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Explaining the Growth of Sub-Saharan Africa: The Role of Institutions



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“Explaining the Growth of Sub – Saharan Africa:
The Role of Institutions.”

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List of Acronyms:

AfDB: African Development Bank

AJR: Acemoglu, Johnson and Robinson

DEA: Data Envelopment Analysis

DIFF-GMM: Difference Generalized Method of Moments

GDP: Gross Domestic Product

GMM: Generalized Methods of Moments

MRW: Mankiw, Romer and Weil

OECD: Organization for Economic Co-operation and Development

SFA: Stochastic Frontier Analysis

SSA: Sub-Saharan Africa

SYS-GMM: Systems Generalized Methods of Moments

UNESCO: United Nations' Education, Science and Culture Organization

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Abstract

Sub-Saharan Africa has been growing at very low rates in the past few decades. The roles of malfunctioning institutions, geographic misfortune and lack of integration in explaining this have been a subject of much debate. This study assesses the role of institutions in explaining the slow growth of Africa. In addition, it explores one of the possible transmission channels, aggregate technical inefficiency, through which institutions affect economic growth. In order to evaluate the impact of institutions on economic growth, the neoclassical growth models (Solow and its augmented version) have been estimated using differenced and systems GMM using data from 35 selected SSA countries from 1996-2005. Rule of law, government effectiveness, regulatory quality, political instability and voice and accountability are found to influence growth of SSA. However, control over corruption has no relation with growth in the continent. Using stochastic frontier analysis, this study found that only three aspects of governance—regulatory quality, government effectiveness and control of corruption—matter in influencing technical efficiency. Political aspects of governance—voice and accountability and political instability—have no relation with technical efficiency. Therefore, Sub-Saharan Africa's poor economic performance (slow growth and aggregate technical inefficiency) can in part be attributed to bad governance.

Keywords: *Growth, Technical Inefficiency, Institutions/Governance, GMM, Stochastic frontier analysis*

Chapter One

1. Introduction



1.1. Background and Statement of the Problem

Africa's participation in the global economy has declined drastically over the past 50 years in terms of GDP, exports and foreign direct investment. For instance, its share in the global GDP has declined from around 3.5 percent in 1950 to 2.5 percent in 2000. The decrease in Africa's share of world export and foreign direct investment is even more drastic. Export as a percentage of world export declined from about 7 to 2 percent in these five decades. While foreign direct investment declined from 5.5 to 1 percent in the same period. The decline of the continent's importance in the global economy is much sharper in terms of its relations with the rest of the world than purely in terms of economic activity. Its share of global GDP in purchasing power parity terms fell by a third between 1950 to 2000 but its share of world exports shrank by two third (Berthelemy *et al.*, 2002).¹

According to the AfDB-OECD (2002) report, the main reason for the continent's gradual detachment from the world economy lies in home-growth changes. Africa's slower growth compared to the rest of the world can alone account for the even greater slump in its share of world trade, since over the past half century the elasticity of foreign trade to GDP has been very high. With an elasticity of two, the sluggish growth of the African economy by itself would account for a 50 per cent fall in its share of world trade.

Ndulu and O'Connell (undated) calculated simple cross-country averages, which, at best, suggest a

¹ This is the summary of AfDB-OECD report (2002).

story of modest growth of the continent over the period of 1960-2000. However, non-African growth consistently outpaced African growth after 1960, with the result that Sub-Saharan Africa's real incomes fell by over 35 percent relative to incomes in other developing regions and by nearly half relative to industrial countries. Another study (Paap *et al.*, 2004) also tried to address the question whether Sub-Saharan African countries have lower average growth rates in real GDP per capita than countries in Asia, Latin America and the Middle East. Contradicting the results of Ndulu and O'Connell (undated), they found that not all African countries (included in their analysis) were performing poorly. They asserted that one out of four African countries had growth rates that matched those of many Asian and Latin American countries. Therefore, there are no clear-cut continent specific clusters in growth of nations. However, the fast growing countries (Congo Republic, Cape Verde, Gabon, Lesotho, Mauritius, Malawi, Seychelles and Zimbabwe) account for a small proportion of the total population of the continent.

Whichever the case may be, a number of explanations were given as to why some regions, especially those located in the tropics, were growing at very low rates. Easterly and Levin (2002) summarized these arguments into three groups. First, the geography fundamentalists emphasize endowments (tropics, germs and crops). Secondly, the institutionalists argue that institutions are the result of tropical location and the cultural differences that forced the European to build either 'extractive' colonies (such as in African and Latin America) or 'settler' colonies (such as in North America and Australia). Finally, policy fundamentalists focus on policies, which include sound macroeconomic policies, openness to international trade, and absence of capital account control. While Rodrik *et al.*, (2004) included a fourth argument postulated by trade fundamentalists who emphasise integration to the global economy as an engine of growth.

Africa's growth determinants have also been found to be different from those of the rest of the world. Except initial output level, variables identified as important in explaining the global pattern of economic growth lose their significance for the Africa-only sample. Moreover, variables that were insignificant in explaining growth elsewhere are very significant in explaining African growth. Among these unique growth determinants, institutions are particularly important in explaining the growth of Africa (Masanjala and Papageorgiou, 2003).

Institutions, as defined by North (1990:3), 'are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction.' In consequence they structure incentives in human exchange, whether political, social or economic. North (1990) continues with his analysis of institutions by redefining them as a form of humanly devised constraints to shape human interactions. These constraints could be formal or informal. Formal constraints include the rules that human beings devise, while informal ones are conventions and code of behaviour. The major role of these institutions in a society is to reduce uncertainty by establishing a stable (but not necessarily efficient) structure to human interaction.



Previous studies by Rodrik *et al.* (2004), Easterly and Levine (2002), Acemoglu, Johnson and Robinson (hence forth AJR, 2001), and others have revealed that institutions/governance play a significant role in explaining cross-country differences in growth rates.² These previous studies, however, are characterized by the use of weak methodology that did not address the existence of heterogeneity of countries, endogeneity of some of the regressors, and possibility of measurement

² There is no standard definition for the concept of governance. However, Kaufmann *et al.* (1999) defined it as the traditions and institutions by which authority of a country is exercised. This includes, (1) the process by which governments are selected, monitored and replaced, (2) the capacity of the government to effectively formulate and implement sound policies, and (3) the respect of citizens and the state for the institutions that govern economic and social interactions among them. From now on, this study uses the term governance and institutions interchangeably acknowledging conceptual differences.

error. Therefore, this study reassesses the impact of different institutional qualities on economic growth of countries in Sub-Saharan Africa by applying more informative panel data and more consistent estimation techniques—difference and systems GMM.

Institutions/governance could affect income directly (a fall in output due to inefficient government and other sort of poor governance) or indirectly by affecting accumulation and productivity. The channels through which bad governance translates into slow growth and low income are probably numerous and, for the most part, still have to be identified (Meon and Weill, 2005). This study traces one of these possible channels—technical inefficiency—through which bad governance translates into poor economic performance.

There exist a number of aspects of governance such as the rule of law, control of corruption, political instability, voice and accountability, government effectiveness, and regulatory quality. Attaining good governance in every aspect is very difficult and costly, especially for poor countries in Africa. The significance of each indicator in explaining the growth of the continent could be very different and needs to be addressed. Therefore, the findings concerning the choice of dimensions of governance that dominate others are important for policy practice. Meon and Weill (2005), for instance, analyzed data from 65 countries to investigate if there is difference in the importance of various institutional qualities. They found that government effectiveness is most robustly associated with aggregate efficiency. While voice and lack of violence have very small coefficients, which imply that political systems and absence of violence might not be as essential in determining the capacity of an economy to make the best of its factor endowments as are the other dimensions of governance. Whether this holds true for the Africa-only sample is an important question addressed in this study.

Therefore, this study appraises the importance of governance variables (developed in a series of researches by Kaufman *et al.* 1999, 2000, 2006) in explaining Sub-Saharan Africa's growth; compares the importance these variables towards the continent's growth; and dwells on technical efficiency as a major channel through which bad governance is translated into lower income per capita in Africa.

1.2. Objectives of the Study

General Objective:

This study is devoted to the discussion of the poor economic performance of Sub-Saharan Africa and the role of good governance to avert this situation.

Specific Objectives:

Specifically, the study dwells on:

- Analyzing the importance of good governance for the economic growth of Sub-Saharan Africa.
- Comparing the significance of different governance indicators in explaining the 'unsatisfactory' economic growth of the continent.
- Tracing the channel of transmission —aggregate technical inefficiency—via which governance affects the growth of the continent.

1.3. Hypotheses

Based on the objectives and problems stated above different hypotheses are developed and tested.

The hypotheses include: governance play an indispensable role in explaining the slow growth of

countries in Sub-Saharan Africa. There is also difference in the significance of various aspects of governance in explaining Africa's slow growth. After raising these points and testing them, the next logical step is to trace the channels of transmission through which bad governance translates into unsatisfactory economic performance. Therefore, we hypothesise that aggregate technical efficiency is one of the major channels via which institutions/governance affect the economic growth of countries in Africa.

1.4. Methodology

Method of Analysis:

Typically, the empirics of long-run economic growth have been analyzed in a cross section regression framework using average data for long periods, say 25 or 30 years (see for instance AJR, 2001; Easterly and Levin, 2002 and others). This method has got limitations as it suffers from the problem of endogeneity; averaging a time series variable implies that not all information is utilized; single equation cross-section regressions are likely to suffer from omitted variable biases (Hoeffler, 2002). The right-hand-side variables are typically endogenous and measured with error (Bond *et al.*, 2001). A dynamic panel data approach addresses these limitations (Hoeffler 2000).

Hoeffler (2000) proposed first difference generalized method of moments (DIF-GMM) of Arellano and Bond (1991) and systems generalized method of moments (SYS-GMM) estimator by Blundell and Bond (1998) in estimating dynamic growth models. Both GMM estimators address the bias problems encountered in single equation cross-section regressions, because in a dynamic panel data model we will be able to account for unobserved country specific effects and allow for the endogeneity of one or more of the regressors. Bond *et al.* (2001) also argue (*sic*) that the potential

for obtaining consistent estimates even in the presence of measurement error and endogenous right-hand-side variables is a considerable strength of the GMM approaches in the context of empirical growth research. Hoeffler (2002) used Sargan tests and found SYS-GMM estimator to be more efficient than DIF-GMM estimator, provided that some restrictions are valid.³

With the above justifications to utilize of dynamic panel approach in analyzing cross-country growth, this study utilizes the generalized methods of moments in the analysis of the importance of good governance. The classical growth models (the original Solow 1956 and its augmented version suggested by Mankiw, Romer and Weil, henceforth MRW, 1992) augmented with institutions are estimated using the GMM techniques in a panel context.

As mentioned above, the channels through which bad governance translates into lower income are diverse. Not only accumulation of factors of production but also the extent to which a country is utilizing the resources efficiently determines growth in its income. Efficiency is one possible channel through which governance affects the economic growth of nations. To trace this channel, a stochastic frontier approach is adopted in this study. In the stochastic frontier approach, technical inefficiency measures how close a country's production is to what the country's optimal production would be for using the same bundle of inputs. To find the inefficiency scores of countries, first a production frontier is estimated, providing a benchmark for each country regardless of its inputs. Then, the inefficiency score is computed by comparing the optimal output per worker with the effective output per worker (Meon and Weill, 2005). This study explains the inefficiencies scores

³ The restrictions imposed are on dynamic level equation of the form:

$$Y_{i,t} = \alpha + \beta * Y_{i,t-1} + \phi X_{i,t} + u_i + V_{i,t}$$

with the regressors satisfying: $E(\Delta X_{i,t} u_i) = 0$ and the initial conditions satisfying the restriction:

$$E(\Delta Y_{i,t-1} u_i) = 0$$

of Sub-Saharan Africa countries with institutions, controlling for geography, educational attainment of the population, and historical factors.

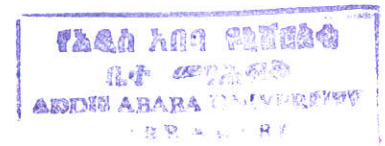
Data Sources:

Data for 35 selected Sub-Saharan African countries is analyzed in this study. The data is taken from different sources. Data on real GDP, investment, population growth, labour force, land area, and classification of countries into different income groups are taken from World Development Indicators (World Bank, 2006); while, data on enrolment in secondary schools (as a proxy for human capital formation) is taken from UNESCO.⁴ The list of landlocked countries and data on the former colonizers' identity are taken from Wikipedia.⁵

Quality of institutions/governance, however, is difficult to measure and is subjected to biases as it is dependent on expert opinion and subjective perceptions (of residents, entrepreneurs, foreign investors, and the civil society at large) regarding quality of governance in different countries (Kaufmann *et al.* 1999; Gwartney *et al.*, 2006; and Meon and Weil, 2005). This, however, does not mean that the data on governance is nonsense. Kaufmann *et al.* (1999) gave several reasons why this kind of data is useful in measuring governance quality. First, objective data on various aspects of governance, such as the prevalence of corruption, is difficult to obtain. Second, perceptions of the quality of governance may (*sic*) often be as important as objective differences in institutions across countries. While a country may nominally enjoy a set of sound institutions according to certain standards, the confidence of residents of the country in these institutions is also required if they are to contribute to economic growth. Third, Kaufmann *et al.* (1999) found that subjective

⁴ www.unesco.org/education

⁵ <http://en.wikipedia.org/>



perceptions can have significant explanatory power for future economic outcomes.

The above rationales justify the use of perception based data on governance. Such data on indicators of governance such as rule of law, control of corruption, voice and accountability, political stability, government effectiveness, and regulator quality are taken from World Bank governance data (Kaufman *et al.*, 2006).⁶

1.6. Significance of the Study

The preceding studies on cross country growth analysis dwelt on the discussion of the primacy of the role of institutions over geography and trade in influencing countries' growth globally. There is no consensus over this issue and the area is still open for detailed scrutiny. Even those studies focusing on the impact of institutions in explaining Africa's growth are characterized by some weaknesses in the methodology they utilize to explain a complex process such as economic growth. Cross section Ordinary Least Squares, Random and Fixed Effects panel estimations were the major methods used by these authors. However, such methods are flawed. To address the methodological limitations of the previous studies, this study adopts differenced and systems GMM estimation technique to estimate the growth models. These techniques enable us to get consistent estimates of the growth models.

In addition, institutions could influence growth of nations directly or indirectly via some transmission channels. This study, therefore, tries to trace one of the channels—technical inefficiency—through which poor institutions translate into slower growth.

⁶ The meaning of these indicators is discussed in detail in Chapter 4. The data is available at www.worldbank.org/wbi/governance

1.7. Limitations of the Study

The study has some specific limitations and some in common ones sharing them with all or some of the previous cross-country studies on the institutions-growth nexus. Like all cross-country growth-institutions nexuses, this study suffers from the fact that institutions at a country level are crude and obscure important dimension of heterogeneity within the country (Pande and Udry, 2006). The study of Pande and Udry (2006) suggests a micro-approach for the analysis of institutions' impact on growth, where a homogeneous unit smaller than a country that better reveals the causal effect of institutions to be analysed.

Because of data unavailability on enrolment in secondary schools and the indicators of governance quality, the time dimension of our panel data is limited. As a result, we can not use bi-decadal averages of the macroeconomic variables over time to account for business cycle dynamics. However, accounting for such business cycle dynamics is important (Ulubasoglu and Doucouliagos, 2004; and Bond *et al.*, 2001). The use of five year averages of our data leaves two data points only. Moreover, changes in institutional quality are likely to have effects on growth only with lags (Gwartney *et al.*, 2005). The almost one decade data we have on governance is too short to give a long-run relationship between governance and growth.

Finally, this study adopted the classical growth models (Solow and Augmented Solow) to assess the impact of institutions on economic growth in Sub-Saharan Africa. However, there is no consensus on the question of whether growth in African could be modelled using standard growth theories (see Masanjala and Papageorgiou, 2003). This study sets aside this variable/model



uncertainty and proceeds with estimating classical models.

1.8. Organization of the Study

The study is structured as follows: Chapter 2 assesses the relevant literature; while Chapter 3 dwells on the model selection, specification and method of estimation. Chapter Four presents the data analysis and discussions of the results. The final chapter gives the summary, policy recommendations and extensions.

Chapter Two

2. Review of the Theoretical and Empirical Literature

There is a large disparity in income level of countries located in different parts of the world. Those regions in the tropics, like Sub-Saharan Africa and Latin America, are poor; while those in the temperate zone have higher incomes. According to Sachs (2000), for instance, of the thirty economies classified as high income by the World Bank, only two small economies—Hong Kong and Singapore—are located in the geographical tropics, and these two constitute just one percent of the population of rich economies. The Sub-Saharan Africa dummy is also found to be negative and significant in economic growth regressions. This indicates that countries in the continent have been growing at lower rates relative to other developing regions. This supports the idea that Africa has been growing extremely slowly (Barrios *et al.*, undated).

During its independence around 1960s, there was hope that Africa would follow the path of prosperity. In fact, until the early 1970s there was negligible difference between the growth of Sub-Saharan Africa and other developing regions in the world. The parity situation had changed dramatically by the second half of the decade, as Africa's growth started to slow down and by the early 1980s the continent suffered from economic contraction (Barrios *et al.*, undated).

However, Paap *et al.* (2004) have found that there is no continental specific cluster in the growth of nations. There are countries in Africa that grow at the same rate as countries in other part of the world. One out of four African countries has moderate growth rates. Yet the countries with higher rates of growth (Republic of Congo, Cape Verde, Gabon, Lesotho, Mauritius, Malawi, Seychelles and Zimbabwe) account for a small fraction of the total population in Africa.

Various explanations have been given for this growth divergence among countries in different parts of the world. These explanations are organised under two headings in this study. The first and oldest argument for growth divergence has been that of the neoclassical and the endogenous growth theories, which focus on accumulation and productivity as well as, in its endogenous version, advances in technological as the engine of growth. Thus, Africa has been growing so slowly only because investment and technological advancement has been limited in the continent and population growth is very high (see for instance Hoeffler, 2000). The more recent arguments focus on other factors (geography, institutions, and integration) as the fundamental causes of growth. Tropical area is characterized by slower growth because of bad geography, malfunctioning institutions and lack of integration.

2.1. Accumulation and Productivity as Sources of Growth

Much of the research on long-run economic growth is grounded in either neoclassical or endogenous growth theory. According to the neoclassical theory, the income level of a country is determined by resources and exogenously given technology. The higher a country's savings rate and the lower its population growth, the higher is steady-state per capita income (Olson *et al.*, 1998).

The neoclassical model also assumes that there are diminishing returns to investment in physical and human capital and it predicts that countries will converge to the same level of income and growth rates, at least conditional on the determinants of steady state (see Solow, 1956; MRW, 1992, and Olson *et al.*, 1998). This is because countries that have not yet reached their steady state

(because they have less capital per worker and thus a higher marginal product of capital) should grow more rapidly than those that have already reached their steady-state growth (Olson *et al.*, 1998). Both the Solow (1956) model and the augmented Solow model of MRW (1992) predict that countries with similar technologies and rate of accumulation and population growth should converge in terms of income per capita. However, this convergence occurs more rapidly in the original Solow model than in its augmented version (MRW, 1992).

Endogenous growth models feature constant or increasing returns to human and physical capital. These models emphasise that externalities increase with the stock of capital and investment in capital. These externalities account for the absence of general convergence. Therefore, the endogenous models are consistent with the hypothesis that initially poorer economies remain ‘permanently below the initially better endowed economies’ even with the observed divergence in per capita income (Pritchett 1997, cited in Olson *et al.* 1998).

Broadly speaking, neither neoclassical nor endogenous growth theory can account for the fact that simultaneously developing countries as a whole have been falling further behind in economic growth, and that a subset of these countries has grown much faster than other developed countries. However, endogenous growth models can predict that conditional convergence is possible. The poor can converge with the rich provided that certain pre conditions are satisfied. Based on endogenous growth theory, low income countries will tend to catch up only if they have reasonably good governance. Convergence could not be explained without taking the quality of institutions into account (Olson *et al.*, 1998).

2.2. Geography, Integration and Institutions

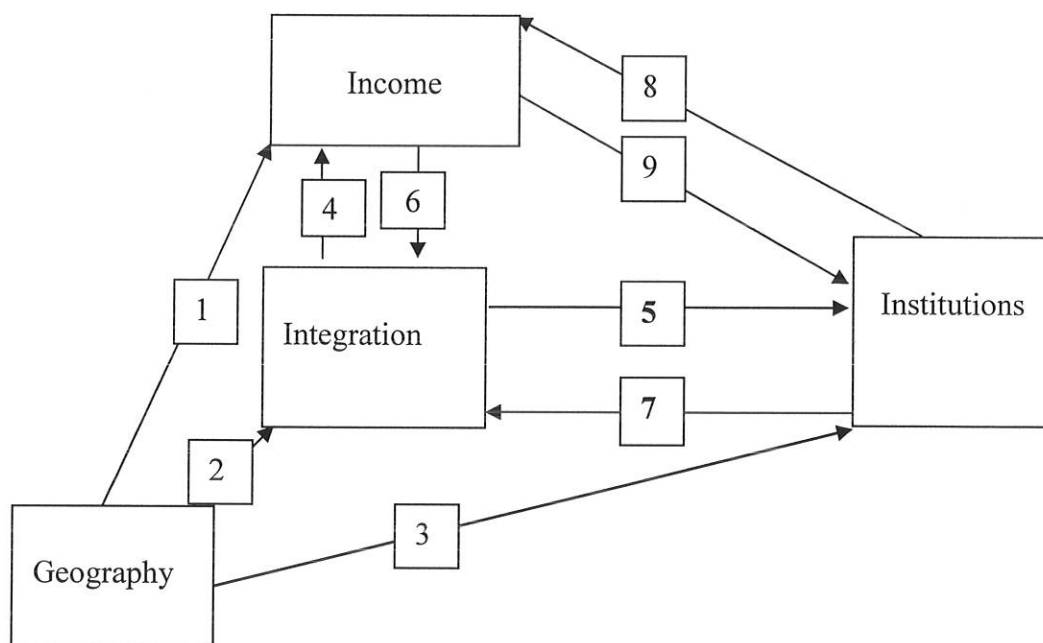
Recently, different theories have been developed to explain the difference in income level of countries in the tropics and those in the temperate zone. As discussed above, growth theory has traditionally focused on physical and human capital accumulation, and, in its endogenous version, on technological change. Rodrik *et al.* (2004) argue that accumulation and technological changes are at best proximate causes of economic growth. Rather, the deep determinants of growth that dictate which society will innovate and accumulate, and therefore develop, are geography, integration, and institutions. The complete discussion of the three major hypotheses as to the cause of growth divergence between countries in the tropics and those located in the temperate zone are presented in this section.

These hypotheses emphasise the variation in geography, institutions and integration. Geography fundamentalists, for instance, place geography/endowment at the centre of the story (Rodrik *et al.*, 2004). They argue that the environment directly influences the quality of land, labour, and production technologies (Machiavelli, 1519; and Montesquieu, 1748, cited in Easterly and Levin, 2002). Therefore, geography directly influences economic growth/income. While, the integration view emphasise international trade as a driver of productivity change. Finally, the institutionalists focus on institutions and in particular the role of property rights and the rule of law (Rodrik *et al.*, 2004). Institutionalists hold that the environment's main impact on economic development runs through long-lasting institutions (Easterly and Levin, 2002).

The primacy of one of these factors over the others in determining growth has been at the heart of the debate among growth and development economists. However, the problems of endogeneity and

reverse causality plague any empirical researcher trying to make sense of the relationship among these deep determinants of growth (Rodrik *et al.*, 2004). According to Rodrik *et al.* (2004), the task of demonstrating causality (*sic*) is perhaps easy for geographical determinists, as geography is an exogenous determinant of growth (see Figure 2.1, adopted from Rodrik *et al.*, 2004). Geography may have a direct effect on income (arrow (1) in Figure 2.1), through its effect on agricultural productivity and morbidity. It can also have an indirect effect through its impact on distance from markets and extent of integration (arrow (2)) or via its impact on quality of institutions (arrow (3)).

However, trade fundamentalists and institutionalists have a considerably more difficult job as they have to demonstrate causality for their preferred determinant, as well as identify the effective channel(s) through which it works. For the former, the task consists of showing that arrow (4) and (5)—capturing the direct impact of integration on income and the indirect impact through institutions, respectively—are the relevant ones, while arrows (6) and (7)—reverse feedbacks from incomes and institutions, respectively—are relatively insignificant. Institutionalists, meanwhile, have to worry about different types of reverse causality. They need to demonstrate that improvements in the institutional environment are independent determinants of income (arrow (8)), and are not simply the outcomes of higher incomes (arrow (9)) or of greater integration (arrow (5)) (Rodrik *et al.*, 2004).



Legend:

- 1 — The direct effect of geography on income.
- 2 — The indirect effect of geography on income through its influence on level of integration.
- 3 — The indirect effect of geography on income via its effect on determining institutional quality
- 4 — The direct effect of integration on income.
- 5 — The indirect effect of integration on income through its influence on institutional quality.
- 6 — Feed back effects running from income to level integration.
- 7 — Feed back effect from improvement in institutional quality to level of integration
- 8 — The direct effect of institutions on income
- 9 — Feed back effect from income to institutions.

Figure 2.1: The ‘Deep’ Determinants of Income (adopted from Rodrik *et al.*, 2004)

Easterly and Levin (2002) also proposed a fourth theory—policy fundamentalism. According to this view, history does not play a large role—any adverse historical legacy can be quickly reversed. Accordingly, while tropical environments, disease, and specific crops may have influenced production and institutions, understanding environmental forces is not crucial to understanding economic development today.

The purpose of this study is not to contribute to the debate over the primacy of institutions over geography and integration or vice versa. Still, reviewing these hypotheses is relevant. The following subsections discuss these three hypotheses meant to explain the growth divergence between the tropics and temperate regions.

2.2.1. The Geography Hypothesis

The geography hypothesis places strong emphasis on the role of geography in explaining tropical underdevelopment. Geography is the key determinant of climate, endowment of natural resources, disease burden, transport cost and diffusion of knowledge and technology from advanced areas. The prominent figures in this line of theorizing are Sachs and Warner. Sachs (2000), for example, proposed five hypotheses that, if proved correct, suggest policy solution for tropical underdevelopment in the form of a focus on technological innovation directed at the problems of tropical ecology.



According to Sachs (2000), the five features that amplify the growth difference between the tropics and the temperate regions include first, technologies in critical areas—especially health and agriculture—are ecologically specific and do not easily diffuse across ecological zones. Secondly,

temperate-zone technologies are/were more productive than tropical-zone technologies. The third hypothesis is that technological innovation is an increasing-returns-to-scale activity. Fourth, the tropical region falls behind the temperate region in societal dynamics—especially the processes of urbanization and demographic transition. Finally, geopolitical factors such as military technology superiority and control of globalization institutions further amplify the differences in income levels between the tropics and temperate regions.

2.2.2. The Integration Hypothesis

The prominent scholars who focused on the role of international trade or the level of integration of a country to the world economy in its growth are Frankel and Romer (1999), Dollar and Kraay (2003), and others. The argument here is that trade/openness, as measured by export plus import ratio to GDP or other policy indicators such as tariffs, is the major determinant of growth divergence among nations.

Both international trade and institutions are influenced by common geographical and historical factors. Hence, using these factors as instruments to disentangle the partial causal effects of institutions and trade on income is difficult. Such instruments tell us that both trade and institutions are important in understanding cross country differences in growth in the long-run. Instead of using geographical and historical factors such as settlers' mortality and resource endowments as instrument for current institutional quality, Dollar and Kraay (2003) proposed to use the lagged values of perception based indicators of governance (like the one developed by Kaufman *et al.*, 1999, 2000 and 2006). Dynamic analysis of these indicators revealed that in the short-run trade has a substantial partial effect, while institutions play a smaller role (Dollar and Kraay, 2003).

The partial effect of changes in trade shares in predicting changes in growth rates is substantial, while changes in measure of institutions play a negligible role. The finding suggests that both trade and institutions play an indispensable role in the long-run. However, the impact of integration is remarkable relative to institutions in the short-run (Dollar and Kraay, 2003).

2.2.3. The Institutions Hypothesis

As mentioned previously, North (1991) defined institutions as the humanly devised constraints that structure political, economic and social interaction. According to North, institutions consist both informal constraints (sanctions, taboos, customs, traditions, and code of conduct), and formal rules (constitutions, laws, property rights). Throughout history, institutions have been devised by human beings to create order and reduce uncertainty in exchange. Institutions also evolve incrementally, connecting the past with the present and the future.

There is no standard definition for the concept of governance. Kaufman *et al.* (1999), for instance, have defined governance as traditions and institutions by which authority in a country is exercised. This includes three fundamental themes: first, the process via which governments are selected, monitored and replaced; second, the ability of the government to effectively formulate and implement sound policies; and finally, the extent to which citizens and the state respect the institutions that govern economic and social interactions among them.

The institution hypothesis is currently receiving more attention both in economics literature and in the political arena. This view holds that the environment's main impact on economic development

runs through long-lasting institutions (Easterly and Levine, 2002; AJR, 2001). It is argued that countries with better institutions, more secure property rights, and less distortionary policies will invest more in physical and human capital, and will use these factors more efficiently to achieve a higher level of income (AJR, 2001). The difference between developmental success and failure has little to do with natural resource availability, climate, foreign aid, or luck. It is rather largely a function of whether the incentives within a given society steer wealth-maximizing individuals towards producing new wealth or toward diverting it from others (Knack, 2002).

To estimate the impact of institutions on economic performance, we need a source of exogenous variation in institutions. AJR (2001) argued that the rate mortality of European settlers in the (potential) colonies affected the settlement decision of Europeans. The settlement decisions, in turn, affected early institutions. Early institutions persisted and formed the basis for current institutions.

In places (like part of African and Latin America) where settlement is difficult due to disease, specifically malaria, the European established ‘extractive colonies’. They exploited these areas through trade in slaves, ivory, gold and other important commodities. The institutions they created in these areas empowered the elite to extract minerals and valuable commodities. In other places (like North America and Australia), where settlement is easier, they built ‘settler colonies’. Here, the institutions are copies of that of the home countries’—these places are ‘Neo-Europe’. With this rationale, AJR (2001) used settler mortality as a proxy for current institutions. They found that (*sic*) Africa is poorer than the rest of the world not because of pure geographic or cultural factors, but because of worse institutions.

However, the above result is based on the strong assumption that early institutions persisted and

formed the basis for current institutions. In reality, institutions evolve over time: bad institutions must give way to good ones—i.e. institutions evolve incrementally (see North 1990:83-103; and 1991). Instrumenting institutions with historical factors makes it difficult to disentangle the partial effect of institutions vis-à-vis that of trade, as historical and geographic factors affect institutions and trade at the same time (Dollar and Kraay, 2003). The result is also inconsistent with the findings of geography fundamentalists.

Easterly and Levin (2002) used two stages least squares to distinguish between the geography and institutions hypothesis and found that endowments (tropics, germs, and crops) explain cross-country differences in economic development only through their impact on long lasting institutions. Using settler mortality, latitude and landlockedness as an instrument, they found that after controlling for the impact of endowments on institutions, economic policies do not explain cross-country differences in GDP per capita.

Once institutional variables are added, geography and integration do not have any additional power in explaining development. Institutions trump geography and openness. Normally, international trade and better geographic endowment (as measured by the distance from the equator) foster growth and hence enter with a positive sign in growth regression. However, when institutions are added as explanatory variable, estimated coefficients of geography and openness turn out with unexpected sign (Rodrik *et al.*, 2004).

However, the above argument should not be taken for granted. Theory suggests that democratic institutions may be growth enhancing or growth retarding. The negative effect of democracy on growth is generally attributed to one of two factors. The first argument against democracy is that

democracy undermines investment because democracy leads to pressure for immediate consumption as a democratically elected government is highly susceptible to public influence. This results in reduced investment and hence reduced steady-state income and possibly growth. The second potential problem attributed to democracy is related to the idea of ‘developmental states’. That is, economic development requires a strong hand from above (Butkiewicz and Yanikkaya, 2006).

Choice among the different dimensions of institutional quality is also a big concern. Among others, Butkiewicz and Yanikkaya (2006), tried to settle the question of whether governments should focus on the rule of law or on building democratic institutions. Their finding slightly contradicts the previous held findings that the rule of law (maintenance of property right and absence of corruption) significantly affect growth, while democracy may not necessarily influence growth. The rule of law and democracy are found to be equally important conditions for growth.

Some development success stories, for instance China, prospered under authoritative governments. Corruption may, in fact, foster efficiency of countries plagued with dreadfully slow and inefficient bureaucracy. This is ‘greasing the wheel hypothesis’ (Meon and Weil, 2005). Therefore, such arguments against good governance can not be rejected *a priori*. ‘Strange’ findings, such as strong positive effects of corruption in fostering macroeconomic efficiency, should not turn out to be complete surprise.

2.3. Causality in Institutions-Growth Relation

Subjective measures of institutional quality mount sharply with the level of economic development.

In other words, there is a strong correlation between better institutions and faster economic growth. This casts doubt as to whether the causality runs from institutions to growth rather than the other way round (Glaeser *et al.*, 2004).

However, Dawson (2002) used Granger causality test on institutions versus growth and found that the overall level of economic freedom causes growth. Measures of economic and political freedom are found to cause economic growth, while 'size of government' is caused by growth. Gwarney *et al.* (2006) also proved that while improvement in institutional quality lead to more growth, there is no tendency for stronger growth to enhances governance.

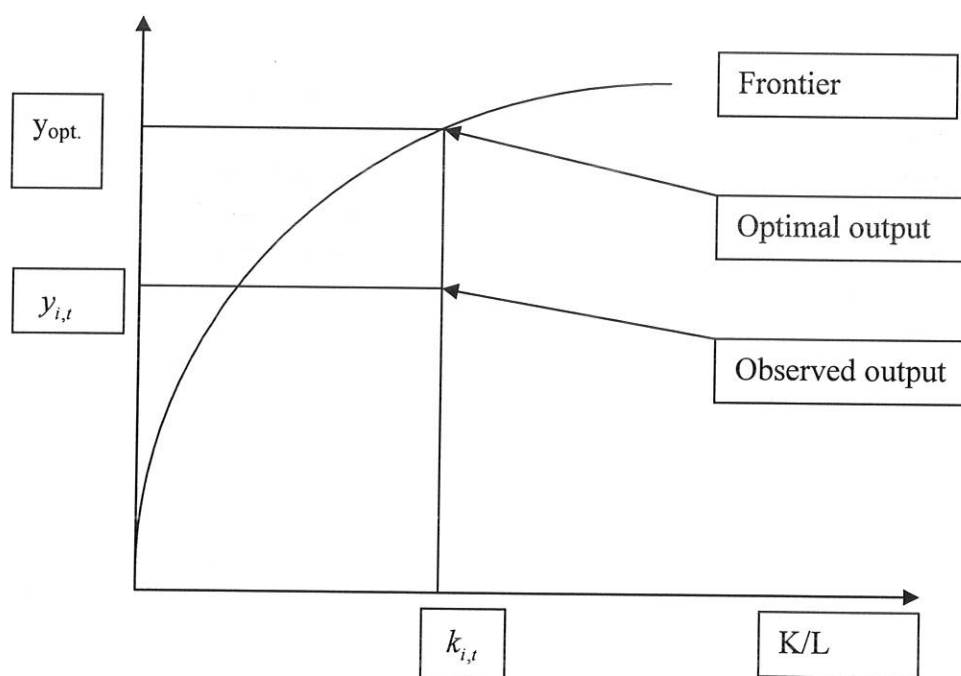
2.4. Transmission Channel

Growth accounting decomposes output growth into the contribution of changes in factor inputs and of total factor productivity (Barro, 1998). This study considers total factor productivity as one of the major channels through which bad governance translates into slower economic growth, specifically whether governance affects growth through total factor productivity (technical inefficiency) or not. Accumulation and productivity are taken as the major factors accounting for the growth differences among nations. The evolution of productivity may actually be the leading driving force of growth. Hence, what matters for growth is not only the amount of factors of production a country is endowed with and has accumulated but also, and mainly, the way those factors are combined (Meon and Weil, 2005).

Technical efficiency measures how close a country's production is to what a country's optimal production would be for using the same bundle of inputs. Frontier analysis is one of the popular

methodologies employed in measuring macroeconomic efficiency. A stochastic production frontier (see Figure 2.2) provides a benchmark for each country regardless of its inputs. In Figure 2.2, the horizontal and vertical axis represents per capita capital ($k = K/L$) and the per capita income ($y = Y/L$), respectively. By comparing the optimal output per worker with effective output per worker, the inefficiency scores of the country is computed. This inefficiency score assesses how close a country's production is to what the country's optimal production would be using the same bundle of inputs (Meon and Weil, 2005).

Figure 2.2: The Production Frontier



Countries operate at different distances from the production frontier. Such differences in technical inefficiency, as measured by the deviation from the production possibility frontier, can be explained by institutional variables. Economic theory is fairly clear on the impact of economic

freedom on efficiency. However, the impact of political freedom on efficiency is uncertain. Political rights and civil liberties may actually promote restrictions on economic activities. Therefore, political freedom and economic freedom can have opposite effects on efficiency. In fact, political rights and civil liberties are found to have no relation with technical efficiency (Adkins *et al.*, 2002)

Olson *et al.* (2000) found that productivity growth is higher in better-governed countries controlling for other factors. A difference in governance is the fundamental factor that explains why some low-income countries are growing faster than others. Meon and Weil (2005) argue that bad governance translate into lower productivity for various reasons. First, bad governance acts as a tax on productive activities and hence reduces the return to productive units. Second, poor governance diverts effort from productive activities. Finally, ill-functioning institutions restrict the diffusion of new ideas and technologies, among other things, by restricting foreign direct investment.

While comparing countries at different level of development, Adkins *et al.* (2002) proposed that developed countries are more efficient than developing countries. This is because these countries are expected to have unmeasured positive externalities that make them more efficient. These might include well developed infrastructure, greater marketization of the economy, or the availability of a wide variety of goods. Their findings reaffirm such arguments as developed countries are found to be closer to the production frontier. According to Adkins *et al.* (2002), human capital has a dual role. It serves as productive input as well as a variable that affects efficiency. This is because a better educated population tends to make better decisions and is able to adopt new technology easily.

2.5. Explaining Africa's Growth: the Role of Institutions

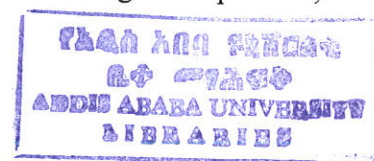
Collier and Gunning (1999) gave various rationalizations for Africa's extremely lower growth rates. These include: lack of social capital, lack of openness to trade, deficient public service, unfavourable geography and risk, lack of financial depth and high aid dependence. The continent is said to be characterized by ethno-linguistic fractionalization and inequality, divorce of the government from the mass, uncontrolled corruption and lack of other social capital. The public sector is also characterized by low returns. All these factors have created a capital-hostile environment in Africa that lowers the rates of return on investment.

A model of path dependence explains the lasting impacts of slave trade and colonialism, which ended long ago, on the growth of Africa. The model provides the explanation for the historical origins of Africa's underdevelopment. With the coming of European colonizers, the continent was dragged from high production equilibria into a state of unproductive activity (Nunn, 2005). Accommodating such strong allegation about a complex process like growth, without qualification, may, however, be troublesome. Collier and Gunning (1999), for instance, have argued that pre-colonial Africa has been characterized by land abundance, high risk, near-subsistence, and low-asset equilibrium. Population was limited by wars and poor nutrition. While, under colonial rule the population began to increase, partly as a result of peace and basic public health measures. Commercialization and innovation (*sic*) slowed and were sometimes even reversed post-independence.

Masanjala and Papageorgion (2003) used Bayesian Model Averaging methodology to answer the

question whether Africa grows differently to the extent of warranting a separate theory of growth. They found that Africa indeed grew differently over the period 1960-1992. The determinants and the mechanisms through which these determinants influence Africa's growth are different from those of the rest of the world. In other words, the growth models that best explain global growth do poorly in explaining African growth and vice versa.

Except the initial output level, variables flagged as important in explaining the global pattern of economic growth lose their significance for an Africa-only sample. In addition, variables that were insignificant in explaining global growth are found to be very significant in explaining African growth. The variables that turn out to significantly affect the growth of Africa are share of GDP in mining, the fraction of primary commodities in exports, years for which the countries have been open, revolutions and coups, and investment (Masanjala and Papageorgion, 2003). However, other studies (Hoeffler, 2002 and Collier and Gunning, 1999) claimed that growth in Africa is explained by the same fundamental factors as in the rest of the world. Africa's slow growth is thus partly explicable in terms of particular variables that are globally important for the growth process, but are low in Africa (Collier and Gunning, 1999).



Even if the determinants of growth were the same, their marginal impact on growth would be different from that of the rest of the world. That is, the relative importance of regressors differs between Africa and the rest of the world. Actually, only two variables emerge as of common importance in the global and Africa-only samples, namely initial level of income and the ratio of investment to GDP. Openness, reliance on primary commodity export, mining, and revolution and coups are important in explaining Africa's growth tragedy. It is also important to note that except revolutions and coups, other measures of institutional quality such as religion, ethno-linguistic

fractionalization, the rule of law, civil liberties and political rights are not pertinent in explaining Africa's growth tragedy (Collier and Gunning, 1999).

Nkurunziza and Bates (2003) analyzed the impact of democracy and political stability on Africa's growth. They found that democracy and political stability are good for economic growth in Africa. The impact of tenure (political stability) on growth varies with the level of democracy. Incumbents who served long terms may produce more economic damage in democratic than in authoritarian political systems. Their result suggests that for a given level of democracy, there is an optimal period of tenure beyond which an incumbent leader harms economic growth.

Political instability as proxied by successful coups, abortive ones and coup plots play a very great role in the growth of Africa. Fosu (2002) suggested that abortive coups have a greater chance of creating uncertainty in the political and economic atmosphere. This is because the existing government usually resorts to harsh measures (like declaration of state of emergency, imprisonment or even the execution of the accused and so on) to deal with the perpetrators of an abortive coup. Coup plots probably have similar, but less intensive, effect compared to failed ones. Therefore, the adverse effect of abortive coups is more pronounced.

Both the level and productivity of the production inputs are adversely affected by coup events. Political instability adversely affects capital productivity, while labour productivity is affected very little by such events. Thus the major transmission channel via which political instability affects the growth of Africa is the deterioration in marginal productivity of capital (Fosu, 2002).

Chapter Three

3. Model Specification and Method of Estimation

This study investigates the role of institutions in explaining Africa's slow economic growth and traces one of the possible channels of transmission—technical inefficiency—through which institutions influence growth. To this end, growth in real GDP per capita is explained by the standard determinants of growth as in the Solow and the Augmented Solow models as well as by institutions. To avoid the bias problems associated with the cross-section specification and the ordinary least squares estimation of the panel specification, this study estimates the panel specification using difference and systems GMM techniques that are considered to be the best available method to avoid the bias problems (see Hoeffler, 2000; Bond *et al.*, 2001; Nkurunziza and Bates, 2003). A stochastic frontier approach is utilized to measure and explain aggregate technical inefficiency. In this approach, first a stochastic production frontier is estimated with real GDP as output, and land, labour and capital as inputs. The inefficiency generated from the stochastic frontier is explained in the second stage regression by historical factors, geography, educational attainment of the citizens, and institutions.

3.1 Model Selection and Specification

3.1.1 Cross Section Models and Associated Problems

Long-run empirics of cross-country economic growth traditionally focused on the analysis of cross section regression equations, where variables are averaged over long period of time such as twenty or thirty years (Hoeffler, 2000). For instance, Easterly and Levin (1999) and Rodrik *et al.* (2004) and others used averages of macroeconomic variables to analyse the impact of institutions on

economic growth.

However, this method of average cross-section regression faces a number of limitations. First, reducing the time series to a single observation, by taking averages, means that not all information is utilized (Hoeffler, 2000). In addition, it is likely that single equation cross-section regressions suffer from omitted variables bias. As single equation cross-section analyses do not allow for countries to start at different levels of technology, these methods suffer from omission of variables that do not change over time, but vary across countries. Under this condition the error term contains unobserved country specific effects due to differences in initial levels of technology. Therefore, the unobserved country specific effect is likely to be correlated with some of the observed regressors and in particular with the initial level of real GDP per worker. As a result the ordinary least square estimates suffer from omitted variable bias (Hoeffler, 2000 and Bond *et al.*, 2001). Thirdly, one or more of the right-hand-side variables may be endogenously determined and measured with error. For example, investment in physical and human capital and population growth could be determined simultaneously with rate of economic growth (Caselli *et al.*, 1996; Hoeffler, 2000; and Bond *et al.*, 2001). This endogeneity problem produces inconsistent estimates of the coefficients.

3.1.2. Panel Specification

Instead of averaging the time series variables over a long period, exploiting the time series data for each country will increase the information available. Employing both the time dimension and cross country information provides a panel data set, which has advantages over time series as well as cross-sectional data set, for the analysis of economic growth (Hoeffler, 2000; and Baltagi, 1995:3). A panel data model can explicitly account for permanent unobserved country specific effects.

Panel data presumes that countries are heterogeneous and controls for this heterogeneity. Time-series and cross-sectional studies, however, fail to account for such heterogeneity and hence are likely to give inconsistent estimates as this causes a serious misspecification. Employing both the time dimension and cross-country information provides more informative and less collinear data, more reliability and more degrees of freedom. With additional, more informative data one can get more reliable parameter estimates (Baltagi, 1995). Panel data models also enable us to construct and test more complicated behavioural models than pure cross-sectional and time-series data. Baltagi (1995), for example, suggested that technical efficiency is better studied with panel than cross-sectional data.

However, panel data sets are not without limitations. The major problem with the use of a cross-country panel, especially for developing countries, is the short time-series. Data on macroeconomic variables in these countries are available for limited time period only. Contrary to this fact, the analysis of growth requires avoidance of cyclical dynamics by taking averages over five-year periods. This imposes a special data requirement of long time horizons.

Selection and Specification of the Model: The cross-country panel regression analysis of economic growth is built on an equation nested in the general specification of the form:

$$\ln(Y_{i,t}) - \ln(Y_{i,t-1}) = \beta \ln(Y_{i,t-1}) + \delta X_{i,t} + u_i + v_{i,t} \quad (3.1)$$

where $Y_{i,t}$ is real GDP per capita of country i in time t ; $X_{i,t}$ is a vector of determinants of economic growth; u_i is a country specific effect; $v_{i,t}$ is white noise (Caselli *et al.*, 1996).

The choice of regressors to be included in $X_{i,t}$ depends on the version of neoclassical model one wants to employ. This study uses the original Solow model and its augmented version, suggested by MRW (1992), and augments them with institutions. The control variables used in the analysis are investment, population growth rate, human capital formation (as proxied by enrolment in secondary schools), as well as indicators of advances in technology and rate of capital depreciation. Advances in knowledge and rate of depreciation are less likely to vary greatly across countries (MRW, 1992). Therefore, it is common to lump them to 5% and add to the population growth rate (MRW, 1992; and Nkurunziza and Bates, 2003).

However, there is an ongoing hot debate on the question whether Africa's growth could be explained by the same fundamental factors like investment, population growth, human capital formation, advance in technology, and depreciation rate as growth in other part of the world (Hoeffler, 2000; and Collier and Gunning, 1999). This study is not endorsing the proposal that Africa's growth is explained by the same fundamental factors as elsewhere in the world. However, we do employ the classical growth models (Solow 1956 and Augmented Solow, MRW 1992) to get a simplified picture of growth in the continent and test whether institutional quality affects growth.

The panel specification of these models used in this study, in line with previous studies (Nkurunziza and Bates (2003), Hoeffler (2000) and others), is given by:

$$g_{i,t} = \alpha + \beta y_{i,t-1} + \Omega I_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \text{ or}$$

$$y_{i,t} - y_{i,t-1} = \alpha + \beta y_{i,t-1} + \Omega I_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (3.2)$$

where $g_{i,t}$ is the growth (logarithmic difference) of per capita real GDP of country i at time t ; $y_{i,t-1}$ is the initial level of real GDP per capita (in logarithm); $X_{i,t}$ is a vector of all control variables such as investment, population growth rate, human capital (enrolment in secondary schools), advances in technology and depreciation rate; $I_{i,t}$ is the governance score of country i at time t ; and $\varepsilon_{i,t}$ is the error term which is decomposed into unobserved time invariant country specific effect, μ_i , which captures the existence of other determinants of a country's steady state real GDP per capita that are not already controlled for by $X_{i,t}$ and $I_{i,t}$, and time variant error (error term hosting all unexplained portion), $v_{i,t}$, components written as:

$$\varepsilon_{i,t} = \mu_i + v_{i,t} \quad (3.3)$$

Combining equation (3.2) and (3.3), we can rewrite the model in panel form as:

$$y_{i,t} - y_{i,t-1} = \alpha + \beta y_{i,t-1} + \Omega I_{i,t} + \kappa_{i,t} + \mu_i + v_{i,t} \quad (3.4)$$

Equation (3.4) can clearly be rewritten in such a way that the dependent variable is logarithm of real GDP per capita:

$$y_{i,t} = \alpha + \beta^* y_{i,t-1} + \Omega I_{i,t} + \kappa_{i,t} + \mu_i + v_{i,t} \quad (3.5)$$

where $\beta^* = (1 + \beta)$

Such a specification of the growth model addresses most of the problems prevalent in cross-sectional specification discussed above. This panel specifications (3.4) and (3.5), address the problem of omitted variable bias introduced due to differences in initial levels of technology across countries, and the exclusion of variables that do not change over time but vary across nations. As

discussed above, estimating the cross section model using Ordinary Least Squares, however, gives inconsistent estimation as one or more of the regressors (say investment) is endogenous and others such as institutions may be measured with errors. These problems may persist if we estimate the panel specification using ordinary least squares method (fixed effects and random effects). The discussion under method of estimation attests that these problems are nicely addressed by using the generalized methods of moments, specifically the difference and systems generalized method of moment.

3.2 Methods of Estimation: Generalized Method of Moments

Both differenced and systems general method of moments techniques address the bias problems encountered in single equation cross-section analysis and ordinary list squares estimation of the panel specification. This is because in a dynamic panel setting, unobserved country specific effects and endogeneity of one or more of the regressors is addressed. GMM methods are perceived to be the best available technique to overcome these problems.

In line with the previous studies (Hoeffler, 2000; Bond *et al.*, 2001; Nkurunziza and Bates, 2003), this study utilizes the generalized method of moments in estimating the Solow growth model and its augmented version. These methods, as discussed above, solve most of the problems that give rise to inconsistent estimates.

The panel Differenced Generalized Method of Moments (DIF-GMM) estimator addresses the above mentioned problems.⁷ To eliminate the country specific effects take the first difference of

⁷ See Appendix A1 for the derivation of the difference GMM estimator.

equation (3.5):

$$\Delta y_{i,t} = \beta * \Delta y_{i,t-1} + \Omega \Delta I_{i,t} + \gamma \Delta x_{i,t} + \Delta v_{i,t} \quad (3.6)$$

This differencing will solve the problem of omitted variable bias as the country specific effects ($u_{i,t}$) drop out when we difference equation (3.5). In other words, DIF-GMM avoids bias resulting from omitted variables, such as initial level of efficiency, which do not vary over time (Caselli *et al.*, 1996; Nkurunziza and Bates, 2003; and Bond *et al.*, 2001).

While the problem of endogeneity is solved by using the appropriate lagged value of the differenced right-hand-side variables as instruments, this is done under the assumption that the error terms are not serially correlated (Caselli *et al.*, 1996). Instrumental variables used in DIF-GMM allow for consistent estimation with endogenous regressors, such as investment and possibly population growth and institutions. Finally, the DIF-GMM approach allows for consistent estimation even when there is measurement error (Caselli *et al.*, 1996; Nkurunziza and Bates, 2003; and Bond *et al.*, 2001).

Even if this general method of moment approach has advantages mentioned above, it is not without limitations. First, finite sample bias can occur when instrumental variables are weak. Second, when the time series are persistent and the number of time series observation is small, the estimator from this method is poorly behaved.⁸ This is because under such conditions, lagged levels of the variables are only weak instruments for subsequent first-differences. In fact, output is highly

⁸ The time dimension of the data used in this study is short as the governance and schooling data we have is limited to a period of almost one decade and seven years, respectively.

persistent series (Bond *et al.*, 2001).

While, systems GMM (SYS-GMM)⁹, suggested by Arellano and Bover (1995) and Blundell and Bond (1998), provides more consistent estimates. It exploits certain assumptions (given below) about the initial conditions to obtain moment conditions that remain informative even for persistent series (Bond *et al.*, 2001).

To solve the problem of inconsistency when the series are persistent, Blundell and Bond (1998, cited in Hoeffler, 2000) suggested estimating a system combining two sets of equations. These are the differenced equations (3.6) and the level equation (3.5). For the differenced equation, suitably lagged levels of $Y_{i,t}$, $I_{i,t}$ and $X_{i,t}$ are used as instruments. Provided the regressors and initial condition satisfy the restrictions

$$E(\Delta I_{i,t} u_i) = 0, E(\Delta x_{i,t} u_i) = 0, \text{ and } E(\Delta y_{i,t-1} u_i) = 0$$

$\Delta I_{i,t}$, $\Delta y_{i,t}$ and $\Delta x_{i,t}$ can be used as instruments in the level equation (Hoeffler, 2000).

3.3 Transmission Channels: Stochastic Frontier Analysis

There are different approaches to measuring technical inefficiency. These include data envelopment analysis (DEA) and the stochastic frontier analysis (SFA). The major differences between these two approaches include: first, the two methods adopt different tools to measure

⁹ African Economic Research Consortium, in its project for explaining Africa's growth, adopted the systems GMM as a preferred method of estimation.

inefficiency scores. DEA uses linear programming technique, while SFA applies econometric tools. The second difference lies in the decomposition of distance from the frontier for each observation. DEA considers the entire distance to the frontier as inefficiency, resulting in inclusion of exogenous events in the inefficiency term. Whereas SFA disentangles this distance between a random error ($v_{i,t}$), taking into account exogenous events, and an inefficiency term ($u_{i,t}$). Finally, SFA requires us to assume functional form, unlike DEA that allows the frontier to envelop tightly the data (Weill, 2006).

The technical inefficiency scores from these two techniques could be a bit different. Weill (2006) used a global sample of 93 countries and found strong correlation between the inefficiency scores predicted using DEA and SFA. This implies, according to Weill (2006), that the results and conclusions are not sensitive to methodological choice. This study adopts SFA to estimates of technical inefficiency scores.

The SFA provides consistent estimates of the inefficiency scores at the aggregate level, and these inefficiency scores are not sensitive to changes in the specification of the production function (Weill, 2006). The stochastic frontier model for panel data utilized in this study is in line with the one suggested by Battese and Coelli (1995) and also employed by Adkins *et al.* (2002). The production function is given by constant return to scale Cobb-Douglass production function as:¹⁰

$$Y_{i,t} = x_{i,t}\beta + v_{i,t} - u_{i,t} \quad (3.7a)$$

This production function could be rewritten in logarithm form as:

¹⁰ The production is represented by a constant returns-to-scale Cobb-Douglas production function for its simplicity. Moroney (1997) argues that at aggregate (economy-wide) level, constant returns-to-scale is virtually compelling. Hence, at aggregate level, the simple Cobb-Douglas is preferable as translog production function need not be homogeneous nor homothetic.

$$\ln Y_{i,t} = \beta \ln x_{i,t} + v_{i,t} - u_{i,t} \quad (3.7b)$$

where $Y_{i,t}$ denotes the real GDP of country i observed in year t ; $x_{i,t}$ is a vector of all inputs, which include land, labour and capital; β is a vector of unknown parameters; the $v_{i,t}$'s are assumed to be $iidN(0, \sigma_v^2)$ random errors, distributed independent of the $u_{i,t}$'s; the $u_{i,t}$'s are non-negative random variables, associated with technical inefficiency.¹¹ They are assumed to be randomly distributed such that $u_{i,t}$ is a truncated distribution, $tN(z_{i,t}\delta, \sigma)$.

The technical inefficiency term in equation (3.7a) and (3.7b), $u_{i,t}$, can be specified as a function of explanatory variables, $z_{i,t}$'s, as:

$$u_{i,t} = z_{i,t}\delta + \varpi_{i,t} \quad (3.8)$$

where $\varpi_{i,t}$ is a truncation of normal distribution $N(0, \sigma^2)$, such that the point of truncation is $-z_{i,t}\delta$, i.e. $\varpi \geq -z_{i,t}\delta$. These assumptions are consistent with the inefficiency term, $u_{i,t}$, being a non-negative truncation of the $N(z_{i,t}\delta, \sigma)$. And $z_{i,t}$ is a vector of explanatory variables associated with technical inefficiency of each country such as institutions, historical factors, geography, level of development and education; and δ is a vector of unknown coefficients.

Let $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$.

¹¹ There is an ongoing debate whether to include human capital as an input in the production function. Some studies (like Adkins *et al.*, 2002) included human capital as an input as well as explanatory variable in the inefficiency model, while others (like Moroney and Lovell, 1997) exclude human capital from the production function (Weill, 2006). This study opts to follow the latter approach as human capital is poorly measured in Africa (see Nkurunziza and Bates, 2003).

Using the above parameterization, a test can be conducted as to whether the estimated frontier is actually stochastic. Failure to reject the null hypothesis that $\gamma = 0$ implies that the variance of inefficiency, σ_u^2 , is zero and hence the deviation from the production frontier is better represented as fixed effects in the production function. Therefore, in such cases, the $z_{i,t}$'s should be included in the production function. Whereas rejecting the null hypothesis suggests proceeding with the estimation of the parameters related to the source of inefficiency within the context of stochastic frontier analysis (Adkins *et al.*, 2002).

Chapter Four

4. Data Analysis and Discussion of Results

This study examines data on 35 selected Sub-Saharan Africa countries in order to assess the role of institutions in explaining Africa's growth and aggregate level technical efficiency.¹² The sample selection is based on availability of data. The period of analysis is limited to 1996-2005 due to lack of governance data for the earlier periods. The number of countries as well as the period covered changes with the inclusion of enrolment in secondary schools (a proxy for investment in human capital) as a regressor.¹³ Data on enrolment in secondary schools is limited to the period 1999-2005 for Africa countries.

Technical efficiency is one of the channels through which inferior institutional quality is translated into slower growth in Africa. Hence, to assess the role of institutions on economic growth, the Solow and the Augmented Solow growth models (given in equation (3.5) in Chapter 3) are estimated using Difference and Systems General Method of Moments (GMM). Here, real GDP per capita is regressed on institutional quality indicators as well as control variables such as proxy for initial condition (lagged value of real GDP per capita), investment, enrolment in secondary schools, population growth, and advances in technology and depreciation rate.¹⁴ In order to trace the transmission channel, a stochastic frontier approach is used. This involves a first stage of estimating the production frontier (given by equation (3.7b) in Chapter 3) and then predicting

¹² For the list of sample countries see Table A4.4 in the Annex.

¹³ The sample size reduces to thirty four countries (as Sudan drops out) with the inclusion of enrolment in secondary school as explanatory variable. The period of analysis is also limited to 1999-2005 with the inclusion of enrolment in secondary schools because data on this variable is available only from 1999 onwards for African countries.

¹⁴ In line with previous studies by MRW (1992) and Hoeffler (2000), this study assumes that depreciation rate and growth in technology do not vary across countries. As commonly done in growth researches, this study assumes that rate of depreciation and technology to sum to 5% for all countries and add 5% to the population growth rate.

inefficiency scores (distance from the frontier) of countries. In the second stage, the technical inefficiency (equation (3.8) in Chapter 3) is explained by institutions, geography, human capital, and historical factors.

4.1. Description of Variables and Data Sources

The indicators of institutional quality are taken from the World Bank governance data developed in a series of research by Kaufman *et al.* (1999, 2000, and 2006). These indicators of institutional quality are based on subjective perception of residents, entrepreneurs, foreign investors and the civic society at large regarding the quality of governance in different countries.

The governance quality of countries as indicated by subjective perception of individuals about quality of governance is clustered into six indicators: voice and accountability, political instability, government effectiveness, regulatory quality, control of corruption, and rule of law. ‘Voice and accountability’ refers to the process by which government is selected and replaced. This measures the aspects of the political process, civil liberties and political rights; and the extent to which citizens of a state are able to participate in selection of their governments. ‘Political instability’ captures the probability that the incumbent government will be destabilized or overthrown by possible unconstitutional and violent means. ‘Government effectiveness’ assesses the quality of public service provision, the quality of bureaucracy, the competence of civil servants, the independence of civil service from political pressure, and the credibility of the government’s commitment to policies. The other related indicator of governance is ‘regulatory burden/quality’, which focuses more on the policies themselves. It measures the incidence of market-unfriendly policies like excessive control over prices and foreign trade regulation or inadequate bank

supervision. 'Rule of law' and 'control of corruption' together evaluate the respect of citizens and the state for the institutions that govern their interactions. 'Rule of law' measures the extent to which agents have confidence in and are abide by the rules of society. That is, it measures the incidence of crime, the effectiveness and predictability of the judiciary, and the enforceability of contract. 'Corruption' is defined as the exercise of public power for private gain. The prevalence of corruption is a manifestation of lack of respect of both the corrupter and the corrupted for the rules that govern their interactions (Kaufman *et al.*, 1999).

The six governance indicators are measured in units ranging from about -2.5 to 2.5, with higher values corresponding to better governance quality. These indicators may overlap. Where there is strong rule of law, the public may refrain from bribing government officials. This is affirmed by the strong pair-wais correlation between 'rule of law' and 'corruption' variables. Their correlation coefficient is around 0.82 (see Table A4.1 in the Annex). Again it is more likely that the users of public sector service may not opt to resort to corruption when public service provision is of high quality and there is modest bureaucratic red tape. The large correlation coefficient (about 0.79) between 'government effectiveness' and 'corruption' variables justifies such an argument. Government effectiveness and rule of law are also highly correlated (with a correlation coefficient of 0.86). This strong positive relation between the two institutional qualities is expected as a government committed to its policies and providing adequate public service can develop the confidence of the public in the rules governing the society.

As shown in Table A4.1, there is a strong correlation between the indicators of institutional quality. Including more than one of these indicators in the growth regression simultaneously may create a

problem of multicollinearity. Therefore, this study uses these indicators individually and compares the importance of each in influencing Africa's growth.

Data on the macroeconomic and social-economic variables used in this study are taken from World Development Indicators (World Bank, 2006). These include real GDP, real GDP per capita, capital formation (investment), population growth rate, land area, labour force, and classification of countries into different income groups. Capital stock data is generated using the investment data from World Bank (2006).¹⁵ Data on the names of previous colonizers and landlockedness is taken from Wikipedia.¹⁶ While, data on enrolment in secondary school is taken from UNESCO.¹⁷

Real GDP, real GDP per capita (RGDPpc) and investment are measured in US Dollars using 2000 as a base year. Population growth rate (n) is measured as the annual percentage change of the total population, while labour force (Labour) measures the total number of people in the working age bracket. Enrolment in secondary schools (school) indicates the total number of students enrolled in all grades in secondary schools. Total land area (Land) is measured in square kilometres. The landlocked dummy (LLockedD) is equal to one for landlocked countries and zero for countries with access to the sea. While British dummy (BritishD) equals one for former Great Britain colonies and zero for others. Landlocked-British colonies dummy (llb) is equal to one for those landlocked countries that have been under the British Empire, and zero otherwise. The income

¹⁵ The capital stock is computed by applying perpetual inventory system using the investment data taken from World Bank (2006). This method of generating capital stock from investment is adopted from Easterly and Levine (2001). Suppose that K_t represents capital stock in period t . Let I_t equals the real investment in period t . Let d equals the depreciation rate, which is usually assumed to equal 7%. With these notations the capital accumulation equation is given as: $K_{t+1} = (1-d)K_t + I_t$. Following King and Levine (1994) this study assumes that capital stock in 1979 is zero and continues using the capital accumulation equation to estimate the capital stock afterwards. That is the capital stock in 1980 equals the investment in 1980, while the capital stock in 1981 is equal to the investment in the year plus the net capital accumulation last year, which equals 93 % of the investment last year and so on. The effect of the 'wrong' assumption that 'capital stock equals zero in 1978' dies out as time pass by.

¹⁶ <http://en.wikipedia.org/>

¹⁷ www.unesco.org/education

group dummy (IGD) is equal to one for countries in low income group and zero for African countries in the upper and lower middle income bracket.

4.2. Data Descriptive and Graphic Analysis

To analyze the causal relationship between governance on the one hand and growth and technical inefficiency on the other, it is necessary to control for other variables (by including them as regressors) as in a regression framework. Yet, in order to pre-empt this relation, correlation analysis and scatter diagrams can be used.

The governance variables and real GDP per capita display a relatively strong positive correlation (see Table A4.1 in the Annex). Rule of law and control of corruption have a strong correlation with real GDP per capita, about 0.6 each. Voice and stability are among the least in their correlation with real GDP per capita. The positive relationship among the governance quality indicators and real GDP per capita is reaffirmed by the scatter plots among them in Figure A4.1 (in the Annex).¹⁸ Countries that have better governance quality have larger income per capita.

African countries included in the analysis on average achieved below zero in governance scores (which run from -2.5 to 2.5 with higher values representing better governance quality). Table 4.1 gives the summary of governance indicators and other variables. The best governance score was assigned to Botswana, Mauritius and South Africa; while Democratic Republic of Congo has been governed very badly.

¹⁸ Even if there is such positive relation as shown in the scatter plot, the 95% confidence interval (shown by the shaded area around the line) is narrow.

Table 4.1: Summary Statistics for Major Variables

Variable	obs	mean	std. dev.
RGDPpc	350	2597.264	(3283.588)
Investment	350	1.44e+09	(3.72e+09)
n	350	2.364838	(1.095932)
school	238	576430.7	(947320.2)
RuleLaw	245	-.6051043	(.5891094)
RegQ	245	-.5110497	(.6194757)
GovEff	245	-.5740969	(.5689457)
corruption	245	-.5319896	(.5619619)
Stability	245	-.4972912	(.9051019)
voice	245	-.4614983	(.7841699)
Labour	350	5468186	(6295927)
Land	350	480978.3	(589274.5)
BritishD	350	.2828571	(.4510324)
IGD	350	.7428571	(.4376845)
llB	350	.0857143	(.2803425)
LLockedD	350	.3142857	(.4648954)

A closer look at the countries with relatively high and low governance scores, i.e. Mauritius, Botswana and South Africa on the one hand, and DR Congo on the other, would better highlight how countries' governance quality is related to incomes.¹⁹ DR Congo was the most politically unstable country in the period covered, with an average score close to the least feasible value of -2.5. The regulatory quality of the country has also been inferior, as low as -2.04 and the country has been scoring below zero on all indicators of governance quality in all the years under analysis. However, Mauritius, Botswana and South Africa, which are the best governed countries in Africa, scored positive values in almost all aspect of governance. The per capita incomes of these countries are relatively higher than that of DR Congo. The average per capita incomes (from 1996-2005) of Mauritius, Botswana, South Africa and DR Congo are around 10000, 8500, 9000, and 650 USD per annum. However, this analysis does not tell us whether there is a causal relation between

¹⁹ Mauritius and Botswana scored positive values on all governance qualities in all years. South Africa has been also governed well, except the negative score for political instability. Whereas, DR Congo scored relatively 'bigger' negative values in all year on all dimension of governance.

institutional quality and income as there could actually be divergence in resource endowment, population growth rate, and decision concerning investment. These factors are controlled for (are included as explanatory variables) as in a regression analysis in the next section.

4.3. Difference and Systems GMM Estimation Results of the Growth Models

To assess the relevance of institutions in explaining Africa's slow growth, the original Solow growth model and its augmented version are estimated using DIF-GMM and SYS-GMM, from the data on 35 selected African countries (1996-2005). The GMM approaches treat the covariates as potentially endogenous and generate internal mechanisms of instrumenting them.²⁰ The Sargan test for the null hypothesis of valid specification is used to test whether these instruments are valid (Bond *et al.*, 2001). The test failed to reject the null hypothesis in all the regressions implying that the instruments are valid. The Wald test for joint significance of the dependent variables strongly rejected the null hypothesis that the coefficients on all the variables are jointly equal to zero (see Table A4.2 in the Annex and Table 4.2).

Most of the standard determinants of growth have the expected sign and enter significantly, supporting the previous held hypothesis about the effects of each of the variables on growth of nations (see Table 4.2 for the summary and Table A4.2 in the Annex for all the regression results).²¹ The first regressor, $\log(\text{GDP}_{t-1})$, is the lagged value of real GDP per capita (in logarithm) and serves proxy for the initial condition. Previous growth studies found that the coefficient of this

²⁰ The DIF-GMM uses lagged values of differenced regressors as instruments (in equation (3.6) in Chapter 3). In addition to this, the SYS-GMM uses the difference of each regressor as an instrument for the level variables (in equation (3.5) in Chapter 3).

²¹ Enrolment in secondary schools, population growth and some times investment enter with wrong sign in some of the regressions and are insignificant in some other.

variable is negative and significant showing conditional convergence in income level of countries. Holding population growth, investments (and schooling) the same, poor and rich countries tend to converge in terms of per capita GDP (Solow, 1956; MRW, 1992; Hoeffler, 2000; Nkurunziza and Bates, 2003). The negative and significant coefficient of the lagged GDP per capita in this study is also in line with the convergence hypothesis.²²

However, the convergence hypothesis is strongly contested and is said not to explain real global economic growth trends. This hypothesis has been challenged by a number of researchers. Barro (1991), for instance, found that past level of income per capita is not related with current income per capita. The endogenous growth theories also predict that poor countries remain permanently poorer than the initially rich ones.

Theory also suggests that those countries that save and invest more are expected to have higher growth in income level. The positive and significant coefficients on log (investment) in most of the regressions is in line with this theory.

The composite variable $\log(n+g+d)$ represents population growth rate, depreciation rate, and the rate of technological progress. As discussed in Section 3.1.2 and restated above, the latter two variables are assumed to sum to 5% in all countries. Therefore, the composite variable is simply the logarithm of population growth augmented with 0.05. Higher population growth lowers income per capita as the available capital must be spread more thinly to the working population (Solow

²² We should be cautious while interpreting the coefficient of lagged real GDP per capita. The convergence hypothesis is based on equation (3.4), where the dependent variable is growth of real GDP per capita. However, as discussed in 3.1.2, this equation can be rewritten such that the dependent variable is real GDP per capita (equation (3.5), the model estimated in this study). In such cases the convergence coefficient is given by $(1 - B^*)$. The coefficients of the lagged real GDP per capita from our regression analysis is positive (but less than one) and significant.

1956, MRW 1992, and Hoeffler 2000). However, the coefficient of the population growth rate variable is insignificant in all specifications and estimation techniques. Therefore, population growth rate does not explain the low income per capita in African countries.

Enrolment in secondary schools (log school) serves as a proxy for human capital formation. Increased investment in human capital as proxied by increased enrolment in secondary schools is expected to affect income per capita positively. Countries with better educated citizen can easily adopt new technologies and innovate new technology domestically and hence grow more rapidly (Adkins *et al.*, 2002). Usually, this variable turns out to be insignificant as enrolment is poorly measured (see Nkurunziza and Bates, 2003). In the DIF-GMM estimation the coefficient for schooling is negative in some of the regression and is insignificant in some other cases; while, it is positive and significant when the Augmented Solow model is estimated using SYS-GMM.²³

²³ Hoeffler (2000) also found negative, but insignificant, coefficient for enrolment in secondary school when estimating the apolitical Augmented Solow model using differenced GMM.

Table 4.2: Summary of Estimation Results of Solow and Augmented Solow Growth Models using Difference and Systems GMM²⁴

log(GDP _t)	Solow Model				Augmented Solow Model			
	Difference GMM		Systems GMM		Difference GMM		Systems GMM	
	Coeff.	(Std. Err.)	Coeff.	(Std. Err.)	Coeff.	(Std. Err.)	Coeff.	(Std. Err.)
log(GDP _{t-1})	.8268	(.02663)***	.9942	(.00369)***	.8275	(.02615)***	1.000	(.01068)***
log(Investment)	.0053	(.00237)**	.0092	(.00190)***	.0061	(.00241)**	-.0039	(.00810)
log(n+g+d)	-.0004	(.00107)	-.0018	(.00176)	-.0004	(.00096)	-.0018	(.00191)
log(school)					-.0007	(.00091)	.0110	(.01044)
Voice	.0444	(.00655)***	.0162	(.00313)***	.0478	(.00476)***	.0173	(.00536)***
Stability	.0158	(.00093)***	.0113	(.00383)***	.0154	(.00377)***	.0257	(.00869)***
Corruption	.0004	(.00913)	.0052	(.00564)	.0041	(.00844)	.0176	(.00667)***
GovEff	.0284	(.00668)***	.0080	(.00363)**	.0338	(.00773)***	.0188	(.00387)***
RegQ	.0580	(.00847)***	.0165	(.00418)***	.0602	(.00773)***	.0158	(.00509)***
RuleLaw	.0297	(.00850)***	.0184	(.00561)***	.0305	(.00999)***	.0226	(.00414)***
Cons_	.0076	(.00092)***	-.1181	(.05072)**	.0078	(.00097)***	-.0298	(.05937)
Number of countries	35		35		34		34	
Number of obs.	105		210		102		170	
	Ch2-stat	p-value	Ch2-stat	p-value	Ch2-stat	p-value	Ch2-stat	p-value
Wald test of joint signif.	1397.30		206930		1562.66		551055.88	
First order autocorr.	-2.14	0.0322	2.24	0.025	2.16	0.0309	-2.20	0.027
Second order autocorr.	-2.14	0.2863	-1.12	0.261	-1.04	0.2961	-1.59	0.111
Sargan test	18.51		14.72		18.24		11.42	

Notes:

Each of the indicators of governance quality is included in the twenty four regressions (see Table A 4.2 in the Annex for the details of these regression results) one at a time. This table simply summarizes the coefficient and the standard error on the indicators of governance quality taken from the respective regressions.

The *, ** and *** indicate that the corresponding coefficients are statistically significant at 10, 5 and 1% level of significance.

This study does not focus on the standard determinants of growth, which here function as control variables. Rather, the interest of this study is in presenting the possible impact of poor institutions

²⁴ This table summarizes the results from twenty four regression analyses using stata9 and an extension (an 'ado file') developed by Roodman (2006) that enables us to estimate systems GMM using stata9 command xtabond2. The first column shows list of explanatory variables, which include the standard variables used in the original Solow model and its augmented version and indicators of governance quality. Column 2-5 present the results (coefficient and the standard error) from the original Solow model using differenced and systems GMM estimation technique. While, column 6-9 presents the results from Augmented Solow model.

in explaining the slow economic growth of African countries. Africa appears to be poorly governed (at least in the period under analysis). As discussed above, African countries have on average scored negative in terms of Kaufman *et al.* (2006)'s indicators of governance quality, which run from about -2.5 to 2.5 with higher values representing better institutional quality—see Table 4.1 for the summary statistics.

The regression results show how governance affects growth in Africa. The coefficients of indicators of governance quality: voice and accountability, political instability, regulatory quality, government effectiveness and rule of law are all positive and strongly significant under different specifications and estimation techniques. However, corruption is insignificant, except under systems GMM estimation of the Augmented Solow Model. This finding supports the hypothesis that Africa's slow economic growth can partially be attributed to bad governance. Those African countries with better governance, as indicated by higher governance score assigned to them by Kaufman *et al.* (2006), have higher real income per capita than those that are poorly governed, controlling for investment, population growth and human capital formation.

These results strongly support the hypothesis that Africa's slower growth can partially be explained by poor governance. The continent appears to lack the necessary institutional qualities that foster growth. This has resulted in extremely slower growth prevalent in African countries. The finding is consistent with previous studies (Collier and Gunning, 1999; Masanjala and Papageorgion, 2003; Nkurunziza and Bates, 2003). Africa's slow growth is thought to be due to lack of the necessary social capital, the divorce of the government from the mass and deficient public service (Collier and Gunning, 1999). The determinants of growth in Africa are different from that of the rest of the

world and institutions are among the unique determinate of the continent's growth (Masanjala and Papageorgion, 2003).

As mentioned in Chapter 1, attaining good governance in every aspect may be very costly for African countries. Thus, African countries could focus on some of the institutional qualities that matter most in explaining growth. The significance of the coefficients on the governance indicators helps us in identifying the dimensions of governance that influence African growth.²⁵ Among the governance quality indicators developed by Kaufman *et al.* (2006), control of corruption has no effect on economic growth in Africa—the coefficient of this variable is insignificant in all estimation techniques and specifications, except under the SYS-GMM estimation of the Augmented Solow Model. This finding is comparable with the 'greasing the wheel hypothesis' which proposes that in a country plagued with excessive bureaucratic red tape corruption may serve as the grease to help the system work properly (see Meon and Weil, 2005).

4.4 Tracing the Transmission Channels: Technical Inefficiency

The channels through which poor governance translates into slower growth and lower per capita income are numerous and mostly yet to be discovered (Meon and Weill, 2005). These possible channels include technical inefficiency, accumulation of physical capital, human capital formation, level of integration to the global economy et cetera. Poor governance acts as a tax on productive activities and reduces the amount of production that accrues to productive units. This would reduce

²⁵ As there are multiple specification and estimation techniques, there are four coefficient estimates for each governance variable. Hence, it is difficult to compare these variables based on the partial elasticity of income with respect to each variable. Even if one opts to take the best estimation technique (SYS-GMM), there is no such thing as the best specification of economic growth in Africa—the question of whether African growth can be modeled using standard growth theories has not yet been settled (see Masanjala and Papageorgion, 2003).

the incentive to use the productive resources intensively and hence lowers productivity (Meon and Weill, 2005).

This study discusses aggregate level technical inefficiency as a possible channel through which bad governance is translated into slower growth or lower income. To this end stochastic frontier analysis (SFA) is used. In SFA, first the production function (specified in equation (3.7b) in Chapter 3) is estimated, and the inefficiency score of each country for all years is predicted.²⁶ In the second stage, the inefficiency score generated in the first step is explained with covariates (equation (3.8)). This is the two stage approach towards measuring and explaining inefficiency. As is commonly done in cross country efficiency analysis, real GDP ($Y_{i,t}$) is taken as the output of country i in period t .²⁷ The inputs ($X_{i,t}$'s) include land, labour and physical capital stock of country i in year t . While, inefficiency scores of countries ($u_{i,t}$'s) are explained by institutional variables and country characteristics ($Z_{i,t}$'s), which include geography variable (landlockedness), colonizers' identity (British dummy), investment in human capital (school), combined dummy for British colonial heritage and geographic misfortune (landlocked), and income group dummy.

Many recent studies on the determinants of technical efficiency at the aggregate level adopt a one-stage approach instead of the two stage approach. In this approach, the production frontier and an equation of inefficiency as a deterministic function of some explanatory variables are estimated simultaneously. Doing this requires all the variables to vary significantly within countries over time.

²⁶ The production is represented by a constant returns-to-scale Cobb-Douglas production function for its simplicity. Moroney (1997) argues that at aggregate level, constant returns-to-scale is virtually compelling. Hence, at aggregate level, the simple Cobb-Douglas is preferable as translog production function need not be homogeneous nor homothetic.

²⁷ The notations used in this section are the standard notations in efficiency analysis and match the production and technical inefficiency models in equations 3.7-3.9 in Chapter 3.

However, indicators of governance quality do not meet this requirement (Meon and Weil, 2005). Institutional quality indicators exert large inertia, as past experience influences current perception about institutional quality (Paldam 2002, cited in Meon and Weil 2005). Due to this a two-stage approach is adopted in this study, despite well-known limitations.

The stochastic production frontier is estimated using maximum likelihood technique (Table 4.3). The frontier, which is a time varying decay model, converges after 50 iterations.²⁸ The Wald test for joint significance of the inputs to production strongly rejects the null that the coefficients are jointly equal to zero. To check whether the production frontier is actually a stochastic frontier, the null hypothesis $\gamma = 0$ (the variance in technical inefficiency is zero) is tested.²⁹ The test statistic ($t=3.93$) indicates that the null hypothesis is strongly rejected—the frontier is actual a stochastic frontier. Therefore, we can proceed with estimating the parameters related to source of inefficiency within the context of SFA.³⁰ The inefficiency model (Table 4.4) explains the variation in technical inefficiency across African countries.

²⁸ The statistical software used to estimate the frontier and the inefficiency models is stata9. And the time varying decay model is consistent with the assumption made in Section 3.3, the inefficiency scores ($u_{i,t}$) have truncated normal distribution.

²⁹ Where $\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$. For the details see Chapter 3.

³⁰ However, failure to reject the null would imply that the variance of inefficiency is zero and hence the deviation from the frontier is better represented as a fixed effects—the $Z_{i,t}$'s should be included in the production function (Meon and Weil, 2005).

Table 4.3: Estimates of the Production Frontier

log(GDP)	Coef.(Std. Err.)
log(land)	0.218(.0504594)***
log(labor)	0.171(.0669834)**
log(capstock)	0.452(.0350391)***
_cons	77.25(361.6341)
Sigma_u2	0.287(.0732848)***
Sigma_v2	0.005(.0004172)***

Notes: Number of iteration: 50; Number of observation: 350
Wald Ch2: 318. Prob>Chi2=0.000
Log Likelihood=313

Table 4.4: Summary of Results from the Technical Inefficiency Model

Inefficiency	Coef. (Std. Err.)
LLockedD	1.071(.4796974)**
IGD	-0.174(.3994566)
BritishD	2.003(.5599835)***
School	0.000(1.00e-08)**
lIB	-2.230(.8326909)***
RuleLaw	-0.002(.0307187)
RegQ	-0.082(.0194061)***
GovEff	-0.057(.0258351)**
Corruption	-0.046(.0240203)*
Stability	0.028(.0204742)
Voice	0.038(.0284196)
_cons	77.251(361.6341)

Notes: Number of observation 170; Number of groups 34

Overall R-sq = 0.3359

Wald chi2 (6) = 22.65 Prob > chi2 = 0.0009

Like the summary of the growth regression results, this table summarizes the six technical inefficiency regression results. The governance variables enter one at a time in the mean inefficiency models. The coefficients on the control variables and test statistics are that of Table A4.3.2a. For the details of the regression results see Table A4.3 in the Annex.

The *, **, and *** represent that the corresponding coefficients are statistically different from zero at 10, 5, and 1% level of significance.

The technical inefficiency scores are explained (Table 4.4) by running Generalized Least Squares estimation (in a Random Effects setting), where the dependent variable comprises the inefficiency scores ($u_{i,t}$'s). The sign of coefficients on the variables used to explain the technical inefficiency tells us whether the variable is improving efficiency or not. Positive, significant coefficients imply inefficiency increases with the increase in the variables and the country is moving further away from the frontier, and vice versa.

Countries with access to the sea have the opportunity to import more efficient techniques from the technological leaders, and integrate with the rest of the world at much lower cost. One can, therefore, expect these countries to be more efficient and closer to the frontier than landlocked countries. The positive and significant coefficient of landlocked countries dummy supports this argument. Landlocked countries are further away from the frontier—less efficient—than those African countries with access to the sea (see Table 4.4).

Developed countries have unmeasured externalities in the form of better infrastructure, greater market orientation of the economy, and so on that make them more efficient (Adkins *et al.*, 2002). All countries in Sub-Saharan Africa are classified as developing by World Bank (2006). To account for the minor differences in level of development of the countries, this study uses the World Bank (2006) classification of countries into different income groups. The coefficient on this dummy is insignificant in all the inefficiency models. The result does not support the theory and could be due to the small variation in the level of development among Sub-Saharan African countries. The result is expected from statistical point of view as there is less variation in the data

across countries: around 75% of the countries in our sample are classified as low income—see Table 4.1 for the summary statistics.

Countries with highly educated manpower are expected to be more able to adapt to a changing economic environment and fill the technological gap between them and the leading technological country. This reduces the distance from the frontier and hence improves the countries' efficiency (Adkins *et al.*, 2002). The proxy for human capital—enrolment in secondary schools—enters significantly with the wrong sign in some of the regressions. This could be, as discussed above, due to measurement problem as enrolment is poorly measured (see Nkurunziza and Bates, 2003).

Nunn (2005), AJR (2001), and others have explained Africa's underdevelopment by linking it to the effect of colonial heritage, the colonizers' identity and its lasting impacts on Africa's growth. These studies, however, have not clearly stated the impact of colonialism on aggregate technical inefficiency of the ex-colonies. To the best of our knowledge, there is no research linking colonizers' identity to its effects on aggregate technical efficiency of the former colonies. However, Yu (2006) linked agricultural productivity with colonial heritage. The coefficient of the dummy variable for former British and Portuguese colonies indicates that base efficiency (in the agricultural sector) is substantially lower than the reference group—French Colonies.³¹

To assess the effect of colonial heritage on aggregate technical efficiency of African economies, this study includes Great Britain dummy (BritishD) and a dummy combining geography (Landlocked) and colonial heritage (British influence)—(llB)—as a control variable in the technical inefficiency

³¹ Yu (2006) found contradicting results about the effect of colonial heritage on agricultural productivity—different techniques put French colonies at better productivity position, while other techniques show the British colonies are more productive.

model. The British dummy turns out to be positive and strongly significant. Therefore, the ex-British colonies are located further away from the frontier relative to the French and others colonies. While *llb* is negative and significant—the British colonies located further away from the coast are more efficient than those with access to the sea and those that had been under other colonizers. The inefficiency of the former British colonies relative to others may be due to policy followed in controlling the colonies—indirect rule—and the imposition of wrong curricula of education on the subjects.³² Dumont (1968), when discussing the effects of colonial heritage on African growth, argued that the education curricula inherited from the colonial ‘mother’ has been obstructionistic.³³ As a result, those with formal education are unfit for productive work in industry and agriculture. The worst contribution of the British educational system, for instance, has been that the educated look-down the most needed work in Africa—agriculture.

Of the six governance variables, the three (regulatory quality, government effectiveness, and control of corruption) enter significantly with the expected sign in the inefficiency model. Thus, controlling for historical and geographic factors, countries with better regulatory quality, effective government and less corrupt civil servants are more efficient. This finding is in line with that of Olson *et al.* (2000) and Adkins *et al.* (2002). Productivity growth is higher in better governed countries (Olson *et al.*, 2000). As discussed in Chapter 2, Adkins *et al.* (2002) found that economic freedom significantly influences efficiency. While political freedom does not have any relation with technical efficiency. The insignificant coefficient on ‘voice’ and ‘stability’—political

³² The essence of indirect rule is that the administration of African territories must be based upon African institutions managed by African leaders with the advice of British officials (Matthews, 1937).

³³ Rene Dumont (1968)’s book has been written in French in 1962. It was translated to English by Phyllis Nauts Ott (1968).

variables—is in line with the findings of Adkins *et al.* (2002). Rule of law is not related to technical efficiency either.

Therefore, Africa's slow growth can in part be attributed to bad governance—governance significantly influences economic growth in the continent. There is also a difference in the importance of various governance dimensions. There is a large difference among aspects governance in influencing technical efficiency. Regulatory quality, government effectiveness and control of corruption are associated with efficiency with expected sign. Voice and accountability, political instability and rule of law do not have relation with aggregate technical efficiency.

Chapter Five

5. Conclusion and Policy Recommendations

Africa's slow economic growth has in part been attributed to malfunctioning institutions, geographic misfortunes and lack of integration to the global economy. Previous studies have focused on the primacy of institutions' role over that of geography and integration, and vice versa, in explaining this poor economic performance. Even those discussing the role of institutions per se do not totally focus on Africa; are characterized by limitations in the methodology they utilized; and/or have ignored the channels through which worse institutions translate into poor economic outcomes. This study appraises the role of institutions in explaining economic growth of African countries and traces one of the possible channels through which worse institutions translate into slower economic growth. Data on 35 selected Sub-Saharan African countries (1996-2005) taken from World Development Indicators (World Bank, 2006), Kaufman *et al.* (2006), UNESCO and Wikipedia has been analyzed. The original Solow growth model and its augmented version are augmented with institutions and estimated using DIF-GMM and SYS-GMM in order to assess the role of institutions in explaining Africa's growth. The distance of African countries from the production frontier has been predicted and explained using a two-stage approach stochastic frontier framework.

Most institutional variables such as rule of law, regulatory quality, government effectiveness, political instability, and voice and accountability are found to significantly influence economic growth in Sub-Saharan Africa. However, control of corruption does not appear to have any relation with economic growth—it enters insignificantly in all, except one, of the regressions. Institutions were also found to affect technical inefficiency, one of the possible channels of transmission.

Government effectiveness, regulatory quality and corruption are strongly associated with technical inefficiency. However, political variables, voice and accountability—civil liberty and political rights—and political instability, have no relation with countries' efficiency. Rule of law is not related to technical inefficiency either. Therefore, even if almost all governance quality indicators have strong a impact on economic growth in Sub-Saharan Africa, only three of them affect growth via aggregate technical inefficiency.

Therefore, political instability, lack of civil liberty and political rights, the poor quality of public service provision and the less competent civil servants, extended bureaucracy, market unfriendly policies, and the absence of rule of law are the fundamental factors behind Africa's slow economic growth. The continent is growing slowly not only because of geographic misfortune and lack of integration with the global economy but also due to the prevalence of malfunctioning institutions. This negative impact of bad governance on economic growth, in part, runs through the aggregate technical inefficiencies rampant in African countries. Weak public service provision, the incompetence of the civil servants, market unfriendly policies, and uncontrolled corruption contribute to technical inefficiency and hence the slow growth of economies in Sub-Saharan Africa. Therefore, improving the qualities of these institutions would foster total factor productivity and hence economic growth.

In this study, institutions have been found to have significant impact on economic growth in Sub-Saharan African countries. Hence, instead of concentrating all their efforts on technological innovation, investment in physical and human capital as well as controlling population growth, African countries must follow a parallel policy agenda of improving the quality of their institutions. In addition, these policies should focus on the institutional qualities that affect economic growth

most such as rule of law, government effectiveness, regulatory quality, political instability, and voice and accountability. This implies that adopting market friendly policies, providing an effective judiciary system, making contracts enforceable by law, building political stability, providing effective government service, strengthening civil liberty and political rights should be the major policy agenda of these countries. Findings from regression analysis revealed that corruption does not influence economic growth so that African countries can set aside control of corruption, at least for the time being.

Technical inefficiency is not the only channel through which bad governance may translates into poor economic performance. Other possible channels such as investment, human capital formation, policy effectiveness, level of integration to the global economy and so on are yet to be traced. Even if political variables—voice and accountability, and political stability— and the rule of law are not related to technical efficiency, they are influencing growth in the continent, probably through other transmission channels. Tracing these channels is open for future research.

The growth regression results are based on standard neoclassical growth models. Yet, there is no consensus on whether African growth can be explained by the same fundamental variables as elsewhere in the world. This model/variable uncertainty is another area open for future research. With the best specification of economic growth problem in Sub-Saharan Africa, we can talk of comparing different aspects of governance based on the partial elasticity of income per capital to changes in these governance qualities.

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Annex:

Table A4.1: Correlation between Real GDP per Capita and Governance

	RGDPpc	RuleLaw	RegQ	GovEff	corruption	Stability	Voice
RGDPpc	1.0000						
RuleLaw	0.6367	1.0000					
RegQ	0.4349	0.7038	1.0000				
GovEff	0.5871	0.8506	0.7732	1.0000			
corruption	0.6017	0.8080	0.6193	0.7833	1.0000		
Stability	0.4378	0.7753	0.5943	0.6416	0.6343	1.0000	
voice	0.4915	0.7232	0.6365	0.7092	0.6159	0.7464	1.0000

Legend: RGDPpc, 'Voice', 'stability', 'corruption', 'GovEff', 'RegQ' and 'RuleLaw' refer to real Gross Domestic Product per capita, voice and accountability, political instability, control of corruption, government effectiveness, regulatory quality, and rule of law, respectively.

Table A4.2: Growth Regression Results of the Original Solow and its Augmented Version using Systems and Differenced GMM³⁴

Notes: The dependent variable in all of the following regressions is logarithm of real GDP per capita [(GDPpc)]. The standard growth determinants are investment (lninvestment), population growth, depreciation rate and rate technological progress (lnpop), and enrolment in secondary school (lnschool). The different governance quality indicators are used one at a time in each of the twenty four regressions.

Table A4.2.1: Difference GMM Estimation Results of the Solow Model

Table A4.2.1a: Rule of Law

Arellano-Bond dynamic panel-data estimation				Number of obs	=	105
Group variable (i): PanelID				Number of groups	=	35
Time variable (t): year				Wald chi2(4)	=	1397.30
				Obs per group: min	=	3
				avg	=	3
				max	=	3
D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8268359	.0266345	31.04	0.000	.7746333	.8790385
lninvestment						
D1.	.0053337	.0023667	2.25	0.024	.0006951	.0099723
lnpop						
D1.	-.0004294	.0010699	-0.40	0.688	-.0025263	.0016675
RuleLaw						
D1.	.0297512	.0085043	3.50	0.000	.0130831	.0464194
_cons	.0076983	.0009212	8.36	0.000	.0058928	.0095037

Sargan test of over-identifying restrictions:
 chi2(20) = 18.51 Prob > chi2 = 0.5540
 Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
 H0: no autocorrelation z = -2.14 Pr > z = 0.0322
 Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

³⁴ The models are estimated using Stata9, with the help of extension (xtabond2) contributed by Roodman (2006).

H0: no autocorrelation $z = -2.14$ $Pr > z = 0.2863$

Table A4.2.1b: Regulatory Quality:

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
LD.	.8453883	.0242165	34.91	0.000	.7979249	.8928518
lninvestment						
D1.	.0060497	.0015487	3.91	0.000	.0030144	.0090851
lnpop						
D1.	-.0016533	.0014959	-1.11	0.269	-.0045851	.0012786
RegQ						
D1.	.0580545	.0084767	6.85	0.000	.0414405	.0746684
_cons	.0091066	.0010594	8.60	0.000	.0070302	.011183

Sargan test of over-identifying restrictions:

$\chi^2(20) = 16.93$ $Prob > \chi^2 = 0.6576$

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation $z = -2.38$ $Pr > z = 0.0173$

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation $z = -0.56$ $Pr > z = 0.5734$

Table A4.2.1c: Government Effectiveness

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8217714	.0236618	34.73	0.000	.7753951	.8681477
lninvestment						
D1.	.0040411	.0022911	1.76	0.078	-.0004494	.0085316
lnpop						
D1.	-.0006924	.0013035	-0.53	0.595	-.0032472	.0018623
GovEff						
D1.	.0284531	.0066773	4.26	0.000	.0153658	.0415405
_cons	.0082497	.0009114	9.05	0.000	.0064633	.010036

Sargan test of over-identifying restrictions:

$\chi^2(20) = 18.58$ $Prob > \chi^2 = 0.5492$

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation $z = -2.20$ $Pr > z = 0.0280$

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation $z = -1.25$ $Pr > z = 0.2124$

Table A4.2.1d: Control of Corruption

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8307419	.0239316	34.71	0.000	.7838368	.8776471
lninvestment						
D1.	.0049779	.001922	2.59	0.010	.0012108	.008745
lnpop						
D1.	.0003353	.0014973	0.22	0.823	-.0025993	.00327
corruption						
D1.	.0004054	.0091345	0.04	0.965	-.017498	.0183087
_cons	.0071624	.0008029	8.92	0.000	.0055889	.008736

Sargan test of over-identifying restrictions:

$\chi^2(20) = 17.31$ $Prob > \chi^2 = 0.6326$

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation $z = -2.12$ $Pr > z = 0.0344$

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation $z = -0.99$ $Pr > z = 0.3234$

Table A4.2.1e: Political Instability

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8454634	.034523	24.49	0.000	.7777996	.9131271
lninvestment						
D1.	.0049232	.0032371	1.52	0.128	-.0014213	.0112677
lnpop						
D1.	.0005038	.0011953	0.42	0.673	-.0018388	.0028465
Stability						
D1.	.0158156	.0033527	4.72	0.000	.0092444	.0223868
_cons	.0070686	.000932	7.58	0.000	.0052419	.0088954

Sargan test of over-identifying restrictions:
 chi2(20) = 24.09 Prob > chi2 = 0.2384
 Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
 H0: no autocorrelation z = -2.19 Pr > z = 0.0286
 Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
 H0: no autocorrelation z = -1.07 Pr > z = 0.2832

Table A4.2.1f: Voice and Accountability

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8648878	.0306917	28.18	0.000	.8047332	.9250425
lninvestment						
D1.	.0068712	.0022331	3.08	0.002	.0024944	.0112481
lnpop						
D1.	.0011054	.0015666	0.71	0.480	-.001965	.0041758
voice						
D1.	.0444706	.006558	6.78	0.000	.0316172	.057324
_cons	.0053053	.0008756	6.06	0.000	.0035891	.0070215

Sargan test of over-identifying restrictions:
 chi2(20) = 18.77 Prob > chi2 = 0.5371
 Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
 H0: no autocorrelation z = -2.22 Pr > z = 0.0267
 Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
 H0: no autocorrelation z = -1.16 Pr > z = 0.2474

Table A4.2.2: Difference GMM Estimation Results of the Augmented Solow Model

Table A4.2.2a: Rule of Law

Arellano-Bond dynamic panel-data estimation		Number of obs	=	102
Group variable (i): PanelID		Number of groups	=	34
		Wald chi2(5)	=	1562.66
Time variable (t): year		Obs per group: min	=	3
		avg	=	3
		max	=	3

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8275126	.0261562	31.64	0.000	.7762474	.8787778
lninvestment						
D1.	.0061055	.0024121	2.53	0.011	.0013778	.0108332
lnSchool						
D1.	-.0007091	.0009132	-0.78	0.437	-.0024989	.0010806
lngpop						
D1.	-.0004492	.0009669	-0.46	0.642	-.0023444	.0014459
RuleLaw						
D1.	.0305613	.0099921	3.06	0.002	.0109772	.0501455
_cons	.007855	.0009736	8.07	0.000	.0059468	.0097631

Sargan test of over-identifying restrictions:

chi2(20) = 18.24 Prob > chi2 = 0.5716

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation z = -2.16 Pr > z = 0.0309

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation z = -1.04 Pr > z = 0.2961

Table A4.2.2b: Regularity Quality

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8444992	.0250768	33.68	0.000	.7953496	.8936489
lninvestment						
D1.	.0075468	.0016574	4.55	0.000	.0042983	.0107954
lnSchool						
D1.	-.001593	.0004637	-3.44	0.001	-.002502	-.0006841
lngpop						
D1.	-.0016766	.0013911	-1.21	0.228	-.0044031	.0010498
RegQ						
D1.	.0602931	.0077341	7.80	0.000	.0451345	.0754516
_cons	.0094572	.0010485	9.02	0.000	.0074022	.0115122

Sargan test of over-identifying restrictions:

chi2(20) = 16.82 Prob > chi2 = 0.6645

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation z = -2.39 Pr > z = 0.0167

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation z = -0.41 Pr > z = 0.6788

Table A4.2.2c: Government Effectiveness

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8170707	.0234405	34.86	0.000	.7711282	.8630133
lninvestment						
D1.	.0045541	.002461	1.85	0.064	-.0002693	.0093774
lnSchool						
D1.	-.0008755	.0008482	-1.03	0.302	-.0025379	.0007868
lnpop						
D1.	-.0010626	.0011719	-0.91	0.365	-.0033594	.0012342
GovEff						
D1.	.0338789	.0065775	5.15	0.000	.0209873	.0467704
_cons	.0086278	.00092	9.38	0.000	.0068246	.0104309

Sargan test of over-identifying restrictions:

chi2(20) = 18.54 Prob > chi2 = 0.5521

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation z = -2.20 Pr > z = 0.0278

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation z = -1.24 Pr > z = 0.2

Table A4.2.2d: Control of Corruption

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8406635	.0209641	40.10	0.000	.7995747	.8817524
lninvestment						
D1.	.0063584	.002015	3.16	0.002	.002409	.0103077
lnSchool						
D1.	.0004474	.0006991	0.64	0.522	-.0009228	.0018177
lnpop						
D1.	.0004665	.0013653	0.34	0.733	-.0022096	.0031425
corruption						
D1.	.0041506	.0084479	0.49	0.623	-.012407	.0207083
_cons	.0072315	.0007959	9.09	0.000	.0056715	.0087914

Sargan test of over-identifying restrictions:

chi2(20) = 18.45 Prob > chi2 = 0.5579

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation z = -2.13 Pr > z = 0.0332

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation z = -1.01 Pr > z = 0.3131

Table A4.2.2e: Political Instability

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8448883	.0353545	23.90	0.000	.7755949	.9141818
lninvestment						
D1.	.0060647	.0031935	1.90	0.058	-.0001944	.0123239
lnSchool						
D1.	.0016056	.000605	2.65	0.008	.0004198	.0027914
lnpop						
D1.	.0003955	.0011077	0.36	0.721	-.0017757	.0025666
Stability						
D1.	.0154858	.0037712	4.11	0.000	.0080944	.0228772
_cons	.006803	.0009861	6.90	0.000	.0048702	.0087358

Sargan test of over-identifying restrictions:

chi2(20) = 23.03 Prob > chi2 = 0.2871

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation z = -2.18 Pr > z = 0.0293

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation z = -1.11 Pr > z = 0.2663

Table A4.2.2f: Voice and Accountability

D.lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc						
LD.	.8823276	.0224547	39.29	0.000	.8383172	.9263379
lninvestment						
D1.	.0067725	.0020047	3.38	0.001	.0028434	.0107016
lnSchool						
D1.	.0010848	.0007091	1.53	0.126	-.0003049	.0024746
lngpop						
D1.	.0014518	.0014315	1.01	0.310	-.0013538	.0042575
voice						
D1.	.0478504	.0047651	10.04	0.000	.0385109	.0571898
_cons	.004683	.0009016	5.19	0.000	.002916	.0064501

Sargan test of over-identifying restrictions:
 chi2(20) = 18.86 Prob > chi2 = 0.5310
 Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
 H0: no autocorrelation z = -2.27 Pr > z = 0.0234
 Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
 H0: no autocorrelation z = -1.22 Pr > z = 0.2220

Table A4.2.3: Systems GMM Estimation Results of the Solow Model

Table A4.2.3a: Rule of Law

Group variable: PanelID	Number of obs =	210
Time variable : year	Number of groups =	35
Number of instruments = 18	Obs per group: min =	6
Wald chi2(4) = 206930.45	avg =	6.00
Prob > chi2 = 0.000	max =	6

lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	.9942508	.0036983	268.84	0.000	.9870023	1.001499
lninvestment	.0092973	.0019002	4.89	0.000	.0055731	.0130216
lngpop	-.001838	.0017617	-1.04	0.297	-.0052909	.0016149
RuleLaw	.0184004	.0056172	3.28	0.001	.0073909	.02941
_cons	-.1181563	.0507279	-2.33	0.020	-.2175813	-.0187314

Arellano-Bond test for AR(1) in first differences: z = -2.24 Pr > z = 0.025
 Arellano-Bond test for AR(2) in first differences: z = -1.12 Pr > z = 0.261
 Hansen test of overid. restrictions: chi2(13) = 14.72 Prob > chi2 = 0.325

Table A4.2.3b: Regulatory Quality

Group variable: PanelID	Number of obs =	210
Time variable : year	Number of groups =	35
Number of instruments = 18	Obs per group: min =	6
Wald chi2(4) = 203559.33	avg =	6.00
Prob > chi2 = 0.000	max =	6

lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	1.001366	.0028645	349.58	0.000	.9957513	1.00698
lninvestment	.0084691	.0021534	3.93	0.000	.0042486	.0126897
lngpop	-.0001902	.0018814	-0.10	0.919	-.0038777	.0034973
RegQ	.0165286	.0041839	3.95	0.000	.0083283	.0247289
_cons	-.1575994	.0484208	-3.25	0.001	-.2525024	-.0626965

Arellano-Bond test for AR(1) in first differences: z = -2.27 Pr > z = 0.023
 Arellano-Bond test for AR(2) in first differences: z = -0.97 Pr > z = 0.333
 Hansen test of overid. restrictions: chi2(13) = 17.88 Prob > chi2 = 0.162

Table A4.2.3c: Government Effectiveness

Group variable: PanelID		Number of obs	=	210		
Time variable : year		Number of groups	=	35		
Number of instruments = 18		Obs per group: min	=	6		
Wald chi2(4) = 144559.40		avg	=	6.00		
Prob > chi2 = 0.000		max	=	6		
lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	.9986834	.0030598	326.38	0.000	.9926862	1.004681
lninvestment	.0088224	.0020409	4.32	0.000	.0048222	.0128225
lnpop	-.0013832	.001636	-0.85	0.398	-.0045897	.0018233
GovEff	.0080808	.0036322	2.22	0.026	.0009619	.0151997
_cons	-.1484123	.0479907	-3.09	0.002	-.2424722	-.0543523
Arellano-Bond test for AR(1) in first differences: z = -2.24 Pr > z = 0.025						
Arellano-Bond test for AR(2) in first differences: z = -1.13 Pr > z = 0.257						
Hansen test of overid. restrictions: chi2(13) = 15.72 Prob > chi2 = 0.264						

Table A4.2.3d: Control of Corruption

Group variable: PanelID		Number of obs	=	210		
Time variable : year		Number of groups	=	35		
Number of instruments = 18		Obs per group: min	=	6		
Wald chi2(4) = 165139.54		avg	=	6.00		
Prob > chi2 = 0.000		max	=	6		
lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	.9974091	.0032988	302.35	0.000	.9909436	1.003875
lninvestment	.0095679	.0019782	4.84	0.000	.0056906	.0134451
lnpop	-.0029837	.0014515	-2.06	0.040	-.0058285	-.0001388
corruption	.0052545	.0056411	0.93	0.352	-.0058019	.0163109
_cons	-.1548407	.0495431	-3.13	0.002	-.2519434	-.0577379
Arellano-Bond test for AR(1) in first differences: z = -2.24 Pr > z = 0.025						
Arellano-Bond test for AR(2) in first differences: z = -1.08 Pr > z = 0.279						
Hansen test of overid. restrictions: chi2(13) = 15.20 Prob > chi2 = 0.295						

Table A4.2.3e: Political Instability

Group variable: PanelID		Number of obs	=	206		
Time variable : year		Number of groups	=	35		
Number of instruments = 18		Obs per group: min	=	4		
Wald chi2(4) = 90788.85		avg	=	5.89		
Prob > chi2 = 0.000		max	=	6		
lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	.9992827	.0052037	192.03	0.000	.9890836	1.009482
lninvestment	.0092123	.002274	4.05	0.000	.0047554	.0136693
lnpop	.0000402	.0014822	0.03	0.978	-.0028649	.0029453
Stability	.0113881	.0038313	2.97	0.003	.003879	.0188973
_cons	-.163693	.0476157	-3.44	0.001	-.2570181	-.070368
Arellano-Bond test for AR(1) in first differences: z = -2.25 Pr > z = 0.025						
Arellano-Bond test for AR(2) in first differences: z = -1.12 Pr > z = 0.265						
Hansen test of overid. restrictions: chi2(13) = 17.92 Prob > chi2 = 0.161						

Table A4.2.3f: Voice and Accountability

Group variable: PanelID		Number of obs	=	210
Time variable : year		Number of groups	=	35
Number of instruments = 18		Obs per group: min	=	6
Wald chi2(4) = 229598.60		avg	=	6.00
Prob > chi2 = 0.000		max	=	6

lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	.9985601	.0030401	328.46	0.000	.9926017	1.004519
lninvestment	.0089176	.0019643	4.54	0.000	.0050676	.0127676
lnpop	.0012824	.002001	0.64	0.522	-.0026395	.0052044
voice	.016268	.0031399	5.18	0.000	.0101139	.022422
_cons	-.1481727	.0462148	-3.21	0.001	-.238752	-.0575933

Arellano-Bond test for AR(1) in first differences: z = -2.25 Pr > z = 0.025
 Arellano-Bond test for AR(2) in first differences: z = -1.15 Pr > z = 0.251
 Hansen test of overid. restrictions: chi2(13) = 13.85 Prob > chi2 = 0.385

Table A4.2.4: Systems GMM Estimation Results of the Augmented Solow Model

Table A4.4.4a: Rule of Law

Group variable: PanelID		Number of obs	=	170
Time variable : year		Number of groups	=	34
Number of instruments = 18		Obs per group: min	=	5
Wald chi2(5) = 551055.88		avg	=	5.00
Prob > chi2 = 0.000		max	=	5

lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	1.000273	.0106859	93.61	0.000	.9793289	1.021217
lninvestment	-.0039704	.0081055	-0.49	0.624	-.0198568	.0119161
lnSchool	.0110347	.0104445	1.06	0.291	-.0094362	.0315055
lnpop	-.0018748	.0019185	-0.98	0.328	-.0056351	.0018855
RuleLaw	.0226574	.0041466	5.46	0.000	.0145302	.0307846
_cons	-.029894	.0593774	-0.50	0.615	-.1462716	.0864837

Arellano-Bond test for AR(1) in first differences: z = -2.20 Pr > z = 0.027
 Arellano-Bond test for AR(2) in first differences: z = -1.59 Pr > z = 0.111
 Hansen test of overid. restrictions: chi2(12) = 11.42 Prob > chi2 = 0.493

Table A4.2.4b: Regulatory Quality

Group variable: PanelID		Number of obs	=	170
Time variable : year		Number of groups	=	34
Number of instruments = 18		Obs per group: min	=	5
Wald chi2(5) = 718455.05		avg	=	5.00
Prob > chi2 = 0.000		max	=	5

lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	1.020032	.0082831	123.15	0.000	1.003798	1.036267
lninvestment	-.0131299	.0070539	-1.86	0.063	-.0269552	.0006954
lnSchool	.024127	.0082433	2.93	0.003	.0079704	.0402835
lnpop	-.0022425	.0017154	-1.31	0.191	-.0056046	.0011195
RegQ	.0158078	.0050929	3.10	0.002	.0058259	.0257898
_cons	-.1577495	.0597288	-2.64	0.008	-.2748158	-.0406832

Arellano-Bond test for AR(1) in first differences: z = -2.19 Pr > z = 0.028
 Arellano-Bond test for AR(2) in first differences: z = -1.89 Pr > z = 0.058
 Hansen test of overid. restrictions: chi2(12) = 13.71 Prob > chi2 = 0.319

Table A4.2.4c: Government Effectiveness

Group variable: PanelID				Number of obs	=	170
Time variable : year				Number of groups	=	34
Number of instruments = 18				Obs per group: min	=	5
Wald chi2(5) = 515500.42				avg	=	5.00
Prob > chi2 = 0.000				max	=	5
lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	.9947455	.012362	80.47	0.000	.9705164	1.018975
lninvestment	.0011922	.0089325	0.13	0.894	-.0163152	.0186996
lnSchool	.0027472	.0120257	0.23	0.819	-.0208226	.0263171
lnpop	-.0026238	.0021435	-1.22	0.221	-.006825	.0015774
GovEff	.0188347	.0038784	4.86	0.000	.0112333	.0264361
_cons	.0081682	.073847	0.11	0.912	-.1365691	.1529056
Arellano-Bond test for AR(1) in first differences: z = -2.19 Pr > z = 0.029						
Arellano-Bond test for AR(2) in first differences: z = -1.37 Pr > z = 0.171						
Hansen test of overid. restrictions: chi2(12) = 13.76 Prob > chi2 = 0.316						

Table A4.2.4d: Control of Corruption

Group variable: PanelID
Time variable : year
Number of instruments = 18
Wald chi2(5) = 337520.68
Prob > chi2 = 0.000
Number of obs = 170
Number of groups = 34
Obs per group: min = 5
avg = 5.00
max = 5

lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	.9911205	.009566	103.61	0.000	.9723714	1.00987
lninvestment	.0032609	.0071239	0.46	0.647	-.0107017	.0172236
lnSchool	.0033023	.0091765	0.36	0.719	-.0146833	.021288
lnpop	-.0054986	.0018137	-3.03	0.002	-.0090533	-.0019439
corruption	.0176644	.0066773	2.65	0.008	.0045772	.0307516
_cons	-.0137986	.0610938	-0.23	0.821	-.1335402	.105943

Warning: Uncorrected two-step standard errors are unreliable.
Arellano-Bond test for AR(1) in first differences: z = -2.22 Pr > z = 0.027
Arellano-Bond test for AR(2) in first differences: z = -1.26 Pr > z = 0.208
Hansen test of overid. restrictions: chi2(12) = 13.90 Prob > chi2 = 0.307

Table A4.2.4e: Political Instability

Group variable: PanelID		Number of obs	=	168
Time variable : year		Number of groups	=	34
Number of instruments = 18		Obs per group: min	=	4
Wald chi2(5) = 98518.04		avg	=	4.94
Prob > chi2 = 0.000		max	=	5

lnGDPpc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPpc_1	1.027006	.0103778	98.96	0.000	1.006665	1.047346
lninvestment	-.0275885	.0090468	-3.05	0.002	-.0453199	-.0098572
lnSchool	.0502684	.0103376	4.86	0.000	.0300072	.0705297
lnpop	-.002631	.0040472	-0.65	0.516	-.0105634	.0053014
Stability	.0257842	.0086902	2.97	0.003	.0087517	.0428166
_cons	-.2387854	.0666502	-3.58	0.000	-.3694174	-.1081534

Arellano-Bond test for AR(1) in first differences: z = -2.25				Pr > z = 0.024
Arellano-Bond test for AR(2) in first differences: z = -1.77				Pr > z = 0.076
Hansen test of overid. restrictions: chi2(12) = 8.96				Prob > chi2 = 0.706

Table A4.2.4f: Voice and Accountability

Group variable: PanelID		Number of obs	=	170
Time variable : year		Number of groups	=	34
Number of instruments = 18		Obs per group: min	=	5
Wald chi2(5) = 372121.03		avg	=	5.00
Prob > chi2 = 0.000		max	=	5

lnGDPPc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnGDPPc_1	1.013719	.0091459	110.84	0.000	.9957933	1.031645
lninvestment	-.0088238	.0063621	-1.39	0.165	-.0212933	.0036458
lnSchool	.0206131	.0078155	2.64	0.008	.0052951	.0359311
lngpop	-.0005325	.002309	-0.23	0.818	-.0050581	.0039932
voice	.0173178	.0053655	3.23	0.001	.0068015	.0278341
_cons	-.1561294	.0523654	-2.98	0.003	-.2587637	-.053495

Arellano-Bond test for AR(1) in first differences: z = -2.20 Pr > z = 0.028
 Arellano-Bond test for AR(2) in first differences: z = -1.91 Pr > z = 0.056
 Hansen test of overid. restrictions: chi2(12) = 10.93 Prob > chi2 = 0.535

Table A4.3: Stochastic Frontier Model and Technical Inefficiency Function

Table A4.3.1: Stochastic Frontier Model

Iteration 49: log likelihood = 313.16112
 Iteration 50: log likelihood = 313.16112

Time-varying decay inefficiency model
 Group variable (i): PanelID

Number of obs = 350
 Number of groups = 35

Time variable (t): year

Obs per group: min = 10
 avg = 10
 max = 10

Log likelihood = 313.16112

Wald chi2(3) = 318.77
 Prob > chi2 = 0.0000

lnGDP	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnland	.2188674	.0504594	4.34	0.000	.1199687	.3177661
lnlabor	.1712496	.0669834	2.56	0.011	.0399644	.3025347
lnapstock	.4528536	.0350391	12.92	0.000	.3841782	.521529
_cons	77.25142	361.6341	0.21	0.831	-631.5385	786.0413

sigma2	.2930867	.0732689			.1795576	.478397
gamma	.982262	.0047047			.9702555	.9894746
sigma_u2	.2878879	.0732848			.1442524	.4315234
sigma_v2	.0051988	.0004172			.004381	.0060165

Table A4.3.2: Technical Inefficiency Models**Table A4.3.2a: Rule of Law**

Random-effects GLS regression
Group variable (i): PanelID

Number of obs = 170
Number of groups = 34

R-sq overall = 0.3359

Obs per group: min = 5
avg = 5.0
max = 5

Random effects u_i ~ Gaussian
corr(u_i, x) = 0 (assumed)

Wald chi2(6) = 22.65
Prob > chi2 = 0.0009

u	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
LLockedD	1.071232	.4796974	2.23	0.026	.1310421	2.011421
IGD	-.174778	.3994566	-0.44	0.662	-.9576985	.6081425
BritishD	2.003052	.5599835	3.58	0.000	.9055042	3.100599
school	2.56e-08	1.00e-08	2.56	0.011	5.99e-09	4.52e-08
RuleLaw	-.0020443	.0307187	-0.07	0.947	-.0622518	.0581632
llb	-2.238681	.8326909	-2.69	0.007	-3.870726	-.6066372
_cons	92.02289	.359065	256.28	0.000	91.31913	92.72664

Table A4.3.2b: Regulatory Quality

Random-effects GLS regression
Group variable (i): PanelID

Number of obs = 170
Number of groups = 34

R-sq: overall = 0.3351

Obs per group: min = 5
avg = 5.0
max = 5

Random effects u_i ~ Gaussian
corr(u_i, x) = 0 (assumed)

Wald chi2(6) = 40.57
Prob > chi2 = 0.0000

u	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
LLockedD	1.098559	.4932323	2.23	0.026	.1318411	2.065276
IGD	-.2168131	.4103731	-0.53	0.597	-1.02113	.5875034
BritishD	2.050949	.5758149	3.56	0.000	.9223728	3.179526
school	2.41e-08	9.33e-09	2.58	0.010	5.79e-09	4.24e-08
RegQ	-.0821119	.0194061	-4.23	0.000	-.1201472	-.0440766
llb	-2.310925	.8562349	-2.70	0.007	-3.989115	-.6327358
_cons	92.0009	.3692008	249.19	0.000	91.27728	92.72452

Table A4.3.2c: Government Effectiveness

Random-effects GLS regression
Group variable (i): PanelID

Number of obs = 170
Number of groups = 34

R-sq: overall = 0.3364

Obs per group: min = 5
avg = 5.0
max = 5

Random effects u_i ~ Gaussian
corr(u_i, x) = 0 (assumed)

Wald chi2(6) = 27.03
Prob > chi2 = 0.0001

u	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
LLockedD	1.093555	.4933726	2.22	0.027	.1265628	2.060548
IGD	-.2108847	.410652	-0.51	0.608	-1.015748	.5939784
BritishD	2.039743	.5760505	3.54	0.000	.9107052	3.168782
school	2.36e-08	9.79e-09	2.41	0.016	4.36e-09	4.28e-08
Goveff	-.0576128	.0258351	-2.23	0.026	-.1082487	-.0069769
llb	-2.290486	.8565357	-2.67	0.007	-3.969265	-.6117063
_cons	92.00911	.3692772	249.16	0.000	91.28534	92.73288

Table A4.3.2d: Control of Corruption

Random-effects GLS regression
Group variable (i): PanelID

R-sq: overall = 0.3438

Random effects $u_i \sim \text{Gaussian}$
 $\text{corr}(u_i, X) = 0$ (assumed)

Number of obs = 170
Number of groups = 34

Obs per group: min = 5
avg = 5.0
max = 5

Wald $\chi^2(6) = 27.28$
Prob > $\chi^2 = 0.0001$

u	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
LLockedD	1.090302	.4696418	2.32	0.020	.1698212	2.010783
IGD	-.2040905	.3908825	-0.52	0.602	-.970206	.5620251
BritishD	2.012401	.5481554	3.67	0.000	.938036	3.086766
school	2.37e-08	9.96e-09	2.37	0.018	4.13e-09	4.32e-08
corruption	-.046862	.0240203	-1.95	0.051	-.0939409	.0002169
llb	-2.272583	.8152346	-2.79	0.005	-3.870413	-.6747523
_cons	92.01909	.3514664	261.81	0.000	91.33022	92.70795

Table A4.3.2e: Political Instability

Random-effects GLS regression
Group variable (i): PanelID

R-sq: overall = 0.3217

Random effects $u_i \sim \text{Gaussian}$
 $\text{corr}(u_i, X) = 0$ (assumed)

Number of obs = 168
Number of groups = 34

Obs per group: min = 4
avg = 4.9
max = 5

Wald $\chi^2(6) = 25.79$
Prob > $\chi^2 = 0.0002$

u	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
LLockedD	1.072622	.4633294	2.32	0.021	.1645128	1.980731
IGD	-.153254	.3857069	-0.40	0.691	-.9092256	.6027176
BritishD	2.003229	.5408917	3.70	0.000	.9431008	3.063357
school	2.53e-08	9.98e-09	2.53	0.011	5.70e-09	4.48e-08
Stability	.0286383	.0204742	1.40	0.162	-.0114903	.0687669
llb	-2.236922	.8042623	-2.78	0.005	-3.813247	-.6605973
_cons	92.0212	.3468301	265.32	0.000	91.34143	92.70098

Table A4.3.2f: Voice and Accountability

Random-effects GLS regression
Group variable (i): PanelID

R-sq: overall = 0.3224

Random effects $u_i \sim \text{Gaussian}$
 $\text{corr}(u_i, X) = 0$ (assumed)

Number of obs = 170
Number of groups = 34

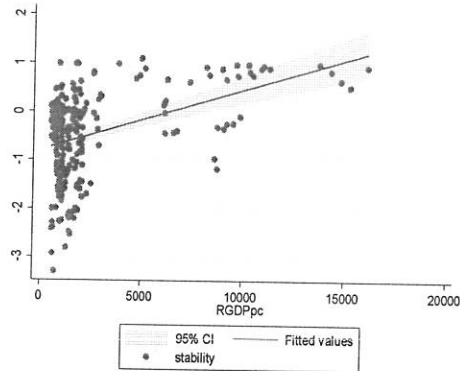
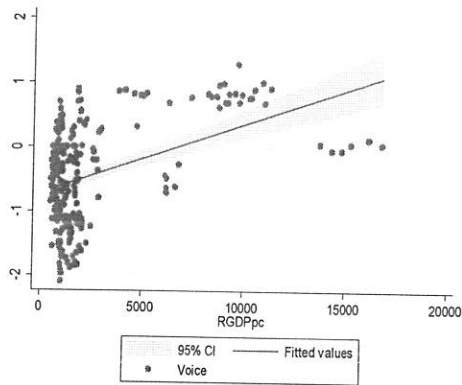
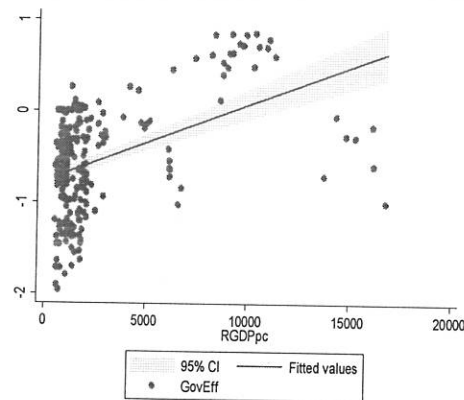
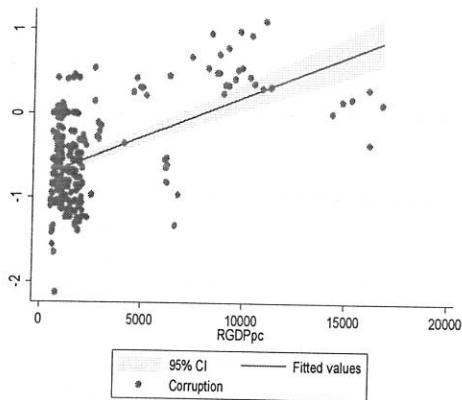
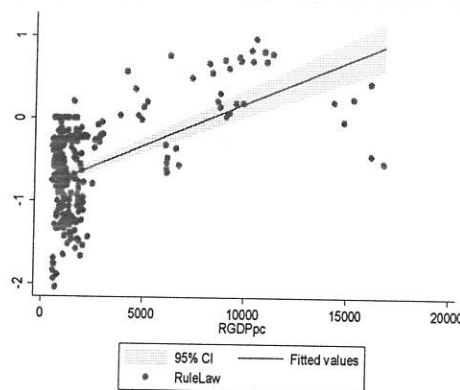
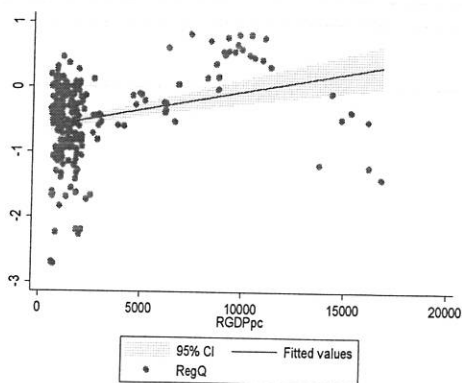
Obs per group: min = 5
avg = 5.0
max = 5

Wald $\chi^2(6) = 24.91$
Prob > $\chi^2 = 0.0004$

u	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
LLockedD	1.066331	.473446	2.25	0.024	.1383936	1.994268
IGD	-.1510036	.3941691	-0.38	0.702	-.9235608	.6215537
BritishD	1.980258	.5529319	3.58	0.000	.8965317	3.063985
school	2.53e-08	9.97e-09	2.53	0.011	5.73e-09	4.48e-08
voice	.0380154	.0284196	1.34	0.181	-.017686	.0937168
llb	-2.209958	.822068	-2.69	0.007	-3.821181	-.598734
_cons	92.02706	.354391	259.68	0.000	91.33246	92.72165

**Table A4.4: List of Sample Countries**

Benin	Gambia, The	Senegal
Botswana	Ghana	Seychelles
Burkina Faso	Guinea	South Africa
Cameroon	Guinea-Bissau	Sudan
Cape Verde	Kenya	Tanzania
Chad	Lesotho	Togo
Comoros	Madagascar	Uganda
Congo	Malawi	Zambia
Congo, Dem. Rep.	Mali	Zimbabwe
Cote d'Ivoire	Mauritius	
Eritrea	Mozambique	
Ethiopia	Rwanda	
Gabon	Sao Tome and Principe	

Figure A4.1: Scatter Plot of GDP per Capita and Governance Variables**Figure A4.1a:** Per capita real GDP vs. voice and accountability **Figure A4.1b:** Per capita real GDP vs. political instability**Figure A4.1c:** Per capita real GDP vs. control of corruption **Figure A4.1d:** Per capita real GDP vs. Government Effectiveness**Figure A4.1e:** Per capita real GDP vs. Regulatory Quality**Figure A4.1f:** Per capita real GDP vs. Rule of Law

Appendix:

A1: Derivation of the Differenced GMM estimator

[The derivation is adopted from Arellano and Bond (1991), and Nkurunziza and Bates (2003)]

Rewrite Equation 3.4 so that all the covariate are stacked in the vector $X_{i,t}$ as :

$$y_{i,t} - y_{i,t-1} = \alpha + \beta y_{i,t-1} + \gamma x_{i,t} + \mu_i + v_{i,t} \quad (A1.1)$$

Equation A1.1 is equivalent to:

$$y_{i,t} = \beta^* y_{i,t-1} + \gamma x_{i,t} + \mu_i + v_{i,t} \quad (A1.2)$$

Where $\beta^* = (\beta + 1)$. By writing Equation A1.2 in first differences, we have:

$$\Delta y_{i,t} = \beta^* \Delta y_{i,t-1} + \gamma \Delta x_{i,t} + \mu + \Delta v_{i,t} \quad (A1.3)$$

given that $\mu_{i,t} - \mu_{i,t-1} = 0$. This transformation solves the problem of heterogeneity (omitted variable bias) by sweeping μ_i from equation A1.1/3.4.

While doing so introduces the problem of endogeneity. Inspection of equation (A1.2) and (A1.3) shows that $y_{i,t-1}$ is endogenous to the error term $v_{i,t-1}$. The relationship between $y_{i,t}$ and $v_{i,t}$ in equation (A1.3) is the same as the relation between the dependent variable and the error term in equation (A1.2) but only lagged once. Hence:

$$\text{if } y_{i,t} = f(v_{i,t}) \Rightarrow y_{i,t-1} = f(v_{i,t-1}) \quad (\text{A1.4})$$

Therefore, estimating equation A1.3 by ordinary least square produces biased estimates of β . Anderson and Hsiao (1982, cited in Nkurunziza and Bates, 2003) suggested to use $\Delta y_{i,t-2}$ (and later $y_{i,t-2}$) as instrument along with other exogenous right-hand-side variables of equation A1.3. Thus, the vector of instrument is given by $Z = [y_{i,t-2} \Delta x_{i,t}]$ assuming that all the variables in $\Delta x_{i,t}$ are exogenous.

Arellano and Bond (1991) argue that if $y_{i,t-2}$ is a good instrument, then $y_{i,t-3}, y_{i,t-4}, \dots, y_{i,t-k}$ are also good instruments. This leads to the following moment restrictions:

$$E(y_{i,t-j} \Delta v_{i,t}) = 0 \quad \forall j=2,3,\dots,(T-1) \quad (\text{A1.5})$$

and;

$$E(x_{i,t-k} \Delta v_{i,t}) = 0 \quad \forall k=1, 2, 3, \dots, (T-1) \quad (\text{A1.6})$$

The moment restrictions in (A1.5) and (A1.6) show that there are more valid instruments than endogenous variables. Hansen (1982, cited in Nkurunziza and Bates, 2003) suggested differenced generalized method of moment. The differenced generalized method of moments estimator is obtained by first putting all the instruments in a single vector:

$$Z^* = [y_{t-2}, y_{t-3}, \dots, \Delta x_{t-1}, \Delta x_{t-2}, \dots] \quad (\text{A1.7})$$

Then, the inverse of the variance-covariance matrix of the instruments denoted A_H , is computed to combine the instruments efficiently and then used to derive the differenced general method of moments estimators:

$$\hat{\delta}_{GMM} = (X'Z^* A_H Z^{*'} X)^{-1} X'Z^* A_H Z^{*'} y \quad (\text{A1.8})$$

Declaration

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

Declared by:

Name: Habtamu Neda

Signature: 

Date: August 2007

Confirmed by Advisor:

Name: Dr. F. Wouterse

Signature: 

Date: 27-07-07

Place and date of submission: _____