the private sector, real exchange rate, inflation, and the size of government control in the exchange rate market appeared insignificant in affecting private investment in the region. Debt servicing significantly and negatively discouraged private investment, while debt stock was not found doing so. The conclusion is that previous period policy measures are more influential in promoting private investment in Sub Saharan Africa. A high debt servicing reduces resource availability for domestic investment immediately than huge external debt stock, whose repayment may be cancelled, at least based on conditions, as observed in HIPCs case.

Key words: - Fiscal policy, panel estimates, private investment, Sub- Saharan Africa

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Sub-Saharan Africa is generally described as the poorest region of the world; one that is getting poorer in the face of sustained growth and significant improvement of living standards in the rest of the world [WB (2005a), UN (2005), cited in Bayraktar & Fofack, 2007]. Virtually all countries in the region have been confronted with deep-rooted developmental constraints: rapid population growth, low physical and human capital development, and inadequate infrastructure, etc... These and other similar economic problems have constituted major impediments to private sector development and to their economies in general. In addition, ethnic conflicts, political instability, and adverse security conditions have aggravated the economic performance of several countries in the region. These all have been putting huge obstacles to the capital formation in the subcontinent- one of the very crucial factors of production for the progress of economies.

Private investment is essential for ensuring economic growth, sustainable development and poverty reduction. It increases the productive capacity of an economy, drives job creation, brings innovation and new technologies, and boosts growth. To quote Agenor & Montiel (1996) pp 81 "*private investment plays an important role in developing nations for the same reason that it does in industrial countries: investment determines the rate of accumulations of physical capital and is thus an important factor in the growth of productive capacity."* However, the amount of physical capital in general and private investment in particular falls short of development needs in these countries. Several studies, such as Anyanwu (2006),

Bayraktar & Fofack (2007), and Mlambo & Oshikoya (2001), show that the contributions to growth of physical capital and total factor productivity in Sub- Saharan Africa (SSA) have been low and have declined over time. The following table is extracted from Bayraktar & Fofack (2007).

Table 1-1 Capital accumulation in Sub- Saharan Africa during 1980-2004 (%age of GDP)

Country Category[1]	Capital Type		
	Private	Public	Total
High income	16.19	7.75	23.90
Middle income	11.24	7.82	18.40
Low income	6.71	7.20	13.68
SSA	11.38	7.59	18.81

Source: - N. Bayraktar & H. Fofack (2007)

According to the neoclassical growth models, such as Solow (1956), economic policies do not affect steady state economic growth, although they can affect the level of output or its growth rate when the economy is in transition from one steady state to another.

However, these days it is believed that macroeconomic policies may affect economic growth either directly through their effect on the accumulation of factors of production, namely capital, or indirectly through their impact on the efficiency with which factors of production are used. Macroeconomic stability-reflected in low and stable inflation, sustainable budget deficits, and appropriate exchange rates-sends important signals to the private sector about the direction of economic policies and the credibility of the authorities regarding their commitment to manage the economy efficiently. Such stability, by facilitating long-term

[1] Low income countries have average per capita income below USD 325, those with middle income have a per capita income between USD 325 and USD 1000, and high income countries have an average per capita income of USD 2760

planning and investment decisions, encourages savings and private capital accumulation (Ghura & Hadjimichael, 1995).

Specifically, endogenous growth models have shown that fiscal policy can have significant effects on economic growth in the long run. For example, in a model that assumes constant returns to scale with respect to government inputs and private capital combined but diminishing returns with respect to private capital alone, Barro (1989 & 1990) has shown that high levels of government taxation distort savings decisions, which in turn lower economic growth in the steady state. Fiscal policy can foster growth and human development through a number of different channels. These channels include the macroeconomic (for example, through the influence of the public investment, as a catalyst, on private investment) as well as the microeconomic (through its influence on the efficiency of resource use) channels.

1.2 Statement of the Problem

The rate of return on both capital and labor and the overall productivity of the Sub- Saharan African economies remain low because of a variety of distortions and institutional deficiencies. The problems include obstacles to international trade, overvalued exchange rate, poor infrastructure, bad governance & corruption, insufficient competition & monopolistic structures in many of the sectors, etc… It has always been argued, in one way or another, that all of these problems are related to the public policies formulated in these countries.

Since 1980s, extensive efforts have been directed at generating economic recovery in Africa through Structural Adjustment Program (SAP) and other similar programmes. However, little (or only recently) attention has been given to the need to promote private investment, although investment is essential in any country for a number of economic reasons. Policy

makers have not tended to give much practical attention to the link between private investment and socio-economic progress. The Structural Adjustment Programme of the World Bank (WB) and the International Monetary Fund (IMF), aiming to address the problem of poverty, emphasize the need to reduce government budget deficits. According to the WB and the IMF, reducing the role of the government would reduce barriers to the economic endeavors. Despite these efforts, the continent's poor economic performance has been persistent due to, among others things, the low levels of private investment as the share of GDP in the subcontinent. This opens a door for suspicion of those policies formulated by these two organizations. However, there is a need to emphasize that the aim of this study is not to attest whether the public policies designed by the WB and/ or the IMF, particularly for the developing world, such as the SSA region, are correct or not. Rather, the paper simply tries to investigate the effectiveness of fiscal policy measures in enhancing the performance of private investment in the region.

There is also lack of unanimity in the empirical findings as to the crowding-in/ crowding-out effects of public investment on private investment. Research outputs often conflict with one another on the issue. For instance, while some have identified positive effects of government investment spending on private investment (Greene & Villanueva (1991)[2], Oshikoya (1994), and Ghura & Goodwin (2000)[3]), others have found the other way round (for example Balassa (1988)).

Moreover, the fewness of studies on private investment behavior in developing countries in general and in SSA in particular provides a rationale for new research contributions. This

[2] Cited in Fitzgerald et al (1992)
[3] Cited in Everhart & Sumlinski (2001)

paper tries to show how private investment is responsive to public policies, among other things, particularly to fiscal policy changes in the sub-continent. Moreover, we incorporate some other factors of interest in order to indicate the relative importance of our fiscal policy variable in explaining the behavior of private investment in SSA.

1.3 Objective of the Study

As stated above, the economies of the sub-continent, in general terms, is not functioning well. A few problems, among others, are also mentioned to show that the topic in hand is quite important. *Can policy makers help enhance the performance of private investment in the region by improving conditions through fiscal policy changes?* The primary objective of the paper is to examine the fiscal policy effects on private investment for a panel of twenty three Sub- Saharan African countries. In doing so, the paper gives attention to the heterogeneity of the countries in the sub- continent. We aspire to contribute to the empirical literature on the effect of fiscal policy, proxied by public investment, on the performance of private investment in the region. In particular:

- The paper tries to show how much the countries in our sample of study are heterogeneous in terms of their macroeconomic performance, which would help us select the appropriate tool of analysis;
- It tries to look at the crowding-in/ crowding-out effect of public investment on private investment in the region. This is of course assumed to show the effectiveness of fiscal policy in enhancing private investment in the region.
- The paper tries to investigate the relative importance of fiscal policy in boosting the availability of private investment in the sub-continent. We make comparisons among the determinants of private investment and deduce the level of importance

of public investment in explaining the behavior of private investment in the sub-continent.

- Finally the paper indicates some possible policy implications.

1.4 Data and Methodology

The Data

The major data sources for the problem under investigation are the WB's World Development Indicators and the WB's African Development Indicators. Effort would be exerted to fill the missing values using alternative sources like the IMF's International Financial Statistics, and Everhart & Sumlinski (2001). Since we are going to use diversified data from various sources, data discrepancy is obvious to occur. To shade light on problems behind the data sources, information on private investment and specific components of fiscal policy variables in developing countries, especially in SSA, is limited reducing the number of countries and the length of time period in our analysis.

The Methodology

The paper does a macro level analysis, thus firm level investment models are irrelevant here. Because the dataset is short and wide, and the focus is on cross-section variation, a panel data econometric analysis is more suited to the problem under investigation. The econometric analysis of private investment in the paper is based on a panel of twenty three Sub Saharan African countries for the period 1986- 2003 based on the availability of the required dataset. We try to incorporate a comprehensive set of explanatory variables in the model that are supposed to explain the actual behavior of private investment in the sub- continent.

We will make a choice among the various alternative panel models based on specification tests. However, for a while we state that the fixed effects model is best suited for the analysis of the problem under investigation. The main reason behind our choice is that, it would be difficult to assume that the unobserved heterogeneity in each country is independent of the other determinants of private investment. In addition, since such a model involves both cross sectional and time elements, tests for heteroscedasticity and autocorrelation is very crucial. Hence, modification of this basic model would be inevitable during the analysis of the paper.

1.5 Working Hypothesis

Based on empirical literature on private investment in developing countries, we propose the following relationships to hold true in our analysis.

- Public investment has a crowd- in effect on private investment in SSA.
- The GDP per capita of Sub- Saharan African countries and its growth rate will have significant positive impact on the performance of private investment in the region.
- Credit availability to the private sector has a significant positive impact on private investment, while real interest rate does not affect private investment in the region.
- Macroeconomic instability variables, such as inflation, real exchange rate, debt stock, and debt service are expected to affect private investment negatively.

The validity of all these statements will be investigated in the fourth section of the paper.

1.6 Significance of the Study

The WB and the IMF are criticized on many accounts. However, the criticism which is common in academic and policy makers circle is their 'one-size-fits all' approach in formulating stabilization policies. It is a day light fact that most of the developing countries

that seek the Bank's and the Fund's intervention (or help) in the event of macroeconomic crisis are treated identically irrespective of their ill-type. Fiscal policy prescriptions from the two agents are not different. We argue that countries are different to one another in many aspects, such as in their institutional setup, geographical location, natural resource endowment, etc... The paper will be helpful in showing how country specific factors are significantly important in fiscal policy formulation to enhance private investment and hence economic progress in the subcontinent.

Moreover, the paper contributes to the existing literature by extending the works of others on fiscal policy devices- for enhancing private investment in SSA by applying panel econometric models. This would give policy makers in developing countries a clue for better policy formulation, because identifying the most significant determinants of private investment and indicating those that fall within the domain of the public policy choices will help improve effectiveness of reform measures taken by government bodies.

The paper also sheds light on the relative importance of fiscal policy measures in enhancing private investment by explicitly modeling the effects of public investment and some other macro variables on private investment. This shows the alternative measures that the government bodies may take in order to accelerate the performance of private investment in the region.

1.7 Limitation of the Study

This research work is basically limited by the availability of data. Information on private investment and the specific components of fiscal policy for developing countries in general and for SSA in particular appears to be limited and of less quality. For example, we are

confined to take public investment as a sole variable of fiscal policy measures taken by government bodies. This is basically due to the unavailability of data on the other fiscal policy variables, such as tax revenue and government budget deficit, in the region. Besides, the demarcation of private investment and public investment depends on the way government bodies treat the variables. So discrepancy in definitional issues is obvious to occur in this regard. This will limit the scope of our inference, which in turn will considerably reduce the power of the conclusiveness of output of the whole work. Moreover, we are forced to analyze the problem within a moderately short period limiting our inference to apply to the short run. Finally, as the topic under investigation is too broad, financial and time variables have also played their role in limiting the capacity of the researcher.

1.8 Organization of the Paper

The next section discusses the theoretical and empirical literature on private investment and fiscal policy issues. Section three presents the data type & sources and its descriptive analysis. More over, we show the strength of the pair- wise relationship among the macro-variables in our analysis. This is followed by the discussion of specification of our empirical model. At the end of the chapter, we propose a feasible econometric model that, we believe, would be most fit to the problem under investigation. The fourth chapter discusses on the diagnostic tests, and the regression results. Finally, conclusions and policy implications would be forwarded at the end of the paper.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

Private investment is essential for ensuring economic growth, sustainable development and poverty reduction. It increases the productive capacity of an economy, drives job creation, brings innovation & new technologies, and boosts income growth. Unfortunately, policy makers do not tend to give much practical attention to such a link between investment and socio- economic progress. Thus the amount of private investment, particularly in African and other developing economies, falls short of development needs. And the benefits of investment in emerging and transition economies are much better reaped than those by the African nations.

The quality of investment policies in the sub- continent is so very poor that it influences the decisions of all investors, be they small or large, domestic or foreign, in undetermined way. Transparency, property protection and non discrimination are all the poor. According to United Nations Economic Commission for Africa, (1995), Policies currently being implemented or considered, no matter how genuine, cannot revive the continent's ailing economies unless they accord investment the attention it deserves.

Endogenous growth models are able to generate a linkage between public policies and growth in the long run by assuming aggregate production functions that exhibit non-decreasing returns to scale. These models, particularly those by Barro (1991), Barro and Sala-i-Martin (1992), Khan & Kumar (1993), and Mankiw, Romer, & Weil (1992), show that macroeconomic policies may affect economic growth either directly through their effect on the accumulation

of factors of production, namely capital, or indirectly through their impact on the efficiency with which factors of production are used. These growth models have shown that fiscal policy can have significant effect on economic growth in the long run. For example, in a model that assumes constant returns to scale with respect to government inputs and private capital combined but diminishing returns with respect to private capital alone, Barro (1989 and 1990) shows that high levels of government taxation distort savings decisions, which in turn lower economic growth in the steady state. Barro & Sala-i-Martin (1992) also indicates that if the social rate of return on investment exceeds the private return, then tax policies that encourage investment can raise the growth rate and levels of utility.

Hence, these days it is agreed that public policies, among which fiscal policy is one, can play a significant role in the development endeavor of economies. More recently, Hermes & Lensink (2001) shows that fiscal policy can enhance the economic growth of a country if it aims at influencing the quantity and quality of capital stock in the economy. In general, government policies are critical in determining the rate of economic growth, the levels of private investment and the magnitude of credit to the private sector.

2.1 The Theory of Private Investment and Fiscal Policy

2.1.1 The Theory of Private Investment

In common terms, investment is defined as the capital formation in the production process. However, the theory of private investment is still one of the unsettled issues in economics. Bearing this in mind, in the following paragraphs, we try to revise some of the approaches that have been followed to explain the behavior of investment.

To start with, J. M. Keynes, in his "The general theory of employment, interest, and money", introduced the idea of an independent investment function in an economy. According to Keynes, investment depends on future marginal return to capital relative to the invested fund. He argued that investment decisions are made on uncertain basis making the returns to investment uncertain too. Thus, for Keynes, private investment is highly volatile because investment decisions are affected by the pessimistic and/or optimistic behavior of investors- the so called 'animal sprit' of investors.

Following Keynes, the accelerator theory of investment was propagated in 1950s and 1960s. As cited in Luintel & Mavrotas (2005), the accelerator model of investment, originated mainly by Clark (1917) with further modifications by Chenery (1952) and Koyck (1954), assumes that the desired capital stock at any point in time is a constant multiple of output at that time. According to this theory, investment is a linear function of output changes; i.e. changes in sales and income causes changes in investment. Here the firm is assumed to keep a stable relationship between the capital stock it desires to maintain and the level of output. A key implication of this model is that investment (change in capital stock) is driven by change in aggregate demand. This model, however, disregards the role of profitability, expectations, and the cost of capital in its analysis. Nonetheless, this model often better explains investment behavior than the more recent sophisticated models.

In reaction to these weaknesses, a flexible neoclassical accelerator model of investment was developed in 1960s. This model, pioneered by Dale Jorgenson (1963) and followed by its (1967) and (1971) versions, combines the user cost of capital and the accelerator effect to explain investment behavior. In this model, the firm is assumed to own most of the capital

stock. The firm can either sell the stock or make use of it. But if the firm uses its stock, some costs are inevitable to be incurred. The costs include the forgone interest income that the firm generates had it sold the stock, the depreciation cost that comes with time, and the change in the market value (price) of capital over time (this takes negative value if the value of capital appreciates and positive otherwise). In such a model investment tax credits can be incorporated and if so, they would be deducted from the user cost as they are incentives to the investors.

According to Romer (1996), there are two basic problems with this type of model. The first relates to the impact of exogenous variables on investment. The model assumes that a discrete change in one of the exogenous variables leads to a discrete change in the desired level of capital. For example, if the National Bank reduces interest rate by a discrete amount, the model implies that it discretely reduces the cost of capital and hence the capital stock rises discretely. However, since the rate of change of the capital stock equals investment minus depreciation, a discrete change in capital stock requires an infinite rate of investment. For the economy as a whole, however, investment is limited by the economy's output; thus aggregate investment cannot be infinite. The second problem is that the model does not identify any mechanism through which expectations can affect investment demand. Yet in practice expectations about demand and costs are central to investment decisions: firms expand their capital stock when they expect their sales to be growing and the cost of capital to be low and vice versa. Thus we need to modify such a model by incorporating adjustment cost, be internal or external to the firm, to see a reasonable picture of investment function.

After the flexible accelerator model of Jorgensen was established, only two years were elapsed to enjoy another strand of theory of investment - primed by James Tobin (1969). The model –

Tobin's Q model – summarizes all information about the future that is relevant to a firm's investment decision. In general terms Q is interpreted as the change in the present value of the profit of the firm due to a unit change in its capital stock. *It shows how an additional dollar of capital affects the present value of profits*. The firm does not need to know anything about the future other than the information summarized in Q in order to make decision: if Q is high enough the firm increases its capital stock and vice versa. The model provides some implications due to the effects of change in output, interest rates, and tax policies. For example, in Romer (1996), we find that a permanent increase in output leads to a temporary increase in investment, because capital stocks cannot adjust instantly to such changes. Thus it is not just current output but its entire path over time that affects investment. In other words investment would be higher when output is expected to be higher in the future than when it has been higher.

All these being the varieties of investment theories in the academic circle, we have stated in the introductory part of this paper that they are studied using the institutional set up of the developed economies. Hence it is highly unlikely that they would reflect the investment behaviour of economies in SSA and other developing regions in the world. The analysis of the behavior of private investment in developing countries in general and that of SSA in particular is neither as numerous nor, as owing to data limitations, as conclusive as those for the developed nations.

2.1.2 The Theory of Fiscal Policy

According to the neoclassical growth models, such as the one by Solow (1956), the share of government expenditure in output, or the composition of expenditure and revenue does not

affect the long- run growth rate of an economy. In these models, tax and expenditure measures that influence the savings rate or the incentive to invest in physical or human capital ultimately affect the equilibrium factor ratios rather than the steady-state growth rate. The model indicates that growth is driven by exogenous factors- the dynamics of population and of technological progress; and fiscal policy can only affect the rate of growth during the transition to the steady state.

However, recent growth models, such as the endogenous growth model, have generated a linkage between public policies and growth in the long run. According to these models, macroeconomic policies may affect economic growth either directly through their effect on the accumulation of factors of production, namely capital, or indirectly through their impact on the efficiency with which factors of production are used. Macroeconomic stability-reflected in low and stable inflation, sustainable budget deficit, and appropriate exchange rate-sends important signals to the private sector about the direction of economic policies and the credibility of the authorities regarding their commitment to manage the economy efficiently. Such stability, by facilitating long-term planning and investment decisions, encourages savings and private capital accumulation (Ghura & Hadjimichael, 1995).

The theoretical literature on the relationship between fiscal policy and growth has grown substantially since the mid-1980s, when the endogenous growth models emerged. The models try to show that the process of economic growth is endogenously determined. A crucial difference with the neo-classical growth models is that these new growth models do not assume diminishing marginal productivity of capital. In endogenous growth models investment in human and physical capital ***does*** affect the steady-state growth rate, and

consequently there is much more scope in these models for at least some elements of tax and government expenditure to play a role in the growth process. Since the pioneering contributions of Barro (1990), King & Rebelo (1990) and Lucas (1990), several papers have extended the analysis of taxation, and public expenditure and growth, demonstrating various conditions under which fiscal variables can affect long-run growth. For example, Chhibber & Dailami (1990) argues that a disproportionate share of the change of economic growth of countries is explained by change of private investment as a result from changes in fiscal policy. Hence, according to these models, economic policy – among which fiscal policy is one - can increase the steady- state economic growth if policies aim at influencing the quality and/or quantity of the capital stock in the economy.

Fiscal policy variables, or in other words- instruments, include elements such as taxes, public expenditures, and budget deficits. Endogenous growth models state that the exact nature of the impact of fiscal policy on economic growth depends on the type of fiscal policy instruments used. In particular, growth effects of fiscal policy can be divided into productive & non productive expenditures, and distortionary & non- distortionary taxes. Kneller et al. (1999)[4], for example, finds that distortionary taxation reduces growth, whilst non-distortionary taxation does not; and productive government expenditure enhances growth, whilst non-productive expenditure does not.

Bearing all these in our mind, we should have reservations in that though governments have long been conducting fiscal and monetary policies to stabilize the economy and achieve the desired level of the aggregate variables of the economy, it requires an empirical investigation

[4] Cited in Hermes, N. and Lensink, R. (2000)

to confirm whether these efforts have been made to achieve those stated objectives. This is to indicate that policies, be fiscal, monetary or exchange rate, are conducted not only from economic objectives perspective. Political and other interests of the government bodies are also reflected, in one way or another, in conducting policies. Apart from the above problem in policy making, changes in taxes and/or expenditures may not necessarily indicate changes in fiscal policy. In any ways, however, government policies are critical in determining the rate of economic growth, the levels of private investment and the magnitude of credit to the private sector.

2.2 Empirical Literature on Private Investment and Fiscal Policy in Sub-Saharan Africa

2.2.1 Empirical Literature on Private Investment in Sub- Saharan Africa

As mentioned above, direct application of the models of investment, revised in the first subsection, to the economies of the developing world would be illogical due to the scarcity of data on key variables of the analysis and the incompatibility of the institutional and structural setup of the developing world to the underlying assumptions of the models. Several studies, such as Oshikoya (1994), and Seyoum (2002), argue that data on variables such as wage rates, capital stock, real interest rates and stock market prices are hardly available; and assumptions of the basic models such as perfectly competitive markets, little or no government investment and absence of liquidity constraints are hardly acceptable in the context of developing countries making the models less relevant. Thus, these basic problems have prevented a successful establishment of an empirical investment function based on the investment theories mentioned in section 2.1.1.

As one of the major determinants of economic growth, private investment has been investigated extensively in the literature. However, in spite of the abundance of investment models available, very few are devoted to the study of private investment in Africa.

In developing economies, in general terms, the impact of investment on economic development depends on the country's economic conditions and policies, the business policies and strategies, as well as the sector in which the company is located. Specifically aggregate private investment, in the Sub- Saharan African context, is a function of variables such as GDP per capita, GDP per capita growth, availability of credit, fiscal policy variables- such as government capital expenditure (public investment) and government revenue-debt burden, real exchange rate, and measures of irreversibility and uncertainty. The following paragraphs are devoted to discuss the strength of each of these variables in explaining the behavior of private investment in the developing economies with particular emphasis on Sub-Saharan African region.

One of the few variables that are robustly correlated in economics are GDP per capita & its growth and private investment. For example, Blomstrom et al (1996) shows that rapid growth of GDP per capita leads to higher capital formation. Similarly, Oshikoya (1994), using 18 years aggregate data for eight African countries, indicates that private investment is positively related to the growth of real output. The relationship can be derived from a flexible-accelerator model with the assumption that the underlying production function has a fixed relationship between the desired capital stock and the level of real output. Cited in Oshikoya (1994), Green & Villanueva (1990) asserts that countries with higher per capita income could devote more resources to domestic savings, which could be used to finance investment projects. The relationship may also be bidirectional. For example, Levine & Renelt (1992),

using annual panel data for 119 countries for the period 1960- 1989, and applying the extreme bounds analysis, shows that private investment is one of the very few variables that have a positive robust correlation with GDP per capita growth.

These days it is a common belief that firms in developing countries have limited access to credit. Thus, it is sensible to incorporate availability of credit to the private sector as a determinant of private investment in developing countries instead of relying only on interest rates which are administratively controlled. The direct impact of credit availability on private investment is confirmed in several studies. For example, Oshikoya (1994), using ordinary least square method on aggregate data for the period 1970- 1988, shows that changes in volume of bank credit to the private sector have positive impact on private investment activity among African countries. Unlike the well- established firms in developed countries, the paper further indicates, bank credit remains the most important source of investment financing among private enterprises in developing countries. According to the findings of this work, in Sub- Saharan African countries, where financial markets are generally repressed, credit policy affects investment directly through the stock of credit available to firms that have access to preferential interest rates rather than through the indirect interest channel.

In the neoclassical model of investment, interest rate is treated as one of the user cost of capital. However, several empirical studies of private investment, such as Oshikoya (1994) and Seyoum (2002), did not show direct evidence of this relationship in Sub- Saharan African countries case. Instead, these studies reflected the importance of the underlying conditions of credit and interest rate regulations in financial markets in the region. Nevertheless, some evidences, using data from countries which have undergone financial liberalization, shows that

the real cost of credit, rather than the quantity of credit is a powerful explanatory variable. For example, using Indonesian data for the period 1970-88, Chhibber & Shafik (1990) shows a very significant negative relationship between private investment and real interest rate. However, here mention should be made of the fact that most Sub Saharan African countries have yet to undergo financial liberalization. Thus credit accessibility is expected to be a more significant factor (than the interest rate) in affecting private investment in the region.

The other variable of interest is government investment. The effect of government investment on private investment is ambiguous in the sense that while some studies show the existence of positive relationship between the two variables, others indicate that there is a negative relationship. The possible 'crowding in' or 'crowding out' outcomes regarding this relationship has received considerable attention in the private investment literature. The following paragraphs show the case in hand.

Government investment has been used in empirical studies as a direct proxy for the government's contribution to capital accumulation, as well as an indicator of the adequacy of basic economic and social infrastructure. Several empirical studies have attempted to shed light on this issue. A study by Blejer and Khan (1984), cited in Serven & Solimano (1992), based on cross-country data concludes that government investment in infrastructure is complementary with private investment while other types of government investment are not. Even Serven & Solimano (1992) itself arrived at similar conclusions based on multi-country panel data. Musalem (1989) - cited in Serven & Solimano (1992) – indicates that private and public investments were complementary in a time-series study of private investment in Mexico. Chhibber & Dailami (1990) also shows that to the extent public investment expenditures result in the provision of public services which reduce the cost of production of

the private sector, they have a positive effect on private profitability and investment. Higher aggregate public investment expenditures can also raise demand and increase capacity utilization in the private sector.

On the other side, public investment expenditures are assumed to crowd- out the private sector in input and product markets, or even in financial markets. Given the relatively high dependence of business enterprises in developing countries on debt capital, particularly bank loans to finance their investment and growth, the spirit of 'financial crowding out' is rather serious. Private sector companies are prone to face much more tough credit supply constraints from the banking sector rather than their public sector counterparts. Besides, private companies are excluded from the resources of non-banking financial institutions, such as insurance and pension fund companies. Access to these resources is reserved exclusively for public sector companies and often at subsidized rates. Balassa (1988), using cross-section estimates, argues that an increase in public investment leads to a decline in private investment. Furthermore, it indicates a finding that confirms a negative correlation between the share of public investment in total investment and the size of incremental capital-output ratios, which indicates that public investment is less efficient than private investment.

Seyoum (2002) supports the crowding out effect and elaborates it in the following fashion. The crowding out effect of public investment in developing countries may not be felt through higher taxes and/or increased interest rates as in industrial countries; rather it is likely to take one or all of the following three forms. First, limited market size in many developing countries implies public investment in productive sectors may displace private ventures, causing a strong crowding out. Second, financial crowding out may take place as both agents run for the same and often limited credit pool. And finally financing public investment through domestic

and/or foreign borrowing could crowed out private investment through its effect on inflation and debt accumulation which render the business environment uncertain. In any case, this issue is among the unsettled ones in the study of the behavior of private investment in developing countries.

Fiscal policy may also take another form- reducing the government budget deficit. This has been the main fiscal policy measure that the WB and the IMF have been propagating since the early 1980s in an attempt to stabilize the economies of the developing world. Research works like Serven & Solimano (1992) indicate that high fiscal deficits push up interest rates or reduce the availability of credit to the private sector, or both; thus crowding out private investment. Other things equal, higher deficits crowd out the private investment as a result of lower access to bank credit, higher real interest rates, and a more appreciated real exchange rate. Hence measures like the one followed by the bank and the fund should allow private investment to improve. However, it is the way fiscal deficit is corrected that matters. The mix of tax increases and spending reductions will affect aggregate private investment in a variety of ways. If the efforts to reduce the public deficit often involve cutting back on public investment, some of these expenditures (especially on such components of infrastructure as roads and communication networks) may be complementary with private investment and will cause private investment to fall. This underscores the need to protect public expenditure on infrastructure during the adjustment process to encourage the recovery of investment and growth.

It is a common fact that most economies of the SSA are caught with excess debt burden whose repayment exerts extraordinary effect on the investment environment of the economies. Since the debt crisis of the early 1980s, inclusion of debt burden as a key restraint of private

investment is a common practice in the analysis of private investment in developing nations. High debt-service payments related to large external debt may reduce the available funds for investment since they divert foreign exchange away from the import of capital and intermediate goods. Furthermore, the debt burden imposes a sort of marginal tax by reducing expected return on investment; and finally, it affects the credit worthiness of the country by imposing restrictions to its access to future foreign credit to finance investment or trade.

Several empirical studies have found negative association between private investment and debt overhang as proxied by debt to GDP ratio (Serven (1998), Greene and Villanueva, (1991) (cited in Serven & Solimano (1992)). Cited in Seyoum (2002), Borensztein (1990) argues that it is credit unworthiness associated with debt overhang that really matters for investment than the disincentive effect of mounting debt to GDP ratio. In its externally constrained investment model for developing countries, Fitzgerald et al. (1992) includes debt service (as ratio to GDP) in its model and finds a statistically significant negative coefficient for 22 developing countries in the sample. However, the coefficient for the African sub-sample (only three countries) is negative but not statistically significant, which the paper attributes to dominance of concessional loan in African countries.

A rapidly expanding recent literature on private investment decision has focused attention on the irreversible nature of part or all of fixed investment (Dixit and Pindyck, 1994, cited in Seyoum (2002)). When investment is hard to reverse, instability and uncertainty create a value to waiting for more information so as to avoid getting stuck with unprofitable and irreversible project(s). The basis for this theory lies in the asymmetry of the adjustment cost of capital stock, i.e. most investment projects are easily done than undone making downside risks costlier than positive shocks. Under such conditions, optimal investment policies seek a

balance between the value of waiting (which is the present value of future streams of returns in case they fall short of the user cost of capital) and the cost of waiting (which is the net present value of returns forgone by waiting for a project which would turn out successful anyway).The literature points out that the value of waiting could be considerably large particularly when uncertainty is high, suggesting that uncertainty can become a major obstacle for investment.

Political instability and social unrest can also be taken as potential sources of uncertainty and may even be highly damaging factors of the private investment environment. According to Seyoum (2002), there are two important mechanisms through which socio-political factors could influence private investment in developing countries. The first relates to extreme cases of instability that lead to changes in the rules of the game and threatens investors of possible confiscations. The other and perhaps the most common one relates to the unpredictability of the political environment say due to repeated changes of government or officials of key government institutions which undermines the responsiveness of private investors to economic incentives or reform measures. The basic idea is that investors may not regard government policy under political instability as credible, hence creating a value for waiting. This indirectly weakens the effectiveness of fiscal policy measures taken by government bodies to improve the share of private investment in the economy. The above discussed variables are assumed to affect, in one way or another, private investment in SSA; and we try to investigate their relative impact in the analysis part of the paper.

2.2.2 Empirical Literature on Fiscal Policy in Sub- Saharan Africa

According to Odedokun (2001), public expenditure accounted for over 25 percent of GDP in developing countries in the last three decades. Thus, while public expenditure and revenue do

not capture the totality of public actions on the economy, they do account for the sizeable of it. In a development context, fiscal policy serves both as an instrument of macroeconomic stabilization and instrument to achieve growth and poverty reduction objectives.

In the 1980s and early 1990s the principal concern for developing countries was economic stabilization. Many countries experienced high inflation and debt crises brought on in part by large fiscal deficits. Accordingly, fiscal policy measures were focused mainly on stabilization which entailed a preoccupation with inflation management and a revival of private investment; i.e. fiscal policy focused on the fiscal deficit as one way to restrain aggregate demand and to control inflation and the further growth of debt. However, as the data on SSA shows, those measures have failed in enhancing the revival of private investment in the region. Despite the fact that in recent years, most developing countries have focused fiscal policy measures on private investors initiative activities, such as public investment on infrastructure, to help achieve the growth objectives as a way to reduce poverty.

The lesson we take from the 1980s and 1990s fiscal policy measures is that although stability is necessary for growth, it is not sufficient. The design of fiscal policy needs to identify and incorporate the transmission channels through which fiscal policy influences private investment and enhances economic growth. And this requires attention be focused on the likely general growth effects of the level, composition and efficiency of public spending, particularly public capital expenditure, and taxation. Fiscal policy that neglects these effects runs the risk of achieving stability while potentially undermining long-term growth and poverty reduction. (Adam & Bevan (2001))

CHAPTER THREE

THE DATA, SPECIFICATION OF THE MODEL, AND THE METHODOLOGY

In this chapter, we attempt to describe the data set and put forward the relevant model for analysis of the data. First, we briefly explain the data sources. Then, we try to show that, in the sample, there are cross- country differences in various macroeconomic aggregates. Correlation coefficients are also calculated to show the strength of the pair- wise relationship among the variables. Finally, we specify a relevant model to address the problem at hand and propose a feasible econometric model to analyze the data set.

3.1 The Data and Some Stylized Facts

The Data

Our sample consists of 23 Sub Saharan African countries selected based on the availability of data. Data frequency is annual for the period 1986 to 2003. We perform panel estimates for the aforementioned countries of the region (listed in the appendix part). We have a panel of 414 observations. We try to assemble most of the variables proposed by different empirical investment studies in the investment literature to build up our investment equation. The definition of the basic variables is attached to the paper as an appendix.

Given the scarcity of resources in Sub-Saharan African countries, appropriate policy formulation needs to be a central issue, which in turn requires reliable, consistent and internationally comparable database. However**,** lack of data on major macroeconomic variables and inconsistency among different sources on a single variable and even from the

same source in different volumes has been a common problem in the region. To use the words of Geda (2004), pp. 2, *"much of the macroeconomic analysis in Africa suffers not only from lack of accurate sources of data but also from inconsistency across different sources on the one hand and analytical inconsistency within an identified source on the other"*. Bearing this in mind, we try to use most of our data from the WB and the IMF, just to follow the common practice by others in analyzing macroeconomic problems.

Hence, most of our data are extracted from the WB's World Development Indicators (WDI) database. Data on variables such as GDP per capita (GDPPC), growth of GDP per capita (GGDPP), real interest rate (RIR), official exchange rate (OEXR), inflation (INFL), and domestic credit to the private sector (DCRPRV), are all from the 2006 version of this database. Data on private investment (IPRV), public investment (IPUB), and real exchange rate (REXR) are extracted from the WB's African Development Indicator database. However, data on public investment for South Africa is partially extracted from Everhart & Sumlinski (2001). The rest of the data and some missing values of the above variables are extracted from the IMF's International Financial Statistics (IFS) CD-Rom. In addition, we make mean computation in cases where some of the missing values are not extractable from these alternative sources. Hence, data discrepancy in some variables has to be admitted. In the following paragraphs, we try to show summary statistics of our dataset.

Some Stylized Facts

The descriptive statistics, computed and attached as an appendix to the paper, reveals cross-country differences in various macroeconomic aggregates.[5] Such differences show cross-country diversity amongst the fundamentals that derive private investment in the region.

[5] See appendix, ***(Table-1)***

Hence, we argue that the key parameters in private investment function are likely to be heterogeneous and country specific. The region's average real (at 2000 prices) per capita GDP is 589.86 USD. However, some four countries out of the twenty-three in our sample appear to be outliers. Ethiopia and Burundi, on the one side, come out at the bottom with per capita GDPs of 95 USD and 123 USD while Gabon and South Africa, on the other side, come out at the top with per capita GDPs of 3985.05 USD and 3060.22 USD respectively. The per capita GDP of the region is highly unsteady evidenced by the sample's standard deviation of GDP per capita of 37.5. The growth rate of per capita GDP is also uneven across the sample of countries. Though the mean growth rate is -0.04 %, countries like Burundi, Cameroon and Central African Republic have registered huge negative, -1.5% or less, per capita growths. Countries like Uganda and Ghana, on the other side, registered significant positive, more than 1.5%, per capita growths. Thus, both per capita GDP and its mean growth indicate the heterogeneity of the two variables among countries in the region.

Cross- country heterogeneity is also evident in private investment and public investment. The region's mean private investment, according to our data, is 9.73 % of GDP. The mean private investment across the countries sampled ranges from a minimum of 2.48% (Burundi) to a maximum of 22.02% (Gabon). We observe from the table that countries with higher per capita GDP are also those with higher private investment as a share of GDP and vice versa. Exception holds to Cotid'voire, whose mean per capita GDP is above the sample mean (638.51 USD) while its private investment share of GDP is only 6.77% compared to the sample mean figure (9.73%). Relatively speaking, private investment is a stable variable in the region as depicted by its sample Standard deviation (6.00). The cross- country mean level of public investment for the sample is 6.59 % of GDP. The lowest level of public investment is

registered by Zimbabwe and Cameroon, with 2.63 % and 3.69% shares of GDP respectively. The highest figures are those of Ghana and Nigeria, with 10.03 % and 9.68% of GDP respectively. Here those whose public investments are huge are not those whose private investments are huge. Neither are those whose per capita GDP are huge.

The financial development indicators also exhibit significant cross- country differences. For example, the sample average for domestic credit to the private sector is 18.62% of GDP. However, dropping the outlier, South Africa, we find that the sample mean figure is 14.79%. Uganda and Central African Republic registered the poorest offers to their private investors, with 5.31% and 5.56% of their GDPs respectively. Those countries with higher percentage of domestic credit to GDP to the private sector are those with higher per capita incomes. Nevertheless, we do not see any kind of relationship between domestic credit to the private sector and private investment from the table. Money and quasi money (M2) as percentage of GDP, the other measure of financial development, is on average 22.23% for the whole sample of countries in the region. Here South Africa and Ethiopia come out at the top with 50.69% and 39.68% of their GDP, while Uganda and Chad lie at the bottom with 11.51% and 13.42% of their GDP respectively. The average inflation also shows enormous cross-country variations. Though Zimbabwe is the one suffering the most currently, our dataset shows that the highest mean inflation rate, in our period of analysis, is that of Zambia, 62.79% while the lowest is that of Niger, 2.03%. Cross-country heterogeneity is also apparent in real interest rate, real exchange rate, parallel market premium, the level of government control in exchange rate market, official exchange rate movements, and debt stocks and debt servicing (the latter two expressed as percentages of GDP). All these show that the panel of countries in our sample shows important divergence in their levels and growth of real per capita income, levels

of financial development, private investment, public vestment, inflation, real interest rates, exchange rates, the level of government control in the exchange rate market, and in their magnitudes of national debt and debt servicing.

There is also a need to see the pattern of pair- wise relationship among the macro variables in our analysis. This relationship among the macro variables of interest is attested using correlation coefficients at 5 percent significance level. The pair- wise correlation coefficients show a variety of linear association among the variables of interest.[6] Private investment is correlated significantly (at 5%) with the rest of the variables, except for real interest rate and government control. For example, we observe negative and statistically significant association between public investment and private investment for the whole sample. Regarding credit to the private sector, it happens to have positive and statistically significant correlation with private investment. The table also shows the expected negative and significant correlation between private investment & debt service ratio and private investment & debt stock to GDP ratio.

Above all, private investment is highly and significantly correlated ($\rho = 0.53$) with GDP per capita in the region; this may partially be a support for the accelerator theory of investment. However, this high correlation may indicate the possibility of the problem of endogeneity. GDP per capita is also significantly correlated with other regressors, such as, public investment and money and quasy money (M2), indicating the possibility of multicollinearity. In order to minimize these possible problems, we drop GDP per capita in our analysis. Instead, we take one period lagged value of GDP per capita, a variable that is less correlated with the other variables. Moreover, domestic credit to the private sector and money & quasy money

[6] See appendix ***(Table-2)***

(M2) as a percentage of GDP are also highly correlated ($\rho = 0.73$) with each other. Of course, M2 is significantly correlated with the other regressors too, indicating a possibility for multicollinearity. Thus, we have to be cautious in the way we treat this variable in our regression analysis.

3.2. Specification of the Econometric Model

In the theoretical literature context of private investment, the simple accelerator model is the most convenient way to model private investment. We summarize this model based on the works Jorgensen (1971) and FitzGerald et al (1992). This model takes a general form that incorporates an equation linking private investment ($IPRV_t$) to the difference between the desired capital stock (K_t^*) and the capital stock inherited from last period (K_{t-1}), the extent of adjustment being represented by an adjustment coefficient (λ_t) reflecting *implementation lags, financial constraints or uncertainty about the future business condition*. Its simplest version takes the following equation format.

$$IPRV_t = \lambda_t \left(K_t^* - K_{t-1} \right) \quad \text{..... (3.1)}$$

In practice, as FitzGerald et al (1992) shows, a linear formulation for the desired capital stock K_t^* and a stable adjustment coefficient λ_t appear to be implicitly assumed for developing countries in order to permit the absence of capital stock estimates to be eliminated by first differencing of the function:

$$K_t^* = \sum \beta V_{it} \quad \text{..... (3.2)}$$

This yields the following familiar private investment estimation equation with stable coefficients.

$$IPRV_t=\psi_1\left(V_{1t}-V_{1t-1}\right)+\psi_2\left(V_{2t}-V_{2t-1}\right)+---+\left(1-\lambda\right)IPRV_{t-1} \quad \text{..... (3.3)}$$

Where $\psi_i=\lambda\beta_i$ and V_{it}s indicate variables affecting private investment in (3.2) and (3.3).

Equation (3.3) is derived based on equation (3.1), and equation (3.2) in its simple form:

$$K_t^*=\sum \beta V_{it}=\beta GDP_t \quad \text{..... (3.4)}$$

i.e. substituting (3.3) in (3.1) and first differencing the resulting equation, we get

$$IPRV_t-IPRV_{t-1}=\lambda\beta\left(GDP_t-GDP_{t-1}\right)-\lambda\left(K_{t-1}-K_{t-2}\right) \quad \text{..... (3.5)}$$

However, by definition $IPRV_t=K_t-K_{t-1}$; hence substituting this definition in equation (3.5) we effectively reach at equation (3.3). However, it is necessary to reformulate equation (3.3), the simple accelerator model, to accommodate the effects of a number of variables in developing countries context. The variables, among others, include public investment, financial development indicators, and measures of macroeconomic instability indicators.

As mentioned in the introductory part of the paper, the institutional and data constraints among the Sub- Saharan African countries have prevented a successful establishment of a rigorous empirical investment function of the above type. Data constraints are particularly severe both because suitable data on fiscal variables are unavailable for many countries in the region, and because the quality of the available data is not as such convincing.[7] However, given these constraints, we optimize to analyze the effect of fiscal policy changes on private investment for the region using public investment as a measure of fiscal policy.

[7] Data on fiscal policy variables such as tax revenue, government spending on health, education and social security are missing; and this has forced us to use public investment as a proxy for fiscal policy measures.

There is no broad agreement as to the 'correct' specification of the empirical aggregate private investment function for the developing countries. However, several empirical studies of the behavior private investment in developing countries, such as Hermes & Lensink (2001), Luintel & Mavrotas (2005), Mlambo & Oshikoya (2001), Oshikoya (1994), and Seyoum (2002) have postulated the following variables as the basic determinants of private investment. The variables include: per capita GDP ($GDPPC_{i,t}$), the growth rate of per capita GDP ($GGDPPC_{i,t}$), public investment ($IPUB_{i,t}$), real interest rate ($RIR_{i,t}$), real exchange rate ($REX_{i,t}$), inflation ($INFL_{i,t}$), debt stock ($DTOT_{i,t}$), debt servicing ($DSER_{i,t}$), levels of financial development ($FD_{i,t}$), and measures of political instability variables (POL). We also include some combination of official exchange rate ($OEX_{i,t}$) and parallel market premium ($PMP_{i,t}$) in our analysis in order to see the strength of effect of government control in the exchange rate market.

We specify a general testable equation of private investment behaviour that captures the effects of fiscal policy changes and incorporates some of the key arguments forwarded above. In this light, a typical equation for private investment looks:

$$IPRV_{i,t} = \alpha_i + \gamma_t + \beta_1 GDPPC_{i,t-1} + \beta_2 GGDPPC_{i,t} + \beta_3 IPUB_{i,t} + \beta_4 FD_{i,t} + \beta_5 POL_{i,t} \beta_6 INFL_{i,t} + \beta_7 RIR_{i,t} + \beta_8 REX_{i,t} + \beta_9 DTOT_{i,t} + \beta_{10} DSER_{i,t} + e_{i,t}$$

..... (3.6)

$(i = 1\ldots N;$ and $t = 1\ldots T);$

Where i and t denote the cross-sectional and time-series dimension of the variables.

α_i - Captures the unobserved country specific fixed effects (for example differences in initial levels of private investment.);

γ_t - Captures the unobservable individual-invariant time effects (i.e. investment shocks that are common to all countries);

$IPRV_{i,t}$ - The ratio of private investment to GDP;

$GDPPC_{i,t}$ - Real per capita GDP at 2000 prices;

$GGDPPC_{i,t-1}$ -Real per capita income growth;

$IPUB_{i,t}$ -Aggregate public investment as ratio of GDP;

$FD_{i,t}$ - Measures of financial development; $POL_{i,t}$ - Measures of political instability;

$INFL_{i,t}$ - Inflation rate; $RIR_{i,t}$ - Real interest rate; $REX_{i,t}$ - The real exchange rate;

$DTOT_{i,t}$ - Value of total external debt as a ratio of GDP;

$DSER_{i,t}$ - Value of the total debt servicing as a ratio of GDP;

βs - Measure the impact elasticity of $IPRV_{i,t}$ with respect to all the right hand side variables;

$e_{i,t}$ - Normal disturbance term with cross-sectional and time dimensions.

As mentioned above, the focus of the paper is to see the responsiveness of private investment to fiscal policy changes in our sample of Sub- Saharan African countries. Thus, we are mainly interested in the coefficient of $IPUB_{i,t}$, β_3, a variable that reflects the fiscal policy stance of the government through its manipulation of capital expenditure (public investment). Public investment, as discussed in the literature review, on the one side, may crowd- out private investment via increased deficits and high interest rates, commonly called as the Ricardian Equivalence Theorem. The way public investment is funded may also result in discouraging

effects on private investment. For example, if public investment is funded through bonds, it may reduce credit supply to the private sector. On the other side, government investment, particularly those in the developing countries, may act as crowding- in catalyst through the provision of key infrastructures (such as those on energy, transport, and communication). However, in most developing countries, this effect is to be felt only in the long run (a number of periods of more than or equal to 20 in common economics literatures). Due to the shortage of data, it is difficult to extend the data set to longer periods to investigate the long run behavior of private investment in the region. Hence, since the time series is only for 18 years long run inferences would be loud-mouthed, and hence misleading. Thus, time variant heterogeneity does not have much weight in our analysis, putting a rationale for dropping the γ_t term in our model.

The regressors are believed to explain by and large the behavior of private investment in the region. In all the specification work, most of the variables are taken in their ratios to GDP form to minimize the problem of heteroskedasticity. However, still one common problem in such a specification remains: the possibility for the dependent variable (private investment) and some of the explanatory variables (such as per capita GDP, financial development indicators, and some macroeconomic instability measures) to be determined together which weakens the validity of the estimated results. In order to minimize this problem of simultaneity, one period lagged values of GDP per capita, public investment, domestic credit to the private sector as percentage of GDP, and inflation are taken as right side variables.[8] This is done with the assumption that the contemporaneous values of these variables are the ones

[8] The same solution is followed by Bayraktar & Fofack (2007), Mlambo & Oshikoya (2001), and Seyoum (2002)

that reflect the problem in a bold manner. However, growth of per capita GDP takes its period values, as it happens more relevant in explaining private investment in this form.

The other problem is the complete absence of data on some variables. For example, political instability variables are completely missing for most of the countries under investigation; hence, decision is made to drop measures of political instability variables. Moreover, we take the size of domestic credit to the private sector (DCRPRV) as percentage of GDP and money and quasi money (M2) as percentage of GDP as proximate measures of level of financial development. A more developed financial sector offers better credit facility to the private investors. Domestic credit to the private sector is a variable assumed to capture the direct effect of credit rationing on private investment. Because, in developing countries, where credits are rationed and interest rates are arbitrarily settled, interest rates rarely capture the cost of capital to the investors. M2 is M1 plus some other claims that are not instantly liquid, such as withdrawals of time deposit.[9] In our dataset, M2 is highly correlated to domestic credit to the private sector, reflected in their correlation coefficient, 0.73.[10]

Additionally, the growth rates of GDP per capita, official exchange rate, total external debt, debt service, parallel market premium and inflation are supposed to reflect the stance of the macroeconomic stability of the countries in the region. Of course, risk profiles, or uncertainties for short, are functions of macroeconomic instability measures; hence, we believe these variables would also catch the levels of uncertainty in the economy. Debt servicing is defined as the actual payment of the principal and interest on foreign borrowing as percent of GDP. Higher debt service payments related to large external debt reduces the

[9] M1- corresponds to the traditional definition of money.
[10] See appendix, (table-2)

available funds for investment since they divert foreign exchange away from the import of capital and intermediate goods. Furthermore, debt burden affects the creditworthiness of the country by imposing restrictions to its access to future foreign credit to finance investment. However, external debt stock position may also reflect a country's access to the international market to the investors interested in the economy. Taking all these bits and pieces in to account, a modified empirical private investment model for the sampled countries looks:

$$IPRV_{i,t} = \alpha_i + \beta_1 GDPPC_{i,t-1} + \beta_2 GGDPPC_{i,t} + \beta_3 IPUB_{i,t-1} + \beta_4 DCRPRV_{i,t-1} + \beta_5 RIR_{i,t} + \beta_6 INFL_{i,t-1} + \beta_7 REX_{i,t} + \beta_8 M2_{i,t} + \beta_9 DTOT_{i,t} + \beta_{10} DSER_{i,t} + \beta_{11} GOV_{i,t} + e_{i,t}$$

..... (3.7)

The above equation incorporates two measures of financial development. They are domestic credit to the private sector as a percentage of GDP, and money and quasy money (M2) as a percentage of GDP. As stated above, we take most variables in their ratio to GDP to minimize the problem of heteroscedasticity. We drop measures of political instability variables due to lack of data on the variables in the sub-continent. We also drop the individual- invariant time specific heterogeneity term. Some adjustments as to the number and form of the variables in the empirical analysis are to be expected.

3.3 The Methodology

Panel data models in Macroeconomics have become increasingly popular in the past two decades with the increased availability of cross-country data sets that span for long periods. There are several key advantages of using panel data over a single time series or cross- section dataset. The existence of both cross-section and time-series components makes panel data estimation a more flexible and analytically richer method than cross-section or time-series data. In cases where there is limited time-series data available for each country (as is the case

in Sub Saharan African countries), there may be insufficient power of tests of hypotheses. If it is possible to impose some homogeneity conditions upon the parameters across countries, then a panel data model will afford additional power and may allow the detection of relationships not apparent from the individual time series. Unlike cross- section models, with panel models it is possible to control for the country-specific, time invariant characteristics through the use of country-specific intercepts or "fixed effects."

As mentioned in the first sub-section, the econometric analysis of private investment in this paper is based on a panel data set comprising 23 Sub-Saharan African countries observed during the period 1986- 2003. Using the descriptive statistics, we have shown that countries in the SSA differ in terms of their levels of financial development, public investment, inflation, real interest rates, real exchange rates, burden of their national debt and other macroeconomic aggregates. Countries also differ in their risk profile, a key factor for private investment decisions.[11] Given these cross-country diversities amongst the fundamentals that drive private investment, we argue that private investment functions are better estimated using panel data econometric model.

We start with a simple linear model that can be used to characterize a variable's behavior in a panel dataset.

$$Y_{i,t} = \alpha_i + \beta X'_{i,t} + e_{i,t} \quad \text{..... (3.8)}$$

Where i = (1, 2,…, N) and t = (1, 2, …, T) represent the cross-sectional dimension and the time-series dimension respectively. The characteristics of the individual effect α_i will dictate the particular type of panel data estimator used in equation (8). If the individual effects are

[11] Risk levels (uncertainties) are proxied by the macroeconomic uncertainty measures in our data set.

fixed and common across the economic agents, Sub- Sahara African countries in our case, the simple classical Ordinary Least Square (OLS) would produce consistent and efficient estimates of α and β. This model is commonly known as the *pooled least square model*. If α_i are fixed but not common across i = 1,..., N, the pooled estimator would be biased through the misspecification of the mean equation $[E(Y_{i,t}/X_{i,t}) = \alpha_i + X'_{i,t}\beta]$. Thus, an alternative, called the fixed effects estimator (within- group estimator) needs to be generated using the fixed effects model. The fixed effects model is appropriate when individual specific effects may reasonably be viewed simply as parametric shifts in the regression function itself. This might be considered reasonable if the cross- sectional used in the estimation represents a broadly exhaustive sample of the population of the economic agents. If the cross-section is sampled from a larger population so that exhaustiveness remains, then it may be more appropriate to view the individual- specific effects in the sample as randomly distributed effects across the full cross-section of agents. This suggests for an alternative model, the so called the random effects model. This model redefines the unobserved heterogeneity in such a way that $\alpha_i = \alpha + u_i$ where u_i has a zero (unconditional) mean. In most panels, like the one we are going to run, the pooled OLS is highly restrictive in that it treats the unobserved heterogeneity measure as constant among individuals and fixed over time. Hence, a choice has to be made among the available panel models based on diagnostic tests. Being conscious of these, we have to make comparison between the fixed effects model and the random effects model, based on the theoretical framework of the models. (Baltagi (1995), Wooldridge (2000), and Wooldridge (2002))

The two models follow similar assumptions except with regard to the relationship between the unobserved heterogeneity and the regressors. The random effects model assumes that the time-invariant country specific term is uncorrelated with the regressors, while the fixed effects model treats this term as being correlated with the regressors. In chapter four, we will carry out Hausman specification test based on the null hypothesis of orthogonality of the individual effects. Under the null hypothesis, both methods give consistent estimates that are not systematically different from each other, but the random effects model surpasses the fixed effects model by being more efficient.

Before winding up our discussion of the methodology, let us restate our aim in analyzing our dataset. We model empirically the private investment behaviour for the panel of countries and focus on three important issues:

(i) depicting the effect of fiscal policy change, approximated by changes in public investment, on the behavior of private investment;

(ii) attesting the result with the theoretical and empirical literature of private investment vs. fiscal policy; and

(iii) examining other dominant determinants of private investment in the sample of the countries for the sake of comparison with that of fiscal policy changes;

The next chapter concentrates on the estimation of the model and discussion of the results.

CHAPTER FOUR

DISCUSSION OF ESTIMATION RESULTS

INTRODUCTION

In chapter three, we tried to see descriptive analysis of our data set. The data set reveals the heterogeneity of the macro variables in our analysis. Moreover, we provided pair- wise relationship among private investment and its major determinants, including the fiscal policy variable, in a sample of countries in the subcontinent. The correlation coefficients indicate a strong relationship between private investment & GDP per capita, and domestic credit to the private sector & money and quasy money (M2) as percentage of GDP. Some regressors also show similar characteristics implying a need for taking the lagged values of the regressors and dropping M2 to account for endogeneity and multicollinearity problems. Nevertheless, the correlation analysis does not show any significant correlation between private investment and public investment. Finally, we built up a model that would fit the problem under investigation, and suggested a methodology which will suffice for this problem.

In this chapter we try to determine a model, using economic theories and specification tests, which would be most relevant to explain the relationship between private investment and fiscal policy changes in the region. Using Hausman specification test and an F- test we would make a decision. Besides, we discuss on the relative importance of each explanatory variable in explaining the behavior of private investment once the effects of other variables are taken care of.

4.1 Diagnostic Tests

4.1.1 Hausman Specification Test

Comparing the Fixed effects (FE) and Random effects (RE) estimates can be a test for whether there is correlation between α_i and X'_{it}, assuming that the idiosyncratic errors and the explanatory variables are uncorrelated across all time periods. Hausman (1978) developed the construction of a test based on the difference between the RE ($\hat{\beta}_{RE}$ - i.e. the coefficient vector of the RE model) and FE ($\hat{\beta}_{FE}$ - i.e. the coefficient vector of FE model) estimators would help decide which of the two models is better.

Under the null, the variance of the differences $\hat{\beta}_{RE} - \hat{\beta}_{FE}$ is;

$$Var(\hat{\beta}_{RE}) - Var(\hat{\beta}_{FE}) = \Sigma \quad \text{.....} \quad 4.1$$

The Hausman test of the null of no correlation can therefore be conducted using the Wald statistic;

$$W = (\hat{\beta}_{RE} - \hat{\beta}_{FE})' \hat{\Sigma}^{-1} (\hat{\beta}_{RE} - \hat{\beta}_{FE}) \quad \text{.....} \quad 4.2$$

which is distributed as a chi-squared with k degrees of freedom under the null, k being the number of regressors. The Hausman test tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. If they are (insignificant P-value, Prob >chi2 larger than 0.05), then it is safe to use random effects model. If we get a significant P-value, however, we should use fixed effects model. In our case, the Hausman specification test rejects the null of random effects model at 5 percent significance (Prob >chi2 = 0.0437). OLS will produce

biased estimates unless the influence of the omitted variables are uncorrelated with the explanatory variables. The following sub-topic shows that the F- test supports for fixed effects model against pooled OLS.[12]

4.1.2 Fixed Effects Model Vs Pooled OLS Model

We perform a test for individual effects to choose between fixed effects model and pooled OLS. That is we perform a test for if all individual intercepts are the same. If they are, we can just estimate the simple OLS model, and OLS will be unbiased. However, if they are not, we will instead favour the fixed effects specification. The null and the alternative take the following forms:

$$H_0: \alpha_1=\alpha_2=\ldots=\alpha_n; \qquad H_1: \alpha_1 \neq \alpha_2 \neq \ldots \neq \alpha_n \text{; and}$$

$$F(n-1, nT-n-K) = \frac{\left(e'_r e_r - e'_u e_u \right) / \left(n - 1 \right)}{e'_u e_u / \left(n T - n - K \right)}$$

Where, n = no. of individuals (countries in our case) in the analysis

T = number of time periods (years) and;

K= number of regressors excluding the constant.[13]

From the output of our model we have the following:

```
F-test that all u_i=0: F(22,363)= 15.27      Prob > F = 0.0000
```

The p-value, denoting the probability that the null hypothesis being true is stated as 0.000. Our output indicates that we should reject the null hypothesis of all individual intercepts being

[12] The Hausman test results are attached as an appendix.
[13] Greene (2003) pp 292

equal. Hence, we favour the fixed effects model when compared to the OLS model. Since the Hausman test has rejected the random effects model, there is no need to make the Breusch-Pagan Lagrange Multiplier test.

4.1.3 Heteroskedasticity and Autocorrelation

With regard to heteroskedasticity, since our sampling is not exhaustive, using robust standard errors would not be a good solution. Because the robust t statistics will have distributions that are not very close to the t distribution, the use of robust standard errors could throw off our inference. However, since most of the macro variables used in our model are treated in their ratios to GDP, heteroskedasticity is not a highly pronounced problem.

Besides, we should not worry about spurious regression as the use of panel data model (Fixed effects model takes differences) by definition addresses the problem. But for the sake of convenience we may look at the STATA outputs attached in the annex, which show that most of the time dummies are insignificant in affecting the dependent variable. This indicates that time dummies have less pronounced effect in our model. It is, however, difficult to test whether the idiosyncratic errors, e_{it} are serially uncorrelated after fixed effects estimation; because since fixed effects model involves time demeaning, we cannot estimate e_{it}. Thus, the fixed effects model is almost always, by assumption, stated with serially uncorrelated idiosyncratic errors.[14]

[14] Wooldridge (2000) pp 447 presents the case in comparison with that of first differencing.

4.2 Interpretation of the Results from the Fixed Effects Estimation

The discussion in chapter three presented a useful yet preliminary relationship between private investment and some macro variables in SSA. However, in reality most of the variables included in the model and other unobserved disturbances interact with each other; and for policy purposes we need to know the relative impact of each regressor on private investment holding the rest. Given this, since the focus of the paper is on the interaction between private investment and fiscal policy changes, we treat our proxy variable for fiscal policy, public investment, in two alternative scenarios. We try to assess its impact when it assumes its contemporaneous values and when it assumes its one period lagged values.

Generally speaking the model explains 35% (34% when public investment takes its current period values) of the variation in private investment. This small R^2 may signify the loss of degrees of freedom in using panel technique of estimation. Moreover, it may also indicate that some other variables, not incorporated in the model and/or the unobserved heterogeneity term, have significant role in explaining private investment in the region. Perhaps, the effect of lagged values of private investment – a measure of the adjustment effect (the inertia effect) may be too large. In this regard the empirical literature on private investment, such as Serven (2002), indicates that lagged values of the dependent variable have enormous contribution as to the explanation of the behavior of private investment in developing countries. However, since our aim is to look at the behavior of private investment only in a moderately short run set- up, we do not make use of this variable.[15]

[15] We have mentioned why we are confined to short run analysis. Perhaps future research on the area may apply dynamic panel models to look at the long run issues.

The correlation between the unobserved heterogeneity and the explanatory variables is strong enough, -0.661 (-0.659 when using contemporaneous values of public investment), which is a further support as to our preference for the fixed effects model.

The following table presents the alternative results from a fixed effects regression for the model built in chapter three. Model- 1 shows the output when public investment takes its contemporaneous values; while Model- 2 shows the output when public investment takes its one period lagged values. We limit ourselves to one period lag because of limited number of periods in our analysis; and because our interest is to dictate whether fiscal policies have immediate effect or not in affecting the behavior of private investment in the region. We try to make comparisons between the coefficients of each variable of the two models and discuss the coefficients in the eyes of the existing empirical literature. But we should remember that all the coefficients, except that of GDP per capita, are measures of percentage change in private investment as a result of a percentage change in each variable holding the rest. i.e. they are elasticity measures. Moreover, while the individual country effects are dropped through the process, we also dropped the individual time effects because of their insignificance.[16]

[16] The results that include time effects are attached as an annex.

Table 4.1 - Fixed Effects(within) Regression Results (the dependent variable is private investment)

	Model 1(ipub)			Model 2(lipub)		
	Coefficient	t	P-value	Coefficient	t	P-value
Cons	10.720	6.250	0.000	9.897	5.830	0.000
lgdppc	0.093	2.520	0.012	0.097	2.440	0.015
ggdppc	0.113	1.660	0.099	0.142	1.920	0.056
ldcrprv	-0.021	-1.140	0.254	-0.020	-1.070	0.284
rir	0.036	1.780	0.076	0.036	1.770	0.078
linfl	-0.004	-0.410	0.680	-0.004	-0.410	0.684
rexr	-0.007	-0.660	0.508	-0.006	-0.640	0.525
dser	-0.067	-2.880	0.004	-0.066	-2.900	0.004
dtot	0.018	1.870	0.062	0.019	2.050	0.041
gov	0.000	0.130	0.899	0.000	0.220	0.826
ipub	0.069	0.780	0.438			
lipub				0.153	1.790	0.074
R-sq		0.340		0.351		
F(10,380)		4.54		4.83		
Prob > F		0.00		0.00		
No. of Observations		413		413		
No. of Groups		23		23		
Corr (u_i,Xb)		-0.659		-0.661		

As can be seen from the table, when we treat public investment in its contemporaneous values, as in **Model-1**, the coefficients of public investment, one period lagged values of inflation, real exchange rate, one period lagged values of domestic credit to the private sector, and government control, all appear to be insignificant. Even when we incorporate one period lagged values of public investment instead, as in **Model- 2**, all of these variables but one period lagged public investment assume insignificant coefficients. For example, real exchange rate, in both model-1 and model- 2, has negative, small, and insignificant effect on private investment in the region. Most of these variables are taken as macroeconomic instability measures of the economies. Perhaps, the possible reason for their insignificance is the problem with lags in response to policy changes of economic agents. We should remember that most

investment projects are irreversible or costly reversible; hence investment decisions are made slowly. This implies that policies leading to macroeconomic instability may not have immediate impact on private investment.

The coefficient of public investment assumes insignificant small and positive value in model-1 while it assumes significant positive and relatively bigger value in model- 2. This indicates that public investment undertaken in the current period does not have that much significant affect on the performance of private investment. Nevertheless, past period public investment complements private investment in the sample of our countries. The result in Model- 1 can be taken as a clue in that there is sometimes crowding- out and sometimes crowding- in effect of public investment on private investment. This can be taken as the reflection of the ambiguity in the empirical findings in the area.

However, we cannot claim that, based on these two results, complementarity indicates avoidance of crowding- out problems. Rather we can simply state that in the very short run, private investment is not much responsive to public investment. Aklilu (2007) has reached the same conclusion for the case of Ethiopia. Model- 2's result is in line with the findings of several economists. Oshikoya (1994) is a typical case where it takes eight African countries and concludes that public investment strongly and positively affects the behaviour of private investment. A study by Blejer & Khan (1984), based on cross-country data, indicates that government investment is complementary to private investment. Greene & Villanueva (1991) and Serven & Solimano (1991) also arrive at similar conclusions based on multi-country panel data for developing countries.[17]

[17] Blejer & Khan (1984) and Green & Villanueva (1991) are cited in Fitzgerald et al (1992)

Both models indicate that the lagged values of per capita GDP and its annual growth rate have statistically significant (at 5 % and 10% respectively) and positive effect on private investment in the sample of the countries. This is inline with the accelerator theory of private investment. It also agrees with the findings of most of the empirical studies on private investment in developing countries, such as that of Oshikoya (1994) and Seyoum (2002) for SSA, Aklilu (2007) for Ethiopia, and Badawi (2004) for the Sudan. However, the table also shows that the growth rate of per capita GDP has a stronger effect on private investment than a dollar increase in the level of per capita GDP. Thus it is the overall current performance of the economies rather than the level of the economies, which is more important for the performance of private investment in Sub- Saharan Africa. Our descriptive statistics also reveals this.

We expected, based on empirical literature, that the coefficient of domestic credit to the private sector to be significant and positive. However, it appeared insignificant and negative. Studies show different results for different countries in the region. Oshikoya (1994), using eight Sub- Saharan African countries, indicates a strong positive impact of availability of credit to the private sector on the performance of private investment, while Ouattara (2004), analyzing the case of Senegal, shows a negative and significant impact on private investment of the availability of credit to the private sector. Thus, the insignificance of this coefficient in our model indicates that, perhaps the institutional environment surrounding the private sector may be a more important factor in determining the effect of credit availability to the private sector. Thus our measure of financial development is a variable that we think is highly correlated with the unobserved heterogeneity component of the model.

On the other side, we got a positive small but significant effect of real interest rate on private investment. This is in contradiction to the Keynesian and neoclassical model of investment, where interest rate is believed to be a cost to the private investors. However, the result is inline with the works of McKinnon (1973) and Shaw (1973).[18] The logic behind is that a higher real interest rate increases the flow (supply) of bank credits which complements the private sector savings (which tend to be small and fragmented in the SSA) and facilitates capital formation. It is also an indication for the presence of liquidity constraints on private investment decision in the region. Thus, our result is in corroboration with the empirical literature of private investment in developing countries.

The macroeconomic instability measures show some conflicting results. Though they depict the expected negative sign, inflation and real exchange rate are quite insignificant in explaining private investment in the region. But debt stock and debt servicing are significant in explaining private investment. Both models indicate that inflation does not have significant impact on private investors in Sub-Saharan Africa. This result is in fact in conformation with that of Seyoum (2002). Mlambo & Oshikoya (2001) also indicates that the variability of inflation and not inflation rate itself is a factor strongly affecting investors' measure of the level of risk. With regard to the insignificance of the coefficient of the real exchange rate variable , it is a bit strange. However, effects of exchange rate on private investment highly depend on the level of openness of the economies. The higher the openness of the economy the more vulnerable to exchange rate volatility of private investment. Nevertheless most Sub-Saharan African countries are not so much open to the international market. Thus we may take

[18] Both are cited in Luintel & Mavrotas (2005).

this output as reasonable. We can mention research works reaching the same conclusion. Serven (2002) is one of them.

Debt servicing affects private investment significantly (at 1%) and negatively in both model types, while debt stock affects private investment positively and significantly at 5% and 10% in model -1 and model-2 respectively. These differing results of debt service and external debt stock are explained by the notion that the impact on credibility in international financial markets (i.e. the effect of debt servicing) is the one that matters most than the disincentive effect of debt overhang on private investors. More over, a high debt servicing reduces resource availability for domestic investment immediately than huge external debt whose repayment may be cancelled, at least based on conditions, as we have observed in the last few years in the HIPCs case. Cohen (1993) also suggests that the stock of debt itself does not appear to have had a significant influence on investment in developing countries as with that of debt service. Thus, it would be difficult to conclude that this two coefficients are quite inconsistent in explaining the effects of macroeconomic instability on the performance of private investment in our case.

Generally speaking, however, we observe that the role of the macroeconomic instability measures, as compared to other variables such as public investment, GDP per capita and its growth rate, are not that much significant. Moreover, our model remains only satisfactory in explaining the behavior of private investment in Sub- Saharan Africa. However, since the main objective of the paper is to identify if there exists any relationship between private investment and fiscal policy changes, we have made a clear identification of the effect of public investment on private investment. The next chapter winds up the whole work. It also tries to give some policy implications of the whole work.

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions and Policy Implications

In an attempt to answer the question "*Can policy makers help enhance the performance of private investment in the Sub- Saharan Africa through fiscal policy changes",* we have made an empirical analysis using annual (1986- 2003) panel data for twenty three countries in the SSA. The data set depicted the persistence of heterogeneity among the countries in various macroeconomic variables.

The regression results show that the effect of fiscal policy changes, proxied by changes in public investment, on private investment is dependent on the way we treat the variable. If we take contemporaneous values of public investment, fiscal policy will not have significant effect on private investment. However, if we take one period lagged values of public investment instead, we observe that fiscal policy has significant positive effect on private investment. Based on these two results, we can conclude that fiscal policy does not have an immediate impact on the performance of private investment in the region. And perhaps, the significance of the effect of lagged values of public investment could not be taken as guarantee for avoidance of any possible crowd-out effects of fiscal policy measures taken by the government bodies.

The rest of the variables, incorporated in our analysis, depict different characteristics in explaining the behavior of private investment in the region. For example, GDP per capita and its growth rate have positive and significant impact on the performance of private investment

in the region. However, the growth rate of GDP per capita takes much account, though significant only at ten percent, in explaining the behavior of private investment. Hence, we can conclude that the growth rate of per capita GDP has a stronger effect on private investment than a dollar increase in the level of per capita GDP. And we suggest that countries should focus on growth enhancing measures so that they will manage to promote private investment simultaneously. So far as smaller countries manage to grow more than the larger ones, there is no doubt that they better promote their investment performance.

Variables like real interest rate, debt servicing and debt stock, though statistically significant, explain a very small proportion of the behavior of private investment in Sub- Saharan Africa. Even, some of the macro variables such as inflation rate, real exchange rate, domestic credit to the private sector, and government control, are statistically insignificant in affecting the behavior of private investment in the region. These imply that there are some other variables that may have significant contribution in explaining the behavior of investment in the region. For example, the institutional environment surrounding the private sector may be a more important factor in determining the effect of credit availability to the private sector than the size of the credit available in the financial institutions.

Hence, there is a need to take into account the specific institutional and structural peculiarities of the countries in the region to enhance the private sector performance and their economies in general. For this to happen, we believe that successful promotion of both investment and economic growth in Africa requires actions and measures at the national, regional, and international levels.

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APPENDICES

1. Country list

Country	Country Code	Country ID.
Burundi	BDI	1
Benin	BEN	2
Central African Republic	CAF	3
Cote d'ivoire	CIV	4
Cameroon	CMR	5
Ethiopia	ETH	6
Gabon	GAB	7
Ghana	GHA	8
Gambia, The	GMB	9
Kenya	KEN	10
Madagascar	MDG	11
Mauritania	MRT	12
Malawi	MWI	13
Niger	NER	14
Nigeria	NGA	15
Rwanda	RWA	16
Senegal	SEN	17
Chad	TCD	18
Togo	TGO	19
Uganda	UGA	20
South Africa	ZAF	21
Zambia	ZMB	22
Zimbabwe	ZWE	23

2. Variables Definition and Sources

Annual percentage growth rate of GDP per capita: - is based on constant local currency. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. (World Bank, World Development Indicators)

Domestic credit to private sector: - refers to financial resources provided to the private sector, such as through loans, purchases of non equity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises. (World Bank, World Development Indicators)

Extent of government control (GOV) - we combine black market exchange rate and official exchange rate to account for this variable. In order to do so, we use the following formula:
GOV = [(Parallel market exchange rate – official market exchange rate) / official exchange rate] * 100%

GDP per capita: - is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant U.S. dollars. (World Bank, World Development Indicators)

Inflation: - is measured by the consumer price index, and reflects the annual percentage change in the cost to the average consumer of acquiring a fixed basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used. (World Bank, World Development Indicators)

Money and quasi money (M2): - comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government. This definition of money supply is frequently called M2; it corresponds to lines 34 and 35 in the International Monetary Fund's (IMF) International Financial Statistics (IFS).

Official exchange rate: - refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar). (World Bank, World Development Indicators)

Parallel market exchange rate: - is defined as local currency / US$, period average. (World Bank, African Development Indicators)

Private investment: - covers gross outlays by the private sector (including private nonprofit agencies) on additions to its fixed domestic assets. (World Bank, African Development Indicators)

Public investment: - covers gross outlays by the public sector on additions to its fixed domestic assets. (World Bank, African Development Indicators)

Real effective exchange rate: - is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs. This indicator corresponds to the IFS's line rec, and is based on a nominal rate adjusted for relative changes in consumer prices. (World Bank, African Development Indicators)

Real interest rate: - is the lending interest rate adjusted for inflation as measured by the GDP deflator. (World Bank, World Development Indicators)

3.1. Descriptive Statistics

	RIR		Money and Quasy Money(M2) (% GDP)		Parallel Market Premium		DSR (% GDP)		DTOT (%GDP)		REXR	
Country	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Benin	13.88	1.40	24.68	2.87	2.36	1.40	7.83	2.49	74.09	10.58	89.83	9.72
Burundi	7.39	6.63	18.15	3.07	28.26	11.82	40.82	10.70	116.03	41.45	106.84	16.00
Cameroon	15.13	5.47	18.05	3.11	2.57	1.26	20.48	5.11	77.89	29.18	81.37	16.89
Central Afr.	14.79	6.69	16.78	2.40	2.24	1.43	11.92	2.46	73.00	19.85	76.21	18.00
Chad	14.30	12.37	13.42	3.13	2.57	1.26	5.64	1.29	51.70	18.88	84.24	19.70
Cotid'voire	16.85	1.45	25.95	3.38	2.57	1.26	27.77	8.79	140.70	32.90	83.85	14.91
Ethiopia	5.16	8.18	39.68	7.13	149.92	68.76	23.48	12.67	119.26	35.62	61.23	32.90
Gabon	15.46	16.18	17.59	3.86	2.57	1.26	11.97	3.93	79.47	10.43	70.73	21.03
Ghana	-5.04	4.03	18.16	4.80	14.40	33.45	26.84	13.37	85.99	23.76	88.11	21.50
Gambia,	14.29	8.42	25.77	6.09	8.89	6.39	15.99	5.35	123.74	18.45	95.10	9.92
Kenya	10.42	7.16	32.17	3.64	16.16	13.16	28.14	7.98	73.37	22.78	115.14	14.19
Madagascar	11.51	7.63	18.33	2.63	11.27	6.01	24.38	18.30	126.93	13.46	104.08	19.53
Malawi	8.24	12.90	17.66	2.72	29.29	16.79	23.00	11.49	121.50	34.71	83.74	14.58
Mauritania	3.39	2.58	19.34	5.81	142.49	53.40	24.37	3.18	206.96	16.75	95.99	11.19
Niger	17.03	2.21	14.02	4.95	2.62	1.25	18.25	8.66	79.02	9.77	79.23	17.27
Nigeria	-2.09	16.31	19.93	4.78	128.27	105.5	16.58	9.24	101.90	27.23	132.20	67.99
Rwanda	7.97	4.70	15.49	2.16	47.96	26.30	16.07	5.12	58.05	27.66	100.27	14.75
Senegal	12.61	2.19	23.67	2.20	2.57	1.26	18.70	6.99	77.34	10.11	78.06	21.78

South Africa	**5.37**	**4.37**	**50.69**	**3.77**	**7.15**	**5.64**	**11.40**	**1.77**	**8.90**	**8.46**	**93.08**	**12.11**
Togo	**12.15**	**1.40**	**29.78**	**7.32**	**2.39**	**1.39**	**9.93**	**6.81**	**99.01**	**15.76**	**85.93**	**14.61**
Uganda	**-7.22**	**27.72**	**11.51**	**4.01**	**133.33**	**163.32**	**35.85**	**26.82**	**63.73**	**21.30**	**105.20**	**45.33**
Zambia	**-4.39**	**22.69**	**19.21**	**4.00**	**147.73**	**156.9**	**24.80**	**10.16**	**201.60**	**46.58**	**98.35**	**16.25**
Zimbabwe	**-4.30**	**19.75**	**21.32**	**3.48**	**100.15**	**202.2**	**27.67**	**2.89**	**53.20**	**16.59**	**86.39**	**25.37**
Mean, SSA	**8.01**	**13.40**	**22.23**	**9.70**	**42.95**	**88.15**	**20.52**	**12.94**	**96.23**	**50.56**	**91.09**	**27.99**

Source:- Author's computation based on the data sources

3.2. Descriptive Statistics

Country	**GDP Per Capita**			**Priv. Invest (% GDP)**		**Pub. Invest(% GDP)**		**Inflation**		**Domestic Cr. Priv(% GDP)**		**OEX**	
	Mean	**S.D**	**mean growth**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**
Benin	**294.11**	**18.87**	**0.40**	**8.27**	**2.73**	**7.73**	**1.32**	**7.27**	**8.48**	**14.71**	**7.33**	**469.131**	**171.14**
Burundi	**123.38**	**17.35**	**-1.54**	**2.48**	**0.85**	**9.39**	**4.03**	**11.05**	**9.45**	**13.52**	**6.30**	**392.99**	**303.43**
Cameroon	**637.69**	**108.30**	**-1.51**	**14.12**	**1.65**	**3.69**	**3.41**	**4.81**	**8.59**	**14.93**	**7.83**	**469.13**	**171.14**
Central Afr.	**255.10**	**21.80**	**-1.54**	**5.55**	**2.55**	**6.40**	**1.82**	**2.47**	**7.73**	**5.56**	**1.53**	**469.13**	**171.14**
Chad	**185.42**	**11.86**	**0.37**	**9.47**	**14.06**	**6.89**	**2.47**	**3.75**	**12.28**	**6.55**	**5.38**	**469.13**	**171.14**
Cotid'voire	**638.51**	**45.59**	**-1.39**	**6.77**	**2.43**	**4.05**	**1.14**	**5.41**	**6.25**	**24.39**	**9.85**	**469.13**	**171.14**
Ethiopia	**95.48**	**8.35**	**1.09**	**8.41**	**2.12**	**7.35**	**2.32**	**5.27**	**10.25**	**19.97**	**6.38**	**5.21**	**2.69**
Gabon	**3985.05**	**206.18**	**-0.68**	**22.02**	**5.41**	**6.10**	**2.96**	**2.51**	**10.19**	**13.01**	**6.51**	**469.13**	**171.14**
Ghana	**229.13**	**21.42**	**1.87**	**8.45**	**4.33**	**10.03**	**2.20**	**27.59**	**12.50**	**7.24**	**3.70**	**2364.41**	**2884.99**
Gambia, the	**316.19**	**9.20**	**-0.02**	**11.97**	**2.06**	**7.24**	**2.03**	**10.29**	**12.98**	**11.99**	**2.28**	**11.10**	**5.21**
Kenya	**425.68**	**11.92**	**0.15**	**9.33**	**2.25**	**6.11**	**2.87**	**13.28**	**11.33**	**29.49**	**3.09**	**48.62**	**23.57**
Madagascar	**243.52**	**18.53**	**-0.99**	**6.16**	**2.46**	**6.83**	**1.13**	**15.13**	**12.27**	**13.29**	**4.18**	**738.37**	**452.14**

Malawi	**140.89**	**9.07**	**-0.05**	**5.91**	**3.97**	**8.85**	**1.95**	**26.24**	**17.74**	**9.05**	**2.76**	**25.54**	**30.86**
Mauritania	**369.71**	**28.63**	**1.31**	**16.04**	**3.54**	**6.40**	**2.25**	**6.15**	**2.82**	**29.51**	**7.76**	**147.04**	**72.21**
Niger	**166.98**	**12.94**	**-0.69**	**3.56**	**1.55**	**6.73**	**1.79**	**2.03**	**9.64**	**8.66**	**4.85**	**469.13**	**171.14**
Nigeria	**351.68**	**18.88**	**1.14**	**9.52**	**3.26**	**9.68**	**2.86**	**26.74**	**22.61**	**12.63**	**3.18**	**41.09**	**45.72**
Rwanda	**242.49**	**31.34**	**0.68**	**8.22**	**2.55**	**7.49**	**2.63**	**5.88**	**5.24**	**8.36**	**1.66**	**240.15**	**153.77**
Senegal	**409.42**	**18.61**	**0.50**	**9.84**	**1.04**	**5.64**	**1.81**	**2.83**	**7.86**	**22.52**	**5.39**	**469.13**	**171.14**
South Africa	**3060.22**	**106.14**	**-0.14**	**16.04**	**2.44**	**4.38**	**2.42**	**10.40**	**4.24**	**38.34**	**34.7**	**4.56**	**2.48**
Togo	**253.70**	**20.13**	**-0.62**	**12.30**	**3.63**	**4.93**	**3.11**	**4.57**	**9.61**	**20.33**	**4.79**	**469.13**	**171.14**
Uganda	**205.05**	**36.10**	**2.68**	**9.94**	**3.67**	**5.66**	**1.03**	**43.86**	**68.00**	**5.31**	**1.01**	**989.54**	**621.58**
Zambia	**333.30**	**32.53**	**-0.92**	**5.19**	**1.93**	**7.38**	**3.02**	**62.79**	**51.04**	**8.01**	**1.57**	**1384.4**	**1604.45**
Zimbabwe	**604.07**	**48.84**	**-1.14**	**14.14**	**4.12**	**2.63**	**1.04**	**35.62**	**31.88**	**26.46**	**7.94**	**54.32**	**161.58**
Mean, SSA	**589.86**	**37.50**	**-0.04**	**9.73**	**5.99**	**6.59**	**2.96**	**14.61**	**25.97**	**18.62**	**21.29**	**463.89**	**874.47**

Source:- Author's own computation based on the data sources

4. Pair- wise correlation among the basic macro variables

```
pwcorr iprv gdppc ggdppc ipub dcrprv rir m2 infl dser dtot rexr gov, sig star(.05)
```

	iprv	gdppc	ggdppc	ipub	dcrprv	rir	m2	infl	dser	dtot	rexr	gov
Private invest.	1.0000											
GDP Per Capita	0.5364*	1.0000										
	0.0000											
Growth GDPPC	0.0901	-0.0239	1.0000									
	0.0671	0.6283										
Public Invest.	-0.1862*	-0.1746*	0.0977*	1.0000								
	0.0001	0.0004	0.0469									
Domest. Prv. Cr	0.2450*	0.4936*	-0.0513	-0.2662*	1.0000							
	0.0000	0.0000	0.2979	0.0000								
Real int. rate	0.0904	0.0841	0.0086	0.0200	-0.0017	1.0000						
	0.0660	0.0876	0.8608	0.6843	0.9733							
M2	0.1796*	0.3094*	-0.0830	-0.1493*	0.7313*	0.0428	1.0000					
	0.0002	0.0000	0.0917	0.0023	0.0000	0.3854						
Inflation	-0.1514*	-0.1016*	-0.0078	-0.0072	-0.0990*	-0.3171*	-0.1398*	1.0000				
	0.0020	0.0388	0.8747	0.8839	0.0442	0.0000	0.0044					
Debt- Servicing	-0.2650*	-0.1979*	0.0079	0.0692	-0.0524	-0.3302*	-0.1590*	0.3120*	1.0000			
	0.0000	0.0001	0.8733	0.1600	0.2873	0.0000	0.0012	0.0000				
Debt–GDP ratio	-0.1118*	-0.2811*	-0.0103	0.0949	-0.2391*	-0.0952	-0.1286*	0.1677*	0.2246*	1.0000		
	0.0229	0.0000	0.8340	0.0536	0.0000	0.0529	0.0088	0.0006	0.0000			
Real exch. Rate	-0.1465*	-0.1129*	-0.1074*	0.0608	0.0358	-0.1285*	-0.0279	0.1856*	0.2743*	-0.1100*	1.0000	
	0.0028	0.0216	0.0289	0.2168	0.4670	0.0088	0.5710	0.0001	0.0000	0.0252		
Gov. control	-0.0307	-0.0750	0.0279	-0.0739	-0.0936	-0.2916*	-0.1527*	0.4103*	0.1592*	-0.0855	0.243*	1.0000
	0.5338	0.1274	0.5716	0.1335	0.0571	0.0000	0.0018	0.0000	0.0012	0.0824	0.0000	

Source: - Author's own computation based on the data sources mentioned. Note: - * indicates correlation coefficients significant at 5%.

5. Outputs and Specification Test

1. The Fixed Effects Regression When Individual Time Effects are Incorporate (using public investment at its contemporaneous values)

```
xi: xtreg iprv lgdppc ggdppc ipub ldcrprv rir linfl rexr dser dtot gov i.yr,fe

i.yr              _Iyr_1986-2003    (naturally coded; _Iyr_1986 omitted)

Fixed-effects (within) regression          Number of obs      =       413
Group variable (i): ctyid                  Number of groups   =        23

R-sq:  within  =0.3966                     Obs per group: min =        17
       between =0.2715                                    avg =      18.0
       overall =0.3420                                    max =        18

                                           F(27,363)          =      2.78
corr(u_i, Xb)  = -0.6465                   Prob > F           =    0.0000
```

iprv	Coef.	Std. Err.	T	P>|t|
lgdppc	0.093	0.0064	2.52	0.012
ggdppc	0.113	0.0396	1.66	0.090
ipub	0.069	0.0908	0.78	0.438
ldcrprv	-0.021	0.0185	-1.14	0.254
rir	0.036	0.0214	1.78	0.076
linfl	-0.004	-0.0142	-0.41	0.680
rexr	-0.007	0.0112	-0.66	0.508
dser	-0.067	0.0254	-2.88	0.004
dtot	0.018	0.0099	1.87	0.062
gov	0.000	0.0397	0.13	0.899
_Iyr_1987	0.806	1.1894	0.68	0.498
_Iyr_1988	1.668	1.1955	1.40	0.164
_Iyr_1989	0.499	1.2045	0.41	0.679
_Iyr_1990	1.257	1.2155	1.03	0.302
_Iyr_1991	0.969	1.2374	0.78	0.434
_Iyr_1992	0.038	1.2474	0.03	0.975
_Iyr_1993	0.951	1.2696	0.75	0.454
_Iyr_1994	0.965	1.3255	0.73	0.467
_Iyr_1995	0.600	1.3446	0.45	0.655
_Iyr_1996	0.288	1.3138	0.22	0.826
_Iyr_1997	1.004	1.3067	0.77	0.443

_Iyr_1998	1.651	1.2920	1.28	0.202
_Iyr_1999	1.434	1.3109	1.09	0.275
_Iyr_2000	2.324	1.332	1.74	0.082
_Iyr_2001	3.242	1.328	2.44	0.015
_Iyr_2002	3.526	1.336	2.64	0.009
_Iyr_2003	3.697	1.288	2.87	0.004
_cons	10.720	2.288	6.250	0.000
sigma_u	6.1516324			
sigma_e	3.8950095			
rho	0.71382671 (fraction of variance due to u_i)			

Here the output shows that most variables, including the fiscal policy variable-public investment, are insignificant in explaining the behavior of investment. Hence, we prefer to use the lagged values of public investment and build the following alternative output, based on which we perform a Hausman specification test.

2. The Fixed Effects Regression When Individual Time Effects Are Incorporated (using public investment at its one period lagged values)

```
xi: xtreg iprv lgdppc ggdppc lipub ldcrprv rir linfl rexr dser dtot gov i.yr,fe
i.yr              _Iyr_1986-2003    (naturally coded; _Iyr_1986 omitted)

Fixed-effects (within) regression          Number of obs      =       413
Group variable (i): ctyid                  Number of groups   =        23

R-sq:  within  =  0.4090                   Obs per group: min =        17
       between =  0.2805                                  avg =      18.0
       overall =  0.3488                                  max =        18

                                           F(27,363)          =      2.96
corr(u_i, Xb)  = -0.6500                   Prob > F           =    0.0000
```

iprv	Coef.	Std. Err.	T	P>|t|
lgdppc	0.097	0.000	2.440	0.015
ggdppc	0.142	0.039	1.920	0.056
lipub	0.153	0.087	1.790	0.074
ldcrprv	-0.020	0.078	-1.070	0.284
rir	0.036	0.021	1.770	0.078
linfl	-0.004	0.011	-0.410	0.684
rexr	-0.006	0.011	-0.640	0.525
dser	-0.066	0.025	-2.900	0.004
dtot	0.019	0.010	2.050	0.041

gov	0.000	0.000	0.220	0.826
_Iyr_1987	0.551	1.183	0.47	0.642
_Iyr_1988	1.532	1.179	1.30	0.195
_Iyr_1989	0.507	1.191	0.43	0.670
_Iyr_1990	1.270	1.200	1.06	0.290
_Iyr_1991	0.945	1.215	0.78	0.437
_Iyr_1992	0.158	1.233	0.13	0.898
_Iyr_1993	0.968	1.250	0.77	0.439
_Iyr_1994	1.041	1.309	0.80	0.427
_Iyr_1995	0.676	1.327	0.51	0.611
_Iyr_1996	0.311	1.289	0.24	0.809
_Iyr_1997	1.080	1.279	0.84	0.399
_Iyr_1998	1.819	1.278	1.42	0.156
_Iyr_1999	1.481	1.286	1.15	0.250
_Iyr_2000	2.371	1.302	1.82	0.070
_Iyr_2001	3.434	1.313	2.61	0.009
_Iyr_2002	3.668	1.320	2.78	0.006
_Iyr_2003	3.780	1.274	2.97	0.003
_cons	9.897	2.213	5.830	0.000
sigma_u	6.1997809			
sigma_e	3.8739109			
rho	.7192004	(fraction of variance due to u_i)		

```
F-test that all u_i=0:       F(22,363)= 15.27      Prob > F = 0.0000
```

est store fixed

3. The Random Effects Regression When Individual Time Effects Are Incorporated (using public investment at its one period lagged values)

```
xi: xtreg iprv lgdppc ggdppc lipub ldcrprv rir linfl rexr dser dtot gov i.yr,re
i.yr  _Iyr_1986-2003    (naturally coded; _Iyr_1986 omitted)

Random-effects    GLS regression            Number of obs     =       413
Group variable    (i): ctyid                Number of groups  =        23

R-sq:  within     = 0.1209                  Obs per group: min =        17
      between     = 0.3401                                 avg =      18.0
     overall      = 0.1978                                 max =        18

Random effects    u_i ~ Gaussian            Wald chi2(27)     =     61.46
corr(u_i, X)      = 0 (assumed)             Prob > chi2       =    0.0002
```

Iprv	Coef.	Std. Err.	Z	P>|z|
Lgdppc	.0012033	.0004936	2.44	0.015
Ggdppc	.0738834	.0427145	1.73	0.084
Lipub	.1191705	.0894291	1.33	0.183
Ldcrprv	-.0137657	.0173099	-0.80	0.426
Rir	.0351336	.0222117	1.58	0.114
Linfl	.002426	.0115211	0.21	0.833
Rexr	-.0053111	.0109999	-0.48	0.629
Dser	-.0495023	.0252691	-1.96	0.050
Dtot	.0034083	.0080367	0.42	0.672
Gov	.0000898	.0004084	0.22	0.826
_Iyr_1987	.2858411	1.280805	0.22	0.823
_Iyr_1988	1.160069	1.27601	0.91	0.363
_Iyr_1989	-.0052265	1.285935	-0.00	0.997
_Iyr_1990	.7058749	1.292766	0.55	0.585
_Iyr_1991	.4165133	1.307635	0.32	0.750
_Iyr_1992	-.3666659	1.325287	-0.28	0.782
_Iyr_1993	.6186892	1.342837	0.46	0.645
_Iyr_1994	.9682492	1.396312	0.69	0.488
_Iyr_1995	.2633908	1.418312	0.19	0.853
_Iyr_1996	-.1661947	1.3804	-0.12	0.904
_Iyr_1997	.4401701	1.367744	0.32	0.748
_Iyr_1998	1.29535	1.36617	0.95	0.343
_Iyr_1999	.9425124	1.374303	0.69	0.493
_Iyr_2000	1.852779	1.390164	1.33	0.183
_Iyr_2001	2.747119	1.399153	1.96	0.050
_Iyr_2002	3.020113	1.406475	2.15	0.032
_Iyr_2003	3.21703	1.363267	2.36	0.018
_cons	8.366011	2.176134	3.84	0.000
sigma_u	2.1579542			
sigma_e	3.8739109			
Rho	.23681742	(fraction of variance due to u_i)		

est store random

4. The Fixed Effects Model Vs the Random Effects Model (The Hausman Specification Test)

hausman fixed random

---- Coefficients --------

	(b) fixed	(B) Random	(b- B) Difference	Sqrt(diag(v_b-v_B)) S.E.
lgdppc	0.097	0.001	0.096	0.0004
ggdppc	0.142	0.073	0.069	.
lipub	0.153	0.119	0.034	.
ldcrprv	-0.020	-0.014	-0.006	0.006
rir	0.036	0.035	0.001	.
linfl	-0.004	0.002	-0.006	.
rexr	-0.006	-0.005	-0.001	.
dser	-0.066	-0.049	-0.017	.
dtot	0.019	0.003	0.016	0.006
gov	0.000	0.000	-0.000	.
_Iyr_1987	0.551	0.286	0.265	.
_Iyr_1988	1.532	1.160	0.372	.
_Iyr_1989	0.508	-0.005	0.513	.
_Iyr_1990	1.271	0.706	0.565	.
_Iyr_1991	0.945	0.417	0.529	.
_Iyr_1992	0.158	-0.367	0.525	.
_Iyr_1993	0.968	0.619	0.349	.
_Iyr_1994	1.042	0.968	0.074	.
_Iyr_1995	0.676	0.263	0.413	.
_Iyr_1996	0.312	-0.166	0.478	.
_Iyr_1997	1.080	0.440	0.640	.
_Iyr_1998	1.820	1.295	0.524	.
_Iyr_1999	1.482	0.943	0.539	.
_Iyr_2000	2.371	1.853	0.518	.
_Iyr_2001	3.434	2.747	0.687	.
_Iyr_2002	3.668	3.020	0.648	.
_Iyr_2003	3.781	3.217	0.564	.

```
b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg
    Test:  Ho:  difference in coefficients not systematic
      chi2(27) = (b-B)'[(V_b-V_B)^(-1)](b-B)
               =       40.73
     Prob>chi2 =      0.0437
    (V_b-V_B is not positive definite)
```