

Essays on Human Capital and Economic Development

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Abstract

This thesis explores three important factors that have been central to the pursuit of economic development especially in case of developing countries. These are human capital, corruption and institutions.

The first chapter presents an analysis of the role of corruption in determining the distribution of income and, with this, the degree of poverty and inequality. The analysis is based on an overlapping generations model in which individuals may seek to improve their productive efficiency (and hence earnings) by supplementing or substituting publicly provided services (such as education and health) with personal expenditures on human capital investment. Because of capital market imperfections, their ability to do this depends on their inherited wealth which serves as collateral for loans. Corruption is reflected in the pilfering of public funds and a reduction in public service provision, the effect of which is to reduce the earnings of those who rely on such services and to exacerbate the extent of credit rationing for these agents. The dynamic general equilibrium of the model is characterised by multiple steady states to which different income classes converge. Higher levels of corruption lead to higher levels of poverty and may result in complete polarisation between the rich and poor by eliminating the middle class.

The second chapter presents an analysis of the threshold effects of human capital on economic growth. Using a sample of 126 countries (1970-2012), we estimate a dynamic threshold panel model following Hansen (1999) and Caner & Hansen (2004). Our results are twofold: *first*, there exists a significant threshold level of development (proxied by capital stock per capita) below which the effect of human capital on economic growth is insignificant, whereas it is positive significant above it; *second*, while looking into the impact of institutional quality, we find significant thresholds of interaction between institutional quality and development.

Key words: Corruption; Economic Growth; Human Capital; Inequality; Institutions

JEL classification: D31, D73, H41, O15, O43

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Dedication

To My Parents

[Ahsan Waheed Rathore & Dilruba Ahsan]

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Chapter 1

Thesis Introduction

An important question that comes across an individual's mind when studying development and growth across countries is why some countries prosper while others do not? Traditional theory and research by economists over decades have studied the growth patterns of countries and identified determinants of growth. If these are known, why is that some countries move faster towards prosperity while less developing countries are stuck in their poverty traps. Why is this difference there? Underlying this there has been a growing appreciation for the importance of governance and the quality of institutions. This thesis provides an insight to both these policy issues.

Corruption is one of the fundamental issues of development and has been at the forefront of many international development organization's agenda. This has led researchers to study corruption and its possible effects on growth. Many empirical studies have provided evidence of the adverse effects of corruption on growth (Knack & Keefer 1995, Sachs & Warner 1997, Keefer & Knack 1997, Li, Xu & Zou 2000, Gyimah-Brempong 2002) and have identified various channels through which this occurs, such as lowering investment (Mauro 1995), reducing flows of foreign investment (Wei 2000) and causing a misallocation of public expenditure (Mauro 1997, Tanzi & Davoodi 1997).

The effects of corruption are not confined to aggregate outcomes alone rather they extend to distributional outcomes as well. This further aspect of development occupies our principal concern in the first chapter of the thesis. Research on corruption and its distributional consequences have flourished over the years. At the empirical level, a strong positive correlation has been identified between corruption and the degree of inequality in a number of studies. Gyimah-Brempong (2002) and Dincer & Gunalp (2008) using

data on African countries and US states respectively, find evidence of an increase in the degree of inequality as the level of corruption increases. In addition, similar findings are found in Chong & Calderon (2000), Gupta, Davoodi & Alonso-Terme (2002) and Gyimah-Brempong & de Camacho (2006) who base their analysis on a broader sample of developed and developing countries. Finally, Chong & Gradstein (2007) suggest that there may be reverse causation in the relationship between corruption and inequality with both being mutually dependent. At the theoretical level, it has been shown that corruption may impact inequality through various channels. Ahlin (2001) and Foellmi & Oechslin (2007) develop an occupational model where private agents bribe public officials, leading to a redistribution of income as the payment of bribe increases. Glaeser, Scheinkman & Shleifer (2003) develop a judicial model to illustrate how institutions that are weak due to corruption allow only the rich to protect themselves, thus aggravating income inequality. Lastly, Blackburn & Forgues-Puccio (2007) use bureaucratic corruption to show how corruption can foster inequality by compromising the effectiveness of re-distributive policy.

Corruption can take many forms. An important form of corruption which is prevalent in most developing countries is the mis allocation and misappropriation of public funds. Mauro (1997) and Gupta, Davoodi & Alonso-Terme (2002) suggest that corruption distorts the composition of government expenditure by reducing public spending on growth promoting areas (such as education and health) while increasing it on less productive areas (such as military and infrastructure). Corrupt public agents prefer investing in projects which generate the highest bribes and may not necessarily be the most efficient (Anand & Ravallion 1993). As a result, corruption not only reduces the impact of public spending on social outcomes but also reduces the quality of these services. According to the findings of Filmer & Pritchett (1999), doubling public spending on health from 3% to 6% percent of the GDP would only improve child mortality by 9% to 13%. In countries with good governance, a 1% point increase in the share of public education spending in GDP lowers the primary education failure rate by 0.70% while in countries with weaker governance it has no distinguishable impact (Rajkumar & Swaroop 2008). This means that apart from spending less on growth promoting areas, the resources that are invested do not yield the desired outcomes i.e., the efficacy of spending is also vital. This brings us to the problem of leakages and embezzlement of public funds, which is especially common in developing countries (Reinikka & Svensson 2005) though it also exists in the developed world (Baicker & Staiger 2005). A good example of this theory comes from Uganda, a poor Sub-Saharan country where findings from a public expenditure survey showed that

on average schools received only 13% of the budgetary allocation for non-wage expenditures (Rajkumar & Swaroop 2008). Most of the allocated funds were used by public officials for purposes unrelated to education or captured for private gain (leakage). In case of health, According to the Global Corruption Report 2006, 5-10% of the health budget is lost to overpayment whereas in Cambodia, more than 5% of the health budget is lost to corruption before it even leaves the central government. While this corruption hurts the society in general, the greatest burden is borne by the poor who cannot afford private services and are most vulnerable to the quality of governance.

The first chapter focuses on the interplay of corruption and human capital and its effects on the distribution of income and consequently on the growth of an economy. The analysis is based on an overlapping generations model in which individuals may seek to improve their productive efficiency (and hence earnings) by supplementing or substituting publicly provided services (such as education and health) with personal expenditures on human capital investment. Because of capital market imperfections, their ability to do depends on their inherited wealth which serves as collateral for loans. Corruption is reflected in the pilfering of public funds and a reduction in public service provision, the effect of which is to reduce the earnings of those who rely on such services and to exacerbate the extent of credit rationing for these agents. The dynamic general equilibrium of the model is characterized by multiple steady states to which different income classes converge. Higher levels of corruption lead to higher levels of poverty and may result in complete polarization between the rich and poor by eliminating the middle class.

The second part of this thesis focuses on the threshold effects of human capital and its impact on growth. Over the last two decades the role of human capital has been emphasized as an important factor contributing to productivity and other economic outcomes both at the individual as well as at the aggregate level. The microeconomics literature, based on Mincerian human capital earnings function, reports significant returns to schooling. There is a robust relationship between human capital and individual wages where, higher education increases productivity and hence wages. At the macroeconomics level, while theoretically human capital has been identified as an important determinant for growth empirically, there is considerable uncertainty on the extent and magnitude of this contribution. This “empirical paradox”, as Rogers called it, forms the basis of the second part of the thesis.

According to the traditional neoclassical theory there was no role of human capital in the process of economic growth. The Solow-growth model, developed by Robert Solow,

considered economic growth in an economy to be dependent on the economy's savings rate and population rate. Variations in these two variables explained why there were cross-country variations in income per capita. It was with the emergence of endogenous growth theory and the seminal contribution of Lucas Jr (1988) that brought up the role of human capital into the forefront. Lucas viewed human capital formation as an engine of growth. This was followed by Romer who considered human capital to affect growth through technological progress and innovation.

Since the advent of endogenous growth theory there has been a flurry of empirical literature. Early studies using cross sectional data and enrollment rate as a proxy for human capital report a positive significant impact of human capital on growth. These findings were also found to exist in case of panel data. However, more recently, many cross sectional studies have found these findings unconvincing and inconsistent with the microeconomics evidence on returns to education. The possible explanations behind this empirical paradox included issues like measurement error, data quality, econometric technique and existence of outliers as reasons behind this.

One important fact that was not addressed in the above studies was the idea that human capital did not have an insignificant effect across all countries. However, there were some countries, such as the OECD countries, which experienced a positive significant impact while others, including low income developing countries, failed to do so. This meant that apart from the methodology issues and problems with data quality there is something else too that contributes to the failure of human capital in some countries.

Motivated by these observations we seek to empirically investigate the link between human capital and growth. The study contributes to the existing literature by *firstly*, testing the non-linearity in the relationship between human capital and growth and *secondly*, by investigating any underlying country-specific characteristics that is causing it. For the former, we use the dynamic threshold model introduced by Hansen (1999) and Caner & Hansen (2004), which has not been used in this context before. For the latter, we investigate further to see whether there are any country specific characteristics that play any role in shaping this non-linear relationship. To our knowledge, this is the first attempt in estimating the threshold effects of human capital on growth and understanding why it fails to have an impact in some countries. Previously, Rogers (2008) focused on unproductive activities (such as corruption, black market premium on foreign exchange market and brain drain) to explain the heterogeneous effect of human capital on growth however, he did not estimate any threshold level through a threshold estimation regression.

Investigating the second part of this chapter brings us to the fundamental role of institutions in shaping the way human capital behaves in an economy. The quality of institutions, as an important factor contributing to the process of growth, has gained importance over the years (see Hall & Jones (1999); Acemoglu & Robinson (2001); Rodrik, Subramanian & Trebbi (2004); Easterly & Levine (2001) and many others). While the accumulation of physical capital, human capital and the adoption of technology are factors of production necessary for a country to grow it is not sufficient, but the efficiency with which these ‘fundamental causes are used should also be taken into account (Acemoglu 2009). Institutions are important because they influence the structure of incentives. If property rights are not enforced properly individuals will have little incentive to invest in physical or human capital or adopt efficient technologies (Acemoglu, Johnson & Robinson 2005b). The incentive to engage in productive activities is eroded if individuals and business lack confidence that contracts will be enforced and the fruits of their productive efforts protected. Thus, economists and policymakers are increasingly concerned with understanding the reason behind the failure of human capital in playing a role in the process of economic growth.

The analysis begins with estimating the role of human capital in the growth process for a sample of developed and developing countries. The results show that while the impact of human capital is positive significant in developed countries, it is insignificant in developing countries. This is then followed by a threshold regression estimation to see at which stage of development education cannot be productive. The study shows that the impact of human capital is regime specific- depending on the level of development. More importantly, we find that institutions play an important role in shaping the way human capital affects growth. It is not just the economic development but also the inefficiency in institutions that hinders less developed countries to get out the most from their resources. Poor institutional quality in less developed countries acts as an impediment to growth since individuals are likely to divert resources to unproductive uses.

Chapter 2

Human capital and Income Distribution in a Model of Corruption

2.1 Introduction

Corruption is one of the fundamental issues of growth and has been at the forefront of many international organizations' agenda including the World Bank and the International Monetary Fund (IMF). According to Sen (1999) "corruption is one of the major stumbling blocks in the path to successful economic progress". Evidence from the past shows that many poor countries are not able to escape from their poverty traps since they are unable to combat the forces of corruption. In most cases, the problem with these poorest countries can be traced down to corruption by government and public officials which is pervasive throughout the world and exists in almost every society at different levels. The abuse of authority by public officials distorts the government's role in resource allocation and hinders growth prospects. Moreover, evidence shows that the benefits from corruption are likely to accrue to the "better-connected individuals" mostly from the high-income groups (Tanzi 1995). Thus, corruption affects not only macroeconomic aggregates such as investment and growth, but also the distribution of income. According to a United Nations Development Programme, corruption encourages higher investment in capital-intensive projects and lowers investment in labour intensive projects. This bias in investment strategy increases poverty by depriving poor individuals of income generating incentives. This link between corruption, development, poverty and income distribution bring it to the forefront of the international development agenda.

Most of the early theoretical literature on corruption was microeconomics in nature, focusing essentially on partial equilibrium models to study specific issues and questions arising from the principal-agent type relationship between the government and bureaucracy (Bardhan 1997, Rose-Ackerman 1999, Murphy, Shleifer & Vishny 1993, Tanzi 1998). More recently, there has been a growing body of research that addresses the issue from a macroeconomic perspective using general equilibrium models. This chapter seeks to contribute to that research by developing a dynamic macroeconomic model of misgovernance to study the impact of corruption on income distribution and economic development.

Many empirical studies have provided evidence of the adverse effects of corruption on growth (Knack & Keefer 1995, Sachs & Warner 1997, Keefer & Knack 1997, Li et al. 2000, Gyimah-Brempong 2002) and have identified various channels through which this occurs, such as lowering investment (Mauro 1995), reducing flows of foreign investment (Wei 2000) and causing a misallocation of public expenditure (Mauro 1997, Tanzi & Davoodi 1997). Another set of studies suggest that the impact of corruption is not only negative but also two-way causal (Ades & Di Tella 1999, Fisman & Gatti 2006, Paldam 2002, Rauch & Evans 2000, Treisman 2000) implying that corruption and poverty may become so embedded into society that they may establish themselves as almost permanent fixtures (Bardhan 1997, Sah 1988).

In addition to efficiency considerations, further empirical work has also revealed the potential distributional consequences of corruption. The general conclusion of this work is that corruption widens inequality in an economy (Gupta, Davoodi & Alonso-Terme 2002, Gyimah-Brempong 2002, Li et al. 2000)¹. Theoretical studies in this area point to different ways in which corruption may impact on inequality. Ahlin (2001) and Foellmi & Oechslin (2007) focus on an occupational model, where private agents bribe public officials, leading to a redistribution of income as the payment of bribe increases. Glaeser et al. (2003) develop a judicial model to illustrate how institutions that are weak due to corruption allow only the rich to protect themselves, thus aggravating income inequality. Lastly, Blackburn & Forgues-Puccio (2007) use bureaucratic corruption to show how corruption can foster inequality by compromising the effectiveness of redistributive policy.

The existing literature shows that corruption can take many different forms and can impact on growth and income distribution in many different ways. Empirical studies have shown that corruption is often associated with a misallocation and misappropriation of

¹There is also empirical (see You & Khagram (2005)) and theoretical (see Dutta & Mishra (2004, 2013)) literature which looks at the impact of inequality on corruption.

public funds. Mauro (1997) and Gupta, Davoodi & Alonso-Terme (2002) suggest that corruption distorts the composition of government expenditure by reducing public spending on growth promoting areas (such as education and health) while increasing it on less productive areas (such as military and infrastructure). In this study, we focus specifically on corruption in the form of embezzlement, where public officials steal public funds from the education and health budget, which reduces the provision of these services and impedes human capital accumulation. Human capital is defined broadly to include both education and health. Education, being the fundamental right of every individual, is one of the most vital sectors of an economy and is the driver towards better human and economic development. Research over the years has established that higher education is linked with higher economic growth (Barro 1991, Barro & Lee 1994, Mankiw, Romer & Weil 1992), lower infant mortality rate (Jamison, Jamison & Hanushek 2007) and higher levels of democracy (Barro 1999)². Therefore many developed and developing countries have been allocating a considerable amount of their public spending to improve their education systems. However, despite this expenditure, the results are often disappointing as many countries have failed to realise significant improvements in education outcomes (Anand & Ravallion 1993, Harbison & Hanushek 1992, Rajkumar & Swaroop 2008). Corruption in education acts as a major obstacle to development as it threatens a country's social, political and economic future. It is particularly harmful to the poor since without access to education (or access to only low quality education) they have little chances to escape poverty³. According to one study, good governance is central in determining the efficacy of public spending. In countries with good governance, a 1% point increase in the share of public education spending in GDP lowers the primary education failure rate by 0.70% while in countries with weaker governance it has no distinguishable impact (Rajkumar & Swaroop 2008). One of the major causes of this is the embezzlement of public funds from the education budget which compromises the effectiveness of public spending on education. These leakages from public funds reduce school quality. Rather than being used to improve service delivery, they are pocketed by public officials and in some instances, may never be reclaimed. This diversion of resources is especially common in developing countries (Reinikka & Svensson 2005) though it also exists in the

²However, some studies validate the positive impact of education on growth. Studies including Benhabib & Spiegel (1994), Temple (1999), Pritchett (2001) and Rogers (2008) find a weak association between increase in level of education and growth of an economy. The possible explanations for this heterogeneous impact of education on growth include measurement error (Krueger & Lindahl 2001, Hanushek & Kimko 2000), lack of data quality (De la Fuente & Doménech 2006, Cohen & Soto 2007) and reverse causality (Bils & Klenow 2000, Freire-Seren 2002).

³Transparency International: <http://www.transparency.org/topic/detail/education>.

developed world (Baicker & Staiger 2005).

The discussion above explains the importance of education as a form of human capital. However, another crucial aspect which cannot be ignored is health human capital. Where most studies acknowledge the positive impact of human capital on growth, they narrowly define it as the level of schooling. Better health conditions make individuals more productive thus contributing as a major ingredient for economic growth. There have been a number of studies which support the idea that better health conditions and improvements in expected lifetime foster growth (De la Croix & Licandro 1999, Ehrlich & Lui 1991, Kalemli-Ozcan 2002, Zhang & Zhang 2001, Zhang, Zhang & Lee 2001)⁴. Despite this vital feature, the health sector, like the education sector, in many developing countries is plagued by corruption. According to the Global Corruption Report 2006, 5-10% of the health budget is lost to 'overpayment' whereas in Cambodia, more than 5% of the health budget is lost to corruption before it even leaves the central government⁵. It is therefore important to see how the impact of corruption on health, as well as education, may affect human capital, and how this may affect the distribution of income, the level of growth and the degree of poverty in an economy.

The foregoing discussion provides the motivation for this study which examines theoretically the link between corruption, income distribution and development. The aim of the chapter is to study the impact of corruption on one of the most important factors in human development (education and health status) and how this affects the prospective fortunes of individuals⁶. The analysis is based on a dynamic general equilibrium model in which individuals belong to overlapping generations connected by intergenerational altruism. Corruption may arise as bureaucrats have the potential to appropriate public funds intended for the provision of education and health services. The main question is how this leakage of funds affects an individuals' capacity to accumulate human capital and how this, in turn, affects the distribution of income. In accordance with the empirical literature, our model predicts that corruption leads to higher levels of poverty and lower levels of economic performance.

⁴This has been supported by the data as well (Knowles & Owen 1995, Bloom, Canning & Sevilla 2004, Bloom, Canning & Sevilla 2005)

⁵See the Global Corruption Report 2006: Transparency International. http://www.transparency.org/research/gcr/gcr_health.

⁶Strictly speaking, what the analysis deals with is the effect of corruption on poverty, not inequality. These are two distinct concepts which may or may not be related (e.g., everyone in a country could be equally poor). For this reason, the chapter tries to avoid referring to inequality as much as possible, and to avoid providing any explicit measure of inequality.

The chapter is organized as follows. In section 2 the existing literature on corruption and inequality is discussed. Section 3 presents a description of the model. Section 4 contains an analysis of the dynamic general equilibrium while section 6 presents an analysis of the interaction between corruption, growth and income distribution. Section 6 outlines some extensions to the model. Section 7 concludes.

2.2 Literature Review

Many theoretical and empirical studies have been conducted that illustrate a significant impact of income distribution on the growth of an economy. In the contemporary literature various approaches may be identified. First, there is the political economy approach, according to which higher levels of inequality lead to greater redistribution and higher tax burdens, thus creating distortions in productive incentives and hence hampering growth (Rodrik & Alesina 1994, Benabou 1996, Perotti 1993, Tabellini & Persson 1994). Second, there is the credit market imperfections approach, according to which individuals with low levels of wealth have restricted access to credit for funding profitable investment opportunities, implying that greater inequality causes more individuals to be credit constrained which leads to a reduction in investment and a decline in growth (Banerjee & Newman 1993, Galor & Zeira 1993, Piketty 1997). Third, there is the socio-political approach, which suggests that greater inequality reduces growth by leading to increased crime, social unrest and political instability (Alesina & Perotti 1996, Benhabib & Rustichini 1996, Hibbs 1973, Venieris & Gupta 1986). And fourth, there is the demographic approach (see Perotti (1996) and Morand (1999)) which suggests that greater inequality adversely affects growth through its positive impact on the fertility rate.

Another area of concern is the impact of corruption on income distribution and growth. Both empirical and theoretical work in this area has been flourishing over the past years. An early view was that corruption might act as a lubricant that smooths rigidities in the bureaucratic processes, thereby enhancing growth through a more efficient provision of government services. Bribes may act as “speed money” accepted by bureaucrats to overcome institutional rigidities in the bureaucratic process (Leff 1964, Lui 1985). However, this view can be questioned not only on conceptual grounds (Bardhan 1997) but also on the basis of the significant negative relationship between corruption and growth that has been found in many empirical studies (Knack & Keefer 1995, Sachs & Warner 1997, Keefer & Knack 1997, Li et al. 2000, Gyimah-Brempong 2002). Furthermore, Myrdal & Fund

(1968) argue that bureaucrats, rather than speeding up decisions might deliberately create administrative delays in order to attract more bribes.

As indicated by Svensson (2005), the actual cost of corruption to economic growth is not imposed by the corrupt actions themselves. Rather, the primary loss is caused by the way that corruption can support inefficient firms and leads to a misallocation of talent, capital and technology away from socially productive activities (Murphy et al. 1993). Furthermore, corruption may take profits away from firms which may force them to expand less rapidly, choose to shift some of their savings towards the informal sector or even adopt inefficient technologies of production (Svensson 2005). Also corruption may impede growth by creating distortions in policy variables like investment and trade openness (Pellegrini & Gerlagh 2004) and by diminishing school enrollment and academic achievement (Reinikka & Svensson 2005).

In addition to its adverse effects on the private sector, corruption can impact directly on the public sector. Mauro (1997) suggested that corruption distorts the composition of government expenditure by reducing productive public spending on education and health, while increasing non-productive spending on defense (Gupta, Davoodi & Alonso-Terme 2002). This distortion creates a hindrance to economic growth (Knight et al, 1996). Furthermore, Tanzi & Davoodi (1997) illustrate that, although corruption increases the share of investment in GDP, it reduces its productivity, along with reducing the quality of infrastructure and lowering government revenue which is required to finance productive spending. Similar results are found by Haque & Kneller (2008), who argue that where corruption increases public investment, the effect of this investment on growth is reduced.

There is also evidence of a two-way causal relation between corruption and growth. Several authors have found that corruption not only influences growth but also depends significantly on economic prosperity (Ades & Di Tella 1999, Fisman & Gatti 2006, Paldam 2002, Rauch & Evans 2000, Treisman 2000). According to Treisman (2000), almost 50-73 percent of the variations in corruption indices can be explained by variations in per capita income levels. This causal observation implies that corruption and poverty may become so embedded into society that they may establish themselves as almost permanent fixtures, rather than being transient phenomena. This notion is supported by the fact that most of the corrupt and poor countries of the past are among the poorest and most corrupt countries today (Bardhan 1997, Sah 1988).

On the theoretical side, studies such as Ehrlich & Lui (1999) suggest that corruption

hampers growth by diverting resources away from human capital investment (growth promoting activities) to investments in political capital (power seeking activities), while Sarte (2000) shows that corruption retards growth by shifting resources away from the formal (more efficient) sector to the informal (less efficient) sector. More recent studies including Blackburn, Bose & Emranul Haque (2006) investigate the relation between corruption and development and how they interact with each other to create threshold effects and multiple long run equilibria. Furthermore, Blackburn & Forgues-Puccio (2007), Blackburn and Forgues-Puccio (2010) and Blackburn & Sarmah (2008) also examine the effects of corruption with other issues of income distribution, financial liberalization and demographic transition respectively. Blackburn & Forgues-Puccio (2009) show that the effects of corruption are less severe in economies where rent-seeking behaviour is well coordinated.

The foregoing literature focuses on the distortions and inefficiencies caused by corruption which can hamper economic growth. Another area of research concerns the potential link between corruption and income distribution. Most of the empirical literature in this area indicates a positive relationship between corruption and income inequality (Mauro 1995, Gupta, Davoodi & Alonso-Terme 2002, Fisman & Svensson 2007, Gyimah-Brempong 2002, Gyimah-Brempong & de Camacho 2006). Gupta, Davoodi & Alonso-Terme (2002) suggests that corruption increases inequality by creating unequal ownership of assets, reducing the impact of social programs, reducing the progressivity of the tax system, lowering educational quality and attainment levels and lowering growth. Tanzi (1995) also argues that corruption worsens the distribution of income as it benefits only the “better-connected individuals” who are mostly from high-income groups. Similar results are found by Gyimah-Brempong (2002) and Dincer & Gunalp (2008) in their studies for economies located in Africa and United States respectively. In contrast, Li et al. (2000) find an inverted U-shaped relation between inequality and corruption, indicating that inequality is lower in economies where corruption is either low or high, compared to economies where there is intermediate levels of corruption. Conversely, Chong & Calderon (2000) find a quadratic relationship between corruption and inequality, suggesting that corruption and inequality are positively related for poor countries, but negatively related for rich countries. Other researchers have identified a two-way causal relationship between corruption and inequality (Chong & Gradstein 2007, Sonin 2003).

In contrast to the empirical literature, theoretical work on the link between corruption and income distribution is relatively thin. Glaeser et al. (2003) develop a judicial model to illustrate how institutions that are weak due to corruption allow only the rich to protect themselves, thus aggravating income inequality. Ahlin (2001) and Foellmi & Oechslin

(2007) focus on occupational choice models, where private agents bribe public officials to engage in entrepreneurial activities that make them better off. Both analyses show that there is a redistribution of wealth among the population as the size of bribe payments increases. From a different perspective, Blackburn & Forgues-Puccio (2007) develop a macroeconomic model to show how corruption can foster inequality and lower growth by compromising the effectiveness of re-distributive policy. Finally, Alesina & Angeletos (2005) show that, in developing countries, re-distributive and regulatory policies intended towards reducing inequality or improving the fairness of economic outcomes may create more opportunities for corruption. While these studies focus on the impact of corruption on inequality, there is also some empirical and theoretical literature focusing on how inequality affects corruption. Empirically, You & Khagram (2005) finds strong links from inequality to corruption. Theoretically, Dutta & Mishra (2004) and Dutta & Mishra (2013) demonstrate using a multi-market framework how inequality increases corruption in the presence of capital market imperfections.

Whilst many factors have been considered in explaining the link between corruption and income distribution, one factor that has so far eluded attention is human capital. The present study seeks to fill this gap. It aims to do so using a simple theoretical model in which corruption impacts on publicly provided services (education and health care) that contribute to human capital formation. Individuals, who belong to overlapping generations connected by altruism, may augment these services through their own expenditures, or may exclude themselves from these services by paying for private sector substitutes. Each of these raises the earnings of individuals, but each of them must be financed by acquiring loans from financial intermediaries. Capital market imperfections imply that only individuals who receive sufficient bequests of wealth are able to borrow. This leads to an income distribution comprised of three classes - a lower class, a middle class and an upper class. The effect of corruption is two-fold: first, by reducing the provision of public services, it reduces the earnings of individuals who rely on these services and thereby reduces their bequests to offspring; second, because of this, it increases the number of individuals who are credit rationed. In this way, corruption can exacerbate initial inequalities and increase the degree of poverty.

2.3 The Model

The analysis is based on an overlapping generations model with inter-generational altruism. The model assumes a constant population, N , of 2-period lived agents. Each individual has one parent and one child, inheriting wealth from the former when young and bequeathing wealth to the former when old. In the first period, all individuals acquire human capital in one way or another according to their circumstances. In the second period, they consume, leave bequests to their children and work for a wage which depends on their productive efficiency. An individual acquires human capital in one of three ways: she can rely solely on state-provided services at no cost; she can supplement these services with her own individual expenditures (e.g., expenditures on tuition, books, medication, lifestyle, and home facilities); or she can exclude herself from these services by paying for privately-provided substitutes. We denote by N_{it} ($i = 1, 2, 3, \sum_{i=1}^3 N_{it} = N$) the total population of each of these types of individual. Each of the aforementioned options delivers a different level of human capital and different level of productivity. Depending on the level of inherited wealth, the second and third options may require an individual to obtain a loan. Loans are provided by competitive financial intermediaries who have access to a perfectly elastic supply of loanable funds at the exogenous world interest rate. Capital market imperfections mean that an individual's ability to acquire a loan depends on her wealth status.

The time line over the two periods is given in Appendix A. At the beginning of period $t + 1$, an agent receives his inheritance from his parent, b_t . The agent then considers his personal investment in education, x . If borrowing is needed to finance this investment, the agent decides whether or not to default (i.e., whether or not to abscond with his loan). The banks set the amount of required collateral to avoid defaulting (i.e., ration credit to those who will not default).

At the end of period $t + 1$, at the interest rate r , an agent receives back whatever he invested in the capital market (i.e., if $b_t > x$), or pays back whatever he borrowed from this market (i.e., if $b_t < x$). The agent is paid his wage of w . The agent then divides his final income $(1 + r)(b_t - x) + w$ between his own consumption, c_{t+1} , and the bequests to his offspring, b_{t+1} , in accordance with his utility maximisation.

2.3.1 Households

Agents live for two periods. In the first period they acquire human capital and receive a bequest of b_t from their parents. In the second period they work and receive a wage of w_i which is spent on consumption, c_{t+1} . The index $i = 1, 2, 3$ is used to distinguish the different levels of wages associated with the different levels of human capital that an individual may acquire.

Individuals derive utility from their own consumption and the bequests they give to their children⁷. The utility function of an agent born at time t is given by

$$U(c_{t+1}, b_{t+1}) = c_{t+1}^\alpha b_{t+1}^{1-\alpha} \quad (2.1)$$

where $\alpha \in (0, 1)$. The budget constraint of the agent is

$$c_{t+1} + b_{t+1} = x_{t+1} \quad (2.2)$$

where x_{t+1} denotes total income. The agent's decision problem is to maximise 2.1 subject to 2.2. Solving this problem leads to the following optimal allocations for consumption and bequests:

$$c_{t+1} = \alpha x_{t+1} \quad (2.3)$$

$$b_{t+1} = (1 - \alpha)x_{t+1} \quad (2.4)$$

The total income of an individual is deduced as follows. All individuals receive an inheritance of b_t when young which they can invest at the world rate of interest, r . An individual who relies solely on public services for her human capital earns a wage of w_1 when old. An individual who supplements public services with her own expenditure incurs an outlay of e when young and earns a wage of w_2 when old. An individual who substitutes publicly-provided services with privately-provided services incurs an outlay of $p > e$ when young and earns a net wage of $w_3 - \tau$ when old, where τ is a lump sum

⁷As in other models, we account for intergenerational altruism in the simplest way by assuming that parents derive utility from the size of their bequests, as opposed to the utility of their offspring (see Andreoni (1989) for further discussion).

tax⁸. It follows that total income is given by

$$x_{it+1} = \begin{cases} x_{1t+1} = (1+r)b_t + w_1 \\ x_{2t+1} = (1+r)(b_t - e) + w_2 \\ x_{3t+1} = (1+r)(b_t - p) - \tau + w_3 \end{cases} \quad (2.5)$$

We assume appropriate parameter restrictions to ensure that $x_{1t+1} < x_{2t+1} < x_{3t+1}$: that is, $w_1 < w_2 - (1+r)e < w_3 - \tau - (1+r)p$ ⁹. These restrictions have two implications: first, from the three alternative means by which individuals may acquire human capital, privately-provided services is preferred to supplemented publicly-provided services which is preferred to publicly-provided services alone; second, if individuals need to borrow to finance human capital investment, then any loan that is taken out (either e or p) can always be re-paid. Evidently, a necessary condition for the restrictions to be satisfied is that $w_3 > w_2 > w_1$. The basic assumption, therefore, is that, in terms of human capital acquisition, the first-best option is to pay for privately-provided services, the second best option is to access publicly-provided services and to supplement these with personal expenditures, and the third best option is to rely on publicly-provided services alone¹⁰.

Given the above, it is straightforward to derive the dynamic equations governing bequests. That is, from 2.4 and 2.5,

$$b_{it+1} = \begin{cases} b_{1t+1} = (1-\alpha)[(1+r)b_t + w_1] \\ b_{2t+1} = (1-\alpha)[(1+r)(b_t - e) + w_2] \\ b_{3t+1} = (1-\alpha)[(1+r)(b_t - p) - \tau + w_3] \end{cases} \quad (2.6)$$

⁸For simplicity, we assume that only these third types of individual are liable to pay taxes. As we shall see, these are the wealthiest members of the population. Similarly, we assume for convenience that individuals spend a fixed amount, e , on supplements to public services. In a subsequent extension of our analysis, we consider the optimal choice of e .

⁹That is, $w_1 < w_2 - (1+r)e < w_3 - \tau - (1+r)p$.

¹⁰The assumption that individuals with private services earn more than individuals with public services is supported by a number of empirical studies (for education as well as health). In the case of education there is evidence that individuals who go for private education have higher earnings (Binelli & Codina 2012, Bedi & Garg 2000, Calnico & Nopo 2007, Brown & Belfield 2001). In the case of health, there is evidence that individuals find private health care better than public health care (Aljunid 1995). International Policy makers are also encouraging greater use of private providers on the basis that they offer greater choice for consumers and increased competition in the health market (Preker, Harding & Travis 2000, Lea 1993). For further discussion on the provision of private health care see World Health Organisation. The World Health Report 2000. Health Systems: improving performance.

2.3.2 Firms

Firms in the economy employ all three types of labour associated with the three different levels of acquired human capital. Recall that N_{it} is the population of agents with the same human capital status. The production function of firms is given by

$$Y_t = A_1 N_{1t} + A_2 N_{2t} + A_3 N_{3t} \quad (2.7)$$

where Y_t denotes output and A_i is the productivity of workers with identical human capital. Under the assumption of perfectly competitive markets, firms pay workers a wage of $w_i = A_i$.

Productivity is a function of acquired human capital which, depending on an individual's chosen actions, is determined by state expenditure on publicly-provided services, S , personal expenditure on human capital investment, e , and personal expenditure on privately-provided services, p . Formally, we have

$$A_1 = \alpha_1(S) \quad A_2 = \alpha_2(S, e) \quad A_3 = \alpha_3(p) \quad (2.8)$$

where each $\alpha_i(\cdot)$ is an increasing function of its arguments. In accordance with our previous discussion, we assume that $A_3 > A_2 > A_1$ - that is, individuals who acquire human capital from privately-provided services have the highest levels of productivity whereas individuals who acquire human capital by relying solely on publicly-provided services have the lowest productivity. It follows that $w_3 > w_2 > w_1$, as we assumed earlier.

2.3.3 Government

The role of the government is to provide public services (education and health care) that contribute to individuals' human capital. The government finances its expenditure on these services, S , by running a continuously balanced budget. Its revenue consists of the lump sum taxes, τ , paid by the richer members of the population, of whom there are N_{3t} . As we shall see, $N_{3t} = N_3$ (a constant). If all of the tax revenue is delivered to the government, its balanced budget constraint is $S = \tau N_3$. We assume that this is the case for now. Subsequently, we consider the case in which some public funds go missing as result of corruption.

2.3.4 Financial Markets

Borrowing and lending take place in competitive financial markets in which frictions arise because of imperfect enforcement. Specifically, an individual who borrows to finance human capital investment has an opportunity to strategically default by simply absconding with the loan. We model this as follows. Suppose that an individual puts up all of her inherited wealth, b_t , as collateral against a loan for a human capital investment of either e or p . If the individual takes flight and defaults, then she can consume the entire loan in hiding without fear of detection and prosecution. At the same time, however, she foregoes the opportunity to earn a wage and she loses all of her collateral. Evidently, the payoff from defaulting must be no greater than the expected payoff from not defaulting if defaulting is not, in fact, to occur.

Given the above, consider an individual who applies for a loan of e to finance personal expenditure on education and health as a supplement to publicly-provided services. The condition for this individual not to default is $x_{2t+1} \geq e$, where x_{2t+1} is given in 2.5. When holding with equality, this condition gives a critical level of wealth, b^c , below (above) which defaulting will (will not) occur. That is,

$$b^c = \frac{(2+r)e - w_2}{(1+r)} \quad (2.9)$$

Similarly, consider an individual who applies for a loan of p to finance the cost of acquiring human capital through privately-provided services. The condition for this individual not to default is $x_{3t+1} \geq p$, where x_{3t+1} is given in 2.5. When holding with equality, this condition gives another critical level of wealth, b^{cc} , below (above) which defaulting will (will not) occur. That is,

$$b^{cc} = \frac{(2+r)p + \tau - w_3}{(1+r)} \quad (2.10)$$

Under the parametric restrictions $\frac{(w_3 - \tau) - w_2}{1+r} > p - e > \frac{(w_3 - \tau) - w_2}{2+r}$ we have $x_2 < x_3$ and $b^{cc} > b^c$. The above results imply the following. Only if an individual inherits a level of wealth at least equal to b^c is she able to acquire a loan of e ; otherwise, she is denied such credit. And only if an individual inherits a level of wealth at least equal to b^{cc} is she able to acquire a loan of p ; otherwise, she is similarly credit rationed.

2.4 Dynamics of Wealth Distribution

The foregoing analysis allows us to deduce the intergenerational evolution of wealth for each dynastic family. These lineage transition equations are deduced from 2.6, together with our conclusions about the functioning of financial markets. They are summarised as follows:

$$b_{it+1} = \begin{cases} b_{1t+1} = (1 - \alpha)[(1 + r)b_t + w_1] & \text{if } b_t < b^c \\ b_{2t+1} = (1 - \alpha)[(1 + r)(b_t - e) + w_2] & \text{if } b^c \leq b_t < b^{cc} \\ b_{3t+1} = (1 - \alpha)[(1 + r)(b_t - p) - \tau + w_3] & \text{if } b_t \geq b^{cc} \end{cases} \quad (2.11)$$

Under the assumption that $(1 - \alpha)(1 + r) < 1$, each of these equations implies convergence to a unique steady state, as given by

$$b_1^* = \frac{(1 - \alpha)w_1}{1 - (1 - \alpha)(1 + r)}; \quad b_2^* = \frac{(1 - \alpha)[w_2 - (1 + r)e]}{1 - (1 - \alpha)(1 + r)}; \quad b_3^* = \frac{(1 - \alpha)[w_3 - \tau - (1 + r)p]}{1 - (1 - \alpha)(1 + r)} \quad (2.12)$$

Under our previous parameter restrictions, $b_1^* < b_2^* < b_3^*$. To make our analysis interesting, we impose further parameter restrictions such that $b_1^* < b^c, b^c < b_2^* < b^{cc}, b_3^* > b^{cc}$. These restrictions rule out degenerate outcomes where capital market imperfections are irrelevant and any initial differences between individuals automatically vanish¹¹.

Figure 2.1 illustrates the dynamics of wealth distribution through time. It shows that the distribution is history dependent. The initial level of bequest determines an individual's decision to invest in human capital which determines her income level. In turn, this determines the bequest she leaves to her offspring, which determines her offspring's decision to invest in human capital, and so on and so forth.

If the level of bequest is less than the critical value of b^c , an individual has insufficient wealth to be able to borrow to finance any sort of personal investment in human capital. Under such circumstances, the individual is forced to rely exclusively on publicly-provided services which give her the lowest productivity and lowest wage. The wealth of

¹¹For example, if $b^c < \frac{(1 - \alpha)w_1}{1 - (1 - \alpha)(1 + r)} = b_1^*$, then all agents who begin with $b_t < b_1^*$ would inevitably end up like all agents who begin with $b^c < b_t < b^{cc}$. Likewise, if $b^{cc} < \frac{(1 - \alpha)[w_2 - (1 + r)e]}{1 - (1 - \alpha)(1 + r)} = b_2^*$, then all agents who begin with $b^c < b_t < b^{cc}$ would inevitably end up like all agents who begin with $b_t > b^{cc}$. Other trivial cases are similarly excluded.

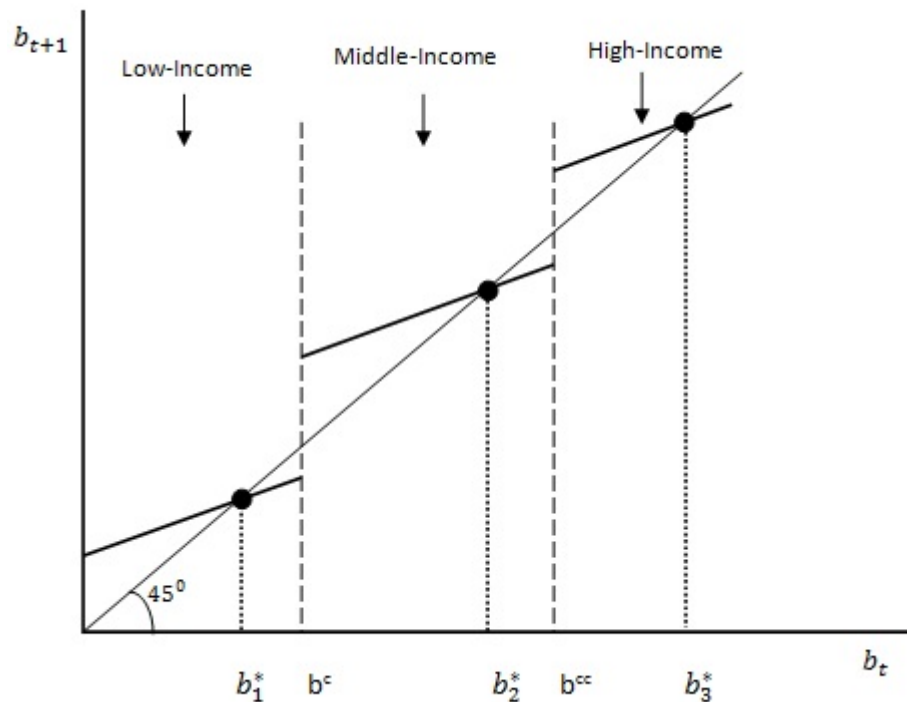


Figure 2.1: Dynamics of Wealth Distribution

all such individuals converges to the low steady state b_1^* .

If the level of bequest is greater than the critical value of b^{cc} , an individual is sufficiently wealthy to be able to obtain a loan to finance the cost of privately-provided education and health services. Under such circumstances, the individual enjoys the highest productivity and highest wage. The wealth of all such individuals converges to the high steady state b_3^* .

If the level of bequest lies between b^c and b^{cc} , an individual is unable to obtain a loan to cover the cost of privately-provided services, but is able to borrow enough to make personal expenditures that supplement publicly-provided services. In this case the individual acquires some intermediate level of productivity and earns some intermediate level of wage. The wealth of all such individuals converged to the intermediate steady state b_2^* .

The analysis above shows that, given some initial distribution of wealth, the economy is divided into three income groups - a low income group, a middle income group and a high income group. The first of these comprises individuals whose inherited level of wealth is so low that they are excluded from the capital market and must rely exclusively on state provided services for acquiring human capital. The second comprises individuals whose

inherited level of wealth is high enough to allow them access to borrowing for personal expenditures that supplement and improve upon state services. The third comprises individuals whose inherited level of wealth is so high that they are able to borrow the full cost of investing exclusively in private services and acquiring human capital entirely by themselves. These characteristics are passed on through successive generations such that initial inequalities persist, implying a long-run distribution of wealth that is history-dependent.

2.5 Corruption

Corruption in this model is the embezzlement of public funds by public officials. The amount of funds that is stolen is a fraction, ϕ , of tax revenues. An implicit assumption is that none of these stolen funds are ever retrieved by the government¹². Given this, then the actual amount of tax revenue available for spending on public services is $(1 - \phi)\tau N_3$, and the actual level of this spending is $\tilde{S} = (1 - \phi)\tau N_3$. Evidently, $\tilde{S} < S$, which shows that the effect of corruption is to reduce public service provision.

The reduction in public services due to corruption affects the income of agents in the low and middle income groups. This follows from the fact that the human capital acquired by these groups, and hence their wages, depends on public services. Specifically, we now have $w_1 = A_1 = \alpha_1(\tilde{S})$ and $w_2 = A_2 = \alpha_2(\tilde{S}, e)$, each of which is lower than before. These expressions can be substituted into 2.9 - 2.12 to deduce the implications for income distribution.

Figure 2.2 shows that corruption has two main effects. The first is that, by reducing the wages of the low and middle income groups (w_1 and w_2), the lineage transition equations for these groups (b_{1t+1} and b_{2t+1}) shift downwards. As such, the steady state level of wealth for each group (b_1^* and b_2^*) is reduced. The second is that the reduction in wages of the middle income group (w_2) causes an increase in the lower critical level of wealth (b^c). As such, the size of this group (N_{2t}) shrinks, whilst the size of the low income group (N_{1t}) expands. Thus corruption hits the economy with a double-whammy: not only are the poor made poorer, but more people are made poor. This is the sense in which corruption exacerbates the degree of poverty in our model. Of course, the high income group are completely unaffected by corruption since this group has no reliance on public service provision.

¹²We assume here that corrupt public officials can steal funds with complete confidence of impunity and consume it without fear of being caught.

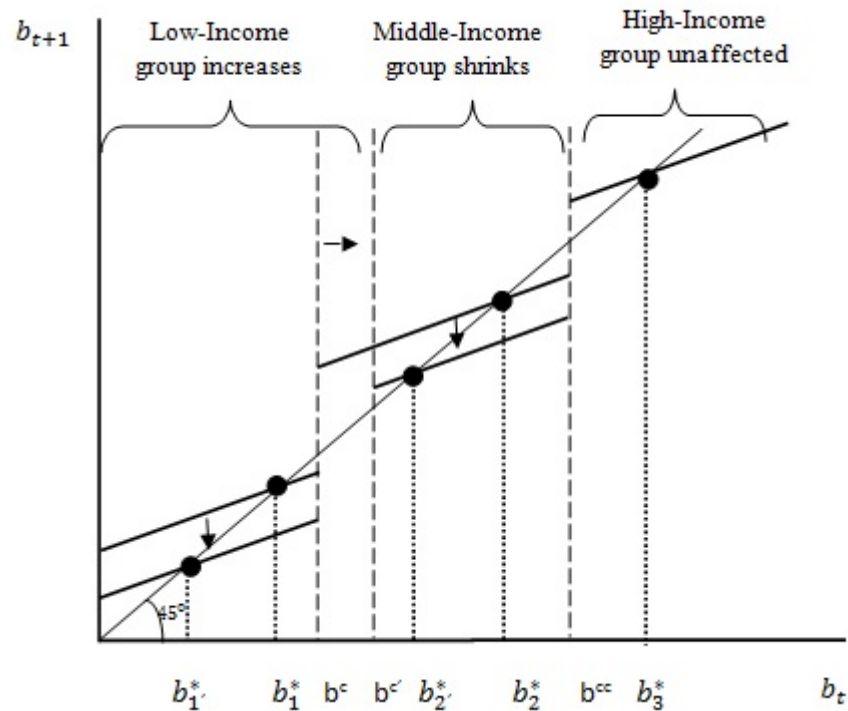


Figure 2.2: (a) Effects of Corruption

Figure 2.3 shows an interesting potential implication of the above. As corruption increases, both the bequest lines (b_{1t+1} and b_{2t+1}) and the critical level of wealth (b^c) shift, respectively, further down and further right. Correspondingly, the size of the middle income group becomes smaller and smaller. In principle, it is possible for this process to lead to a situation where there is no steady state between b^c and b^{cc} . In other words, rampant corruption may eliminate the existence of a middle class altogether so that the economy is polarised into just two (rather than three) groups - the rich and the poor.

The analysis above explains that, whilst corruption may affect society in general, the highest burden is borne by the poor. The productivities of households in different income classes depend on the provision of public goods where, this dependence decreases with the level of income. Corruption leads to a reduction in the provision of public services on which the poor depend most for acquiring human capital not only in terms of education, but also in terms of health status. Many recent studies have reported corruption as having adverse effects on the provision, quality and effectiveness of public health and education programmes (Lewis 2006, Dreher & Herzfeld 2005, Gupta, Davoodi & Tiongson 2001, Rajkumar & Swaroop 2008). The obvious question to ask is why this situation should prevail: why is the level of public spending not being translated into better outcomes? To

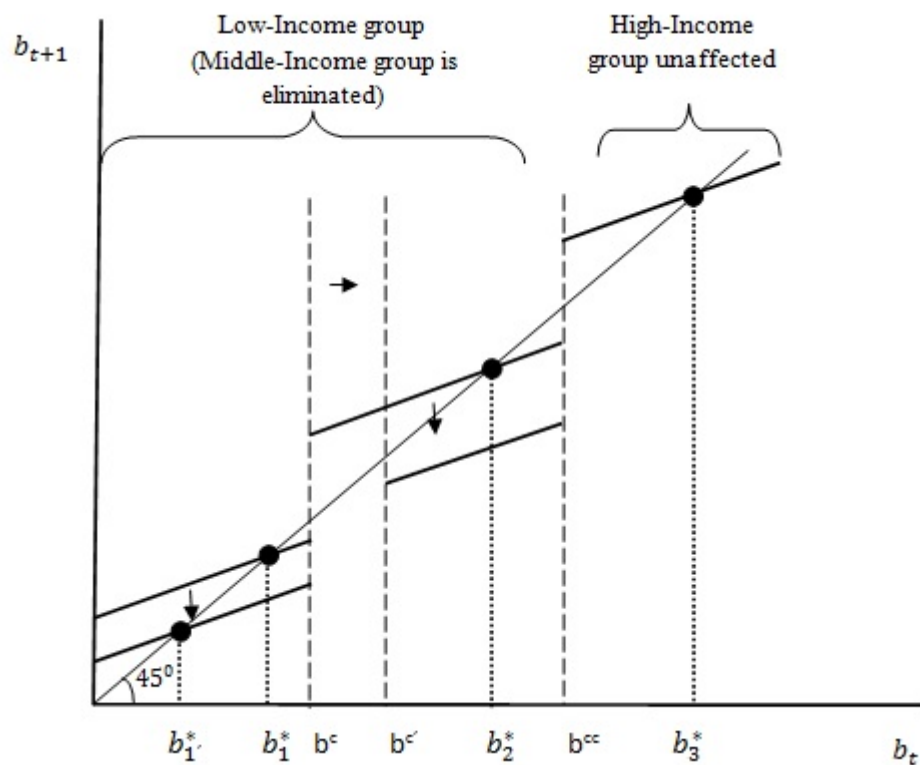


Figure 2.3: (b) Effects of Corruption

many observers, the answer is to be found in the quality of governance which is considered to be one of the key elements for securing economic growth and prosperity. Poor budget management is often regarded as one of the main reasons why governments in developing countries are unable to translate planned public services into effective public services. It is often argued that increasing public expenditure to foster economic growth is not enough if government institutions are weak and malfunctioning (WorldBank 2003)¹³. Similar results are reported by Rajkumar & Swaroop (2008) who argues that simply increasing public health and education spending is unlikely to improve conditions if countries have poor governance. For these to be effective (e.g., in reducing mortality and increasing school attainment), good quality governance is vital.

Our analysis not only contributes to the literature on corruption and inequality, but it may also be viewed from a broader perspective within the context of the research on poverty

¹³For a more detailed discussion on the effectiveness and importance of governance in tackling issues on growth and poverty reduction see the recently updated report by World Bank: Strengthening Governance: Tackling corruption The World Bank's Group's Updated Strategy and Implementation Plan 2012.

traps¹⁴. As we have shown, the dynamic general equilibrium of an economy may be characterized by multiple long run equilibria which are history-dependent. This means that individuals with essentially the same characteristics and abilities but different initial conditions may follow different growth paths and eventually converge to different steady state equilibria. This is aggravated by corruption which not only makes poor people poorer, but which also increases the number of poor people. The implication is that countries which differ in the extent of corruption will also differ in the extent to which they are trapped in relative poverty.

2.6 An Extension

One assumption on which our analysis has been based is that individuals spend an exogenous fixed amount, e , on supplementing publicly-provided services. An alternative approach is to allow this expenditure to be determined endogenously by allowing individuals to choose it optimally. An analysis of this is as follows.

Recall the specifications of productivity in 2.8 and suppose that $\alpha_2(\cdot)$ takes the form $\alpha_2(S, e) = \alpha_1(S) + \varepsilon(e)$, where $\varepsilon'(\cdot) > 0$ and $\varepsilon''(\cdot) < 0$. Then $w_2 = w_1 + \varepsilon(e)$ and the income of this group of workers is $x_{2t+1} = (1+r)(b_t - e) + w_1 + \varepsilon(e)$. The optimal value of e - denoted by e^* (see figure A.2) - which maximises this income satisfies

$$\varepsilon'(e^*) - (1+r) = 0 \quad (2.13)$$

Now recall the critical level of wealth in 2.9 which can be re-written as

$$b^c = \frac{(2+r)e - w_1 - \varepsilon(e)}{(1+r)} \quad (2.14)$$

The relationship between b^c and e is deduced from $\text{sgn}\left(\frac{db^c}{de}\right) = \text{sgn}((2+r) - \varepsilon'(e))$. If $e \geq e^*$, then $\varepsilon'(\cdot) \leq (1+r)$ so that $(2+r) - \varepsilon'(e) > 0$, implying $\frac{db^c}{de} > 0$. If $e < e^*$, then $\varepsilon'(\cdot) > (1+r)$ so that $(2+r) - \varepsilon'(e) \leq 0$, implying $\frac{db^c}{de} \leq 0$. Taken together, these results imply a U-shaped relationship between b^c and e such that $\frac{db^c}{de} < 0$ for $e < \hat{e}$, $\frac{db^c}{de} = 0$ for $e = \hat{e}$ and $\frac{db^c}{de} > 0$ for $e > \hat{e}$, where \hat{e} satisfies $(2+r) - \varepsilon'(e) = 0$ and $\hat{e} < e^*$. This is

¹⁴For a detailed discussion on the models of poverty and reviews on the recent empirical literature see Azariadis & Stachurski (2005).

illustrated in Figure 2.4.

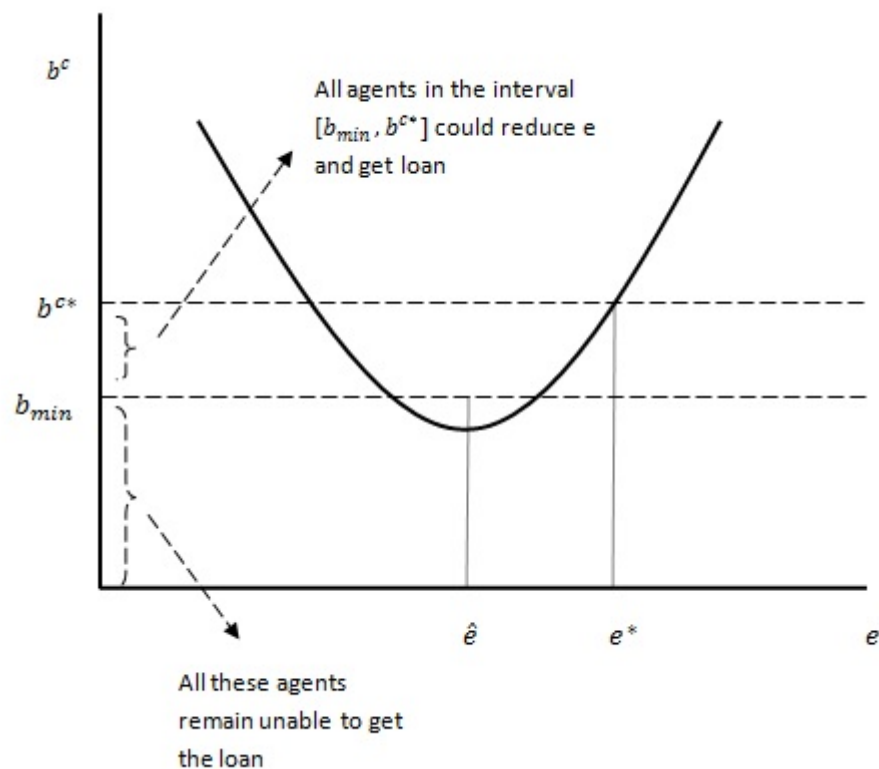


Figure 2.4: Endogenising Human Capital Expenditures

In the previous analysis, e was fixed exogenously so that b^c was also fixed exogenously. If an individual inherited $b_t < b^c$, then she was denied a loan and there was nothing that she could do about this. In the present analysis, however, e is no longer exogenous, but is chosen by the individual who may make this choice in the knowledge that she can influence b^c . Consider an individual for whom $b_t < b^c$ when $e = e^*$ (i.e., whose wealth is less than the critical value b^{c*}). Rather than accepting refusal of a loan, the individual may be able to reduce e slightly so as to reduce b^c such that $b_t > b^c$. By doing this, the individual makes herself eligible for a loan. There may be a number of individuals who can do this, but there is a point at which it becomes infeasible. This is the case for any individual whose $b_t < b^c$ when $e = \hat{e}$ (i.e., whose wealth is below the minimum critical value, b_{\min}^c). Reducing e any further below \hat{e} makes b^c increase so that the individual is still denied a loan. The main conclusions of our previous analysis are unchanged. As shown in Figure 2.5, the only difference is that there is now a series of critical values of wealth between b_{\min}^c and b^{c*} that allow some individuals to take on loans which would have been denied before. As for individuals with $b_t < b_{\min}^c$, these remain ineligible for

loans are remain trapped in poverty.

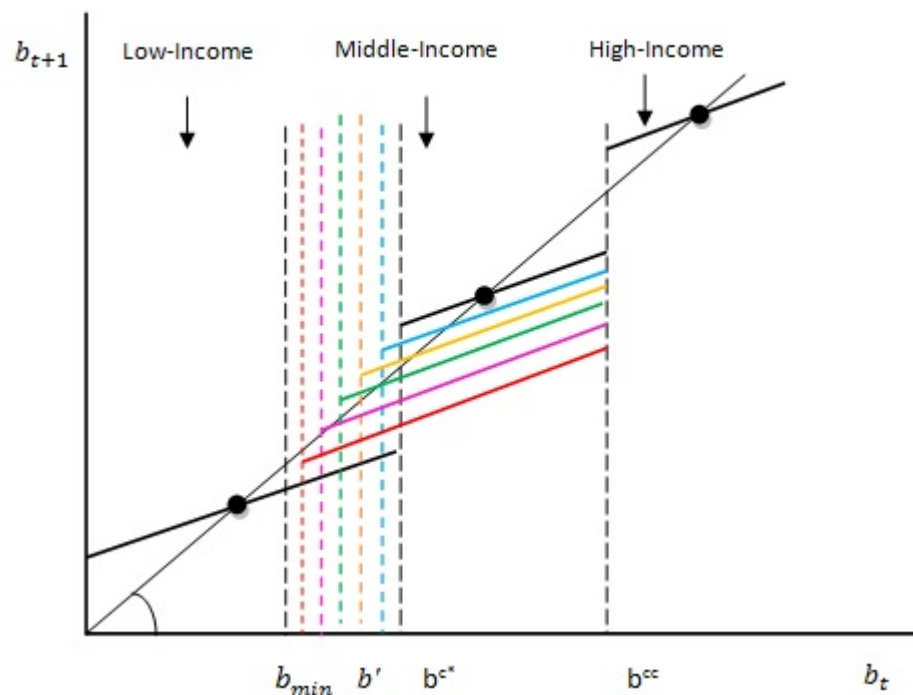


Figure 2.5: Distribution of Wealth with Endogenous Expenditure

2.7 Conclusion

Corruption is an important global phenomena which exists in various forms. Although it may be difficult to define and measure, there is a vast literature which shows that it exists in every society, at different levels and with various adverse effects. The idea that the most poor countries are the ones where corruption is most prevalent explains the intricate link between corruption and poverty. One of the major consequences of corruption is that it leads to distortions and misallocations of public resources which not only act as impediments to growth but which also affects the distribution of income. Whilst these misallocations affects society in general, the greatest burden is borne by the poor as they rely the most on public services compared to the rich. Corruption not only reduces the quality of these services, but also restricts access to them and increases their costs.

The analysis in this chapter has sought to formalise the above ideas in a simple theoretical model of bureaucratic corruption, imperfect capital markets and human capital formation.

The main result is that corruption hits the economy with a double whammy: not only does it make poor people poorer, but it also increases the number of poor people. These are not transient effects. Increased poverty resulting from corruption is a persistent phenomenon that does not disappear. Our analysis endorses the general consensus that corruption is harmful and that improvements in the quality of governance are vital if developing countries are to prosper and escape from their plight.

It is true that our modelling of corruption could be interpreted in another way that relates more to purely efficiency considerations in public goods provision (for example, efficiency of tax collection and/or efficiency of public procurement). To the extent that these compromise public goods provision, they would have the same distributional effects as expounded in the chapter. A further issue worth mentioning is the extent to which corruption might be less damaging in some situations than in others for which we make the following observations. Within the specific context of the present analysis, corruption would have less impact when more people are wealthier to begin with as less people would be reliant on public services. In a broader context, the effects of corruption could be mitigated if one allows for the possibility that corrupt public officials can be caught. This may work in two ways- by deterring some officials from being corrupt in the first place, and by allowing the government to retrieve stolen funds from others who are apprehended. And in a much broader context again, the effects of corruption may depend on the form that corruption takes and the way it is practised. For example, it has been argued that organised corrupt behaviour is less harmful than disorganised corrupt behaviour.

Chapter 3

Threshold Effects of Human Capital and Economic Growth

3.1 Introduction

One of the recent debates in the empirical growth literature when studying the contribution of human capital to the process of economic growth has been the inconsistency between the micro and macro evidence. Following the pioneering work of Schultz (1960) and Becker (1964), the role of human capital has been under extensive research. One important question has been the extent to which human capital contributes to the growth rate of an economy. At the micro level, it has been established theoretically and empirically that human capital formation, as manifested in improvements in education, raises wages. Since 1970s, following Mincer (1974)'s seminal contribution, huge literature on wage and education has established that education increases productivity and thereby leads to higher wages for individuals.

At the macro level, while theoretically there is no debate on the effect of human capital on economic growth, empirically the results are mixed and often conflicting in nature. When the long run data on developed countries is taken the effect of human capital on growth is unambiguous positive, whereas in the case of developing countries the results are mixed. While some studies find that human capital has a positive effect on growth (Barro 1991, Barro & Lee 1994, Mankiw et al. 1992), others show that this effect is not significantly different from zero and even negative in some cases (Benhabib & Spiegel 1994, Pritchett 2001, Temple 1999, Rogers 2008). The possible explanations for this

heterogeneous impact of human capital on growth include measurement error (Krueger & Lindahl 2000, Hanushek & Kimko 2000, Hanushek & Wößmann 2007), lack of data quality (Doménech et al. 2006, Cohen & Soto 2007), reverse causality (Bils & Klenow 2000, Freire-Seren 2002) and unproductive activities (Rogers 2008).

Looking at the stylized facts as well we come across similar findings. Whether it has been suggested by the international development organizations such as the World Bank or the International Monetary Fund or it is the policies adopted by the government, spending on education and efforts to improve it have been increasing steadily in many countries. According to a report by World Bank¹, the total number of out-of-school children have declined from 100 million to 58 million across the world during 2000 to 2012, where South Asia has experienced a drop of more than two thirds of its total out of school children. Among developing countries, in Afghanistan girls enrollment increased from less than 200,000 in 2002 to 2.7 million in 2012 and boys attendance increased from less than a million to about 4.4 million. Also in case of Bangladesh, between 2004 and 2012, the provision of second chance primary education increased to more than 790,000 out of school children from the 90 poorest sub-districts of the country. Despite this, we do not see the positive impact of improvements in human capital on economic growth in these countries. This prompts the big question: “Where has all the education gone?”, famously coined by Pritchett (2001).

Motivated by these observations we seek to investigate empirically the link between human capital and growth. The main contributions of our study are as follows: *Firstly*, We test the non-linearity in the relationship between human capital and economic growth. For this we use the dynamic panel threshold model introduced by Hansen (1999) and Caner & Hansen (2004), which has not been used before in this context. *Secondly*, we investigate further to see whether there are any country-specific characteristics that play any role in shaping this non-linear relationship. For this, we have used several proxies for institutional quality. Institutions and their quality have a fundamental role as they are the underlying determinants of long run performances of countries.

Standard growth theories have shown that accumulation of factors of production (labour and capital) and access to modern technologies determine the level of development in an economy. The accumulation of these factors are, in turn, affected by institutional characteristics. This implies that focusing on physical and human capital alone is not sufficient but the efficiency with which these ‘fundamental causes’ are used should also be

¹World Bank: Millennium Development Goals: <http://www.worldbank.org/mdgs/education.html>.

taken into account (Acemoglu 2009). Therefore, it is not only the economic development rather along with it the inefficiency in the institutions also hinders the developing countries to get the most out of their resources. According to North (1990), third world countries are not able to prosper and come out of their poverty since the set of pay-offs to political and economic activity, defined by institutional constraints, do not encourage productive activity. As a result, we use (i) legal system and property rights, (ii) regulations, and (iii) democracy as proxies for institutional quality in order to investigate whether these characteristics play any role in shaping the effect of human capital.

There are studies in the past which focus on the possibility of multiple-regimes and non-linear relationship between human capital and growth (Durlauf & Johnson 1995, Masanjala & Papageorgiou 2004, Kalaitzidakis, Mamuneas, Savvides & Stengos 2001, Mamuneas, Savvides & Stengos 2006). However, our study differs as we use a unique econometric technique in panel data which has not been used by these studies. Durlauf & Johnson (1995) use the regression tree methodology while Kalaitzidakis et al. (2001) and Mamuneas et al. (2006) use semi-parametric techniques to find evidence of a non-linear relationship between human capital and growth. Masanjala & Papageorgiou (2004), on the other hand, uses the threshold regression methodology in a cross sectional framework whereas our study focuses on a panel data framework. Also, these studies test the non-linearity in human capital and growth and do not focus on the underlying reasons behind this whereas our study tends to address this issue as well.

This chapter is organized as follows. Section 2 reviews the literature on the link between human capital and economic growth. Section 3 details the data and methodology. Section 4 presents the empirical results while section 5 tests for the role of institutions in the relationship between human capital and economic growth. Section 6 concludes.

3.2 Literature Review

Endogenous growth theory, pioneered by Lucas Jr (1988) and Romer (1990), point towards the positive effects of human capital on economic growth, though their approaches differ in the ways of incorporating human capital in the growth models. According to Lucas Jr (1988), human capital accumulation is the engine of growth whereas according to Romer (1990), human capital affects economic growth through technological progress and innovation. Since these seminal contributions human capital has been considered as an important driver of growth. Some recent work, however, has started to take seriously

the idea (motivated by empirical observations) that the importance of human capital may be overstated. In doing so, emphasis has been placed on the role of corruption and how this may interact with human capital in affecting the process of development. Eicher, García-Peñalosa & van Ypersele (2009) examine how the interaction between education and corruption affect institutional reforms and economic development. In their model human capital has productive as well as unproductive effects: while education increases output and hence economic rents it also produces more informed electorates that better monitor government actions. Their findings show that economies with intermediate levels of education remain in a poverty trap since the level of skills creates sufficient corruption rents but not enough monitoring, whereas economies with low or high levels of education can escape the poverty trap. Haque & Hussain (2013) also show that human capital accumulation may have two opposing effects: a positive productivity enhancing effect and negative stealing efficiency effect. Their findings show that countries in which the latter effect dominates are likely to display a net effect of human capital on growth which is ambiguous or insignificant.

On the empirical front, following the work of Mankiw et al. (1992) who augmented the Solow model by incorporating both human and physical capital as inputs of production, there have been flurry of empirical research on the relationship between human capital and growth. The first wave of this literature states that human capital has a positive effect on economic growth. Among these are the early contributions of Barro (1991), Barro & Lee (1994) and Mankiw et al. (1992) who found a robust relationship between human capital and growth rate of an economy. However, since mid-nineties, researchers have started finding conflicting results where some found the relationship to be insignificant while others found it to be even negative. The explanations provided by this literature can be classified into following categories:

(i) Use of different measures

Based on the measure of school attainment constructed in Barro & Lee (1993), the authors in their 1994 study found that while an average year of male secondary education is positively and significantly related to growth, the initial level of female secondary education has a negatively significant coefficient. This result is also consistent when they use change in years of secondary and primary education. Where their results for secondary male education are consistent with their hypothesis, other results seem faulty. The negative coefficient on female education and the reason provided by Barro raises questions regarding the reliability of their results. Also, all other education attainment

coefficients, including primary and higher education, are insignificant which lead to further doubt (Barro & Lee 1994). This study is further extended in Barro (1998) to include the time period from 1960-1995 with a slight change in results from the previous studies. In this case, initial level of male secondary as well as higher education is positively and significantly related to growth. However, female secondary and higher schooling remains insignificant. Also, there is no significant impact of primary schooling for both males and females (Barro 1998).

(ii) Misspecification and Measurement error

Benhabib & Spiegel (1994) were among the first to find the insignificant role of human capital in the process of economic growth. They believe that these results might be due to misspecification of the role played by human capital. They show that human capital stocks in levels, rather than growth rates, play an important role in determining the growth rate of a country. When human capital enters the specification as a separate factor of production, the results are in contradiction with the traditional theory of economic development which says that human capital positively effects economic growth. However, using an alternative specification that uses human capital through its effect on total factor productivity, leads to more positive results. For this they introduce an alternative model that allows human capital to affect per capita growth through two mechanisms: firstly, by affecting the productivity and a nations capacity to innovate and secondly, affecting a nations speed to catch up with the world leader. These two mechanisms imply that human capital in levels, rather than growth rates, affect the growth rate per capita income. When testing this empirically, Benhabib and Spiegel find that not only human capital enters with a predicted positive sign but is also significantly different from zero (Benhabib & Spiegel 1994). However, there are a number of shortcomings in Benhabib & Spiegel (1994)'s study. Firstly, it is the extent of the measurement error in the cross country data on average years of schooling taken from Kyriacou (1991). The data, predicted from the enrollment rates, is likely to cause significant amount of noise since the regression might not hold across all countries and time periods and also there might be error in measuring the enrollment rates (Krueger and Lindahl, 2001). It is also argued that the insignificant and negative effect of human capital of Benhabib and Spiegels (1994) findings is due to the log specification of education and instead a linear specification should be used. Using this although, the effect of change in education on growth remains insignificant but the sign becomes positive. It is also discussed that the insignificant negative result might be due to the low signaling of the education data (Krueger and Lindahl, 2001).

According to these studies, the problem lies in the misspecification of the model and

with using inaccurate proxies for human capital which leads not only to significant measurement error but also biased coefficient estimates. Among this is the work of Krueger & Lindahl (2000) who investigate the effect of schooling on income and GDP growth by bringing together evidence from the micro econometric and macro growth literature. They explain the insignificant effect of schooling due to the presence of measurement error in the first differenced cross country education data. Accounting for this error however, leads to a positive association between the changes in average years of schooling and economic growth. The cross country regression also shows that adjusting for measurement error leads to a greater effect of change in education on growth as compared to the effect found in microeconomic studies. This large effect according to Krueger and Lindahl is due to reverse causality or omitted variable bias (Krueger & Lindahl 2000). Another finding, contrary to the findings of Benhabib & Spiegel (1994), is that the initial level of human capital has little effect on economic growth for an average country. The effect of initial level of education is sensitive to econometric restrictions. Once these restrictions, of linearity and constant coefficient, are relaxed there is little positive effect of initial level of human capital on growth. They further found out that even if these two assumptions are held, the positive effect of initial level of human capital is restricted to countries with lower levels of education and does not apply to an average country (Krueger & Lindahl 2000).

(iii) Quality and use of education

Pritchett (2001) explains these findings as the micro-macro paradox. While the Microeconomics literature provides evidence that higher education leads to higher average income hence fostering growth, the macroeconomic literature shows that education contributes much less than expected. He provides three answers to his question “where has all the education gone?” Firstly, the skills acquired are devoted to socially wasteful and counterproductive activities which have no positive impact on the prosperity of a country. Secondly, the demand for labour remains constant while the supply increases, hence leading to a fall in the marginal returns to labour and thirdly, the quality of schooling varies across countries. While some may effectively improve skills others might not.

Hanushek & Wößmann (2007) and Hanushek and Kimko (2000) discuss the importance of labour-force quality in explaining the effect of human capital on economic growth and the results show that taking into account these labour-quality differences have extremely strong effects on growth rates. They argue that conventional measures of human capital do not consider labour-force quality and hence act as an inaccurate proxy for human capital. Hanushek and Kimko, in an attempt to measure the labour-force quality, construct

new measures of quality based on student cognitive performance on various international tests of academic achievements in mathematics and science. The results for this simple regression show that the quantity of schooling has a positive effect on growth. Extending this model further, they add the measure for labour force quality. The estimates for this show that quality and per capita growth rates are strongly correlated with a one standard deviation increase in labour force quality leading to an annual 1.4 percentage points increase in real growth rate per capita. Also the adjusted R^2 increases to 0.7 from 0.3.

iv) Outliers

Temple (1999) focuses on the role of outliers as a plausible cause for the insignificant role of human capital on growth. His study shows that there is a positive significant relation between human capital accumulation and economic growth rate if the unrepresentative observations in a sample are taken care of. Since the cross country data set consists of a large number of heterogeneous set of countries it is important to focus on the most coherent part rather than focusing on the entire data sample. This may mean omitting a few observations so that it is possible to determine the pattern followed by majority of the observations in the data sample. In order to identify the unrepresentative observations Temple uses a robust estimator, least trimmed squares. Using residuals from robust regression estimates, the unrepresentative observations, the ones with the largest residuals, are identified. His findings show that when least trimmed squares are applied to the same data, the point estimate is nearly three times higher. Therefore, simple OLS regressions are an inappropriate way to estimate cross country growth rates and a careful look at the sample is necessary to see if there are any observations that are hiding the strong positive correlation between human capital accumulation and the growth rate which can otherwise be seen in the majority of the sample.

(v) Data Quality

Doménech et al. (2006) show that existing data on educational attainment contains significant amount of noise and improvements in data quality will lead to more precise schooling coefficients. While looking at the existing data available on schooling they observe considerable number of irregularities in both time series and cross section profiles of the data which they attribute is due to changes in classification criteria. Although the correlation between alternative data set is high, there are also large discrepancies among them. When comparing the Barro & Lee (1996) data set with the OECD data they argue that the main reason for the discrepancies in the Barro and Lee data are due to the exclusion of apprenticeships and other vocational training programmes which are included in the OECD data set. Also, they observe that when considering the time series dimension of the data there

are sharp breaks and implausible changes in attainment levels over very short periods. In an attempt to improve the data quality they constructed new schooling series for a sample of 21 OECD countries covering the period 1960-1995. These series made use of data by the OECD and by a number of national statistical agencies. An attempt was made to obtain more plausible attainment profiles by avoiding unreasonable jumps in the data and including the most reasonable among alternative figures. Using pooled data, at five year intervals, they test a number of growth specifications. The findings, unlike previous ones, show a more promising role of human capital on growth. The coefficient estimates for human capital have a positive significant sign and these results survive the robustness checks as well. Where Doménech et al. (2006) provide some encouraging results as opposed to previous studies, this study has its limitation as well since the analysis is restricted to OECD countries and therefore cannot be applied to all countries in general.

This problem was overcome by Cohen & Soto (2007), who developed a new data set for years of schooling across 95 countries including census data from UNESCO and national sources for the countries not covered by OECD database. According to their analysis, the insignificant effect of human capital on growth is as a result of the misspecification in the functional form of human capital. Instead of a log-log specification, there should be a log linear relationship between income and years of schooling i.e. human capital should be an exponential function of the years of schooling. Secondly, they say that the insignificance is due to the quality of the data. To solve these problems Cohen and Soto develop new series based on the OECD database on education attainment covering the period 1960-2000. They, for the first time, make use of information by age groups. This reduces the measurement error in the data since it is based more on observations rather than assumptions. Also, they avoid the consensus based on different classifications of systems of education which reduces the extent of measurement error in contrast to the case if these alterations to the classification systems are not accounted for. The empirical results show that this new data series obtain significant schooling coefficients for both cross country as well as panel data regressions. Also, Cohen and Soto argue that these results are significant if human capital specification is based on Mincerian definition as opposed to Benhabib & Spiegel (1994) and Pritchett (2001), in which case the schooling variable comes out to be insignificant. Hence they argue, that previous studies like Benhabib & Spiegel (1994) and Pritchett (2001) fail to obtain significant schooling variables since they assumed an inappropriate human capital formulation.

(vi) Difference in econometric technique

The use of econometric technique is another reason presented in the literature that deals

with the disappointing results on the link between human capital and economic growth. Bassanini & Scarpetta (2002) use a novel econometric technique, Pooled Mean Group estimator (PMG), for a sample of OECD countries to discuss the relationship between human capital and economic growth. One advantage of using PMG is that it allows short run coefficients, convergence speed and error variances to vary across countries and assumes homogeneity restrictions only on long-run coefficients. The regression results conclude that the elasticity of long run output per worker with respect to average years of education comes out to be significantly different from zero. This value, 0.6, is in line with the microeconomic literature on private returns to schooling. Thus Bassanini & Scarpetta (2002) conclude that there is a positive impact of human capital on growth given proper econometric techniques are used.

(vii) Reverse Causality

Another issue which is highlighted in growth literature is of reverse causality i.e. whether human capital accumulation promotes growth or whether growth leads to greater incentive to invest in education (Bils & Klenow 2000, Freire-Seren 2002). According to Bils & Klenow (2000) growth is not led by human capital accumulation, instead the growth rate of a country leads to an increase in the level schooling across countries. They conclude that the impact of schooling on growth explains less than one-third of the empirical cross-country relationship (Bils & Klenow 2000). Similarly, Freire-Seren (2002) argues that the insignificant effect of human capital on growth exists in all previous works because they do not analyse the reverse impact of growth on human capital accumulation. He argues that that the level of income in an economy provides the individuals an opportunity to increase their level of education hence determining the level of human capital accumulation. The results show that the effect of the level of income on the individual's formal level of education is positive and significantly different from zero, whereas the estimates that capture the role of human capital on growth is also positive and significant. Therefore confirming two-way causality between the relationship of human capital and growth.

(viii) Unproductive Activities

Where the literature discusses problems of measurement error, data quality, reverse causality and quality of education, Rogers (2008) focuses on unproductive activities as being a reason for the insignificant impact of human capital on growth. The main hypothesis in Rogers study is that schooling does not automatically find its way into productive use. He analyses how the impact of schooling varies across countries with the value of these unproductive activities. Using data on corruption, brain drain and black market premium

on foreign exchange as a proxy for the economy's productive use of schooling, he conducts a cross sectional regression analysis with growth in GDP per worker (1960-2000) as the dependent variable and years of schooling in the adult population as the main independent variable. The findings show that the impact of secondary schooling on economic growth is substantially higher in countries that use schooling productively. However, this analysis can be criticized on the basis of its cross sectional nature and the arbitrarily use of the corruption index which may lead to problems of endogeneity.

The discussion above shows that past literature address more of data and methodology issues except Rogers (2008) and Pritchett (2001) and in this study we try to look at their argument in a more rigorous way. The former shows that there are some country characteristics that make human capital unproductive while the later explains the possibility of unproductive use of acquired human capital. In this chapter we attempt to show two things: firstly, at which stage of development education cannot be productive and secondly is there any underlying characteristics that is causing it. Our study differs from Rogers (2008) and Pritchett (2001) as they do not address the development stages and the underlying country characteristics that may lead to different effect of human capital. Rogers (2008) did cross sectional analysis by splitting the sample based on an arbitrary corruption index. He used corruption data for 1996 to split the sample for the period of 1960 -2000 between "high corruption" and "low corruption" countries. This obviously raises the issue of endogeneity: as the variable to split the sample is taken from 1996, i.e., so late within 1960 - 2000 period, this corruption data must have effect of the growth since 1960s. To overcome these shortcomings of his analysis we utilize endogenous thresholds model developed by Hansen (1999) and Caner & Hansen (2004) using the level of development and underlying characteristics of the economy.

One important assumption found in the past literature is that human capital has the same effect on economic growth across countries. More recently, theoretical studies have focused on the possibility of multiple regimes and nonlinearities in the relationship between human capital and growth. One of the early works in this field was by Azariadis & Drazen (1990) who developed a theoretical model to show that the impact of human capital on growth of output differs across countries. Durlauf & Johnson (1995) and Masanjala & Papanageorgiou (2004) also show the existence of multiple regimes using the regression tree and threshold regression methodology. Kalaitzidakis et al. (2001), using semi-parametric techniques, also found evidence of a non-linear relationship between human capital and growth. In their paper, allowing the effect of human capital to differ intratemporally (across countries) and intertemporally (across time), they show that this relationship can

differ based on different levels of human capital and the way it affects economic growth in different countries. More recently, Mamuneas et al. (2006) also investigate the impact of human capital on the process of economic growth by allowing the contribution of traditional inputs (capital and labour) as well as that of human capital to vary both across countries and time. Their findings show that the average output elasticity of human capital varies substantially across countries and in some cases the estimate is negligible.

With the foregoing in mind, the purpose of this chapter is to contribute to the empirical literature of human capital and growth. On the empirical side, we test for the non-linearity in the relationship between human capital and economic growth however, our study differs from the ones mentioned above as we find the differences in the impact in different stages of development and the country characteristics that cause this difference. In terms of econometric technique, our main advantage over the regression-tree approach, used in some studies mentioned above, is that it is based on an asymptotic distribution theory which formally tests the statistical significance of the regimes endogenously.

3.2.1 Some further motivations for the study

Long run growth of an economy depends on the accumulation of both physical and human capital as well as on the adoption of efficient technology. However, the role played by both types of capital in the process of development may vary. According to Galor & Moav (2004), at the early stages of development, physical capital is the prime engine of growth whereas at later stages of development human capital accumulation becomes the main driver of economic growth. They develop a growth model capturing the replacement of physical capital accumulation by human capital accumulation as a prime engine of growth along the process of development. At earlier stages of industrialization the process of development is fueled by physical capital accumulation and due to the scarcity of physical capital, the return to physical capital is higher than that of human capital. However, as physical capital accumulates, at later stages of development, the complementarity between physical capital and skills increases the rate of return to human capital, thus increasing the importance of human capital in the process of development.

This offers the motivation and theoretical reasoning for this study. Due to scarcity of physical capital, less developed countries are not able to have the desired positive impact of human capital, given there is an increase in human capital accumulation. Since the stock of physical capital is low at a low stage of development, the individual skills

get wasted and thus human capital fails to have its desired impact. This dependence of “the effective utilization of human capital” on the availability of required physical capital prompts the question: “Does the impact of human capital on growth depend on the level of development in an economy?”

Another plausible reasoning for the different impact of human capital in developed and developing countries could be the difference in their reliance on the type of capital that they invest in. Over the past three decades there has been a dramatic change in the industrial landscape of many industrialized countries. Since the beginning of the second industrial revolution in 1960, there has been a shift away from manufacturing towards services. Many high-income countries including the United Kingdom and the United States have started focusing more on knowledge-based capital (KBC) as compared to physical capital by relocating domestic manufacturing operations overseas to developing countries such as China and India to take advantage of lower wage rates, lower trade barriers and transport costs². Table 3.1 shows the percentage share of value added from manufacturing in industrialized and developing countries over time. It reflects the recent transformation from industrialized countries to developing countries as the share of value added in the manufacturing sector in industrialized countries goes down over the years from 80.2 percent in 1995 to 72.2 percent in 2008 whereas it increases in developing countries from 19.8 percent in 1995 to 27.8 percent in 2008.

Table 3.1: Share of world manufacturing value added (%)

	1995	2000	2005	2008
Industrialized countries	80.2	79.1	74.6	72.2
Developing countries	19.8	20.9	25.4	27.8

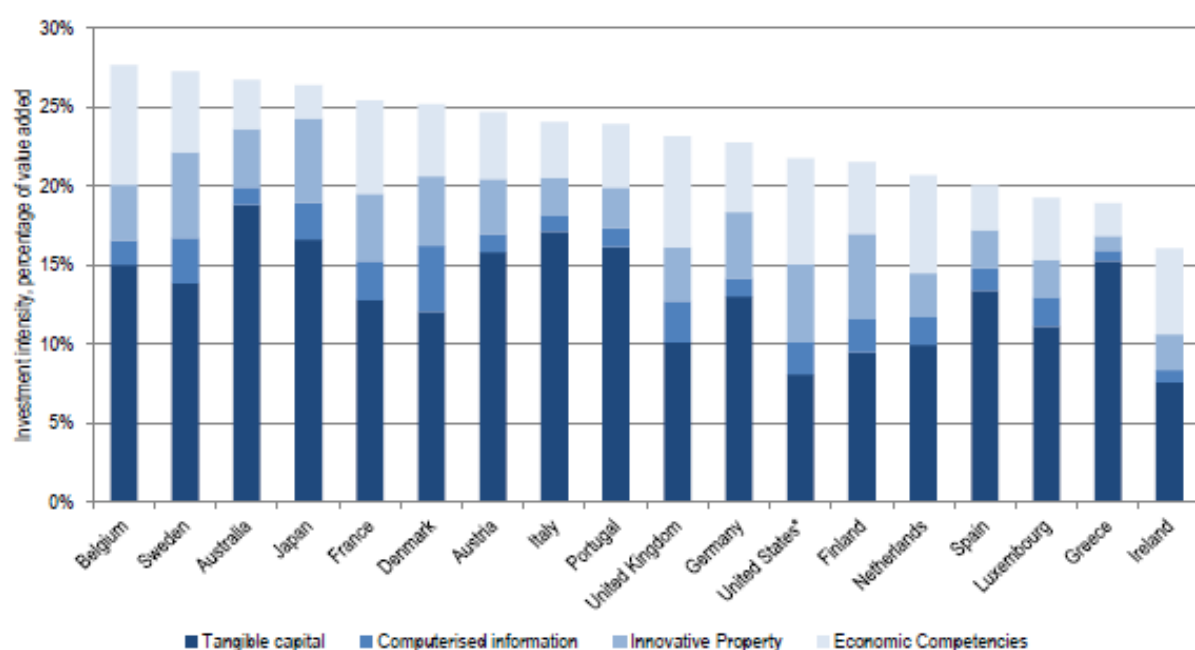
Source: UNIDO (2009)

For example, the textile industry in United Kingdom relocated its manufacturing activities to countries like China where there are low economic barriers to trade, low transport costs and most importantly availability of cheap labour. This meant that while the decisions were still being taken in these industrialized countries, the production was taking place in the developing countries.

²Knowledge based capital comprises of a range of intangible assets that can be classified in the following categories: computerized information (software and databases); innovative property (patents, copyrights, designs, trademarks); and economic competencies (including brand equity, firm specific human capital, networks of people and institutions, and organizational know-how that increases enterprise efficiency) (OECD 2013).

This progressively rising trend of KBC can be seen in case of most advanced economies. In United Kingdom between 1974 and 2004, investment in KBC as a share of market sector gross value added more than doubled. In Australia since 1975 the average annual growth of investment in KBC is 1.3 times higher as compared to investment in physical assets (such as machinery, equipment and buildings). In United States and Japan, also the share of investment in KBC as a percentage of GDP has been rising continuously. A similar trend can also be seen in case of Canada where investment in KBC increased to 6.4% a year as compared to an investment of 4.1% a year in physical capital³. Figure 3.1 shows the investment in KBC and physical capital for some of the industrialized countries. In Sweden, United Kingdom and United States investment in KBC is equal to or greater than the investment in physical capital. Also, countries like Finland and Netherlands invest more in KBC than physical capital.

Figure 3.1: Investment in knowledge based capital and physical capital, 2010 (% of value added)



Source: OECD (2013)

This implies that developed countries have a greater contribution of knowledge-based capital in the growth process as compared to developing countries and since human capital is the one of the common forms of KBC used in these growth accounting studies, the impact of human capital on economic growth is more in case of developed countries.

³New Sources of Growth: Knowledge-Based Capital. Key Analyses and Policy Conclusions, SYNTHESIS REPORT 2013: OECD. <http://www.oecd.org/sti/ind/newsourcesofgrowthknowledge-basedcapital.htm>.

This provides an explanation for the positive and significant impact of human capital on growth in case of these developed countries. However, in case of most developing countries investment is dominated by physical capital and hence human capital has low or in some cases an insignificant impact on growth.

3.2.2 Role of Institutions

This chapter brings the role of institutional quality in shaping the relationship between human capital and economic growth. To address this, we extend our analysis to investigate the following questions: Is it just the level of development which creates this difference or is it due to any specific characteristics of a country? Is there something else that countries should focus on as being a driving force behind growth performance besides factors of production such as physical capital, human capital and technology? Many recent studies (such as Easterly & Levine (2001)) suggest that these factors are only proximate causes of growth and they do not explain why there are differences across countries. This implies that focusing on physical and human capital alone is not sufficient but the efficiency with which these ‘fundamental causes’ are used should also be taken into account (Acemoglu 2009). This prompts us to look at particular characteristics that make developing countries distinctly different from developed countries. In doing so, we incorporate the role of institutions in these countries as it is not only an increase in the level of human capital which is important for economic growth but the extent to which these resources are used efficiently is the point of prime importance.

Douglass North was the first one to bring the role of institutions in economic development to the forefront. North, in his famous book *Institutions, Institutional Change and Economic Performance* (1990) says: “*I wish to assert a fundamental role for institutions in societies: they are the underlying determinants of the long-run performance of economies Third World countries are poor because the institutional constraints define a set of pay-offs to political/economic activity that do not encourage productive activity.*”

Following this, there have been many studies which focus on the role of ‘good’ institutions, with secure property rights, and less distortionary policies, and their significance for economic development (Knack & Keefer 1995, Barro 1996a, Hall & Jones 1999, Acemoglu & Robinson 2001, Acemoglu, Johnson, Robinson & Thaicharoen 2003, Acemoglu, Johnson & Robinson 2005a, Acemoglu et al. 2005b, Rodrik 2000, Rodrik et al. 2004, Dias & Tebaldi 2012) . While there is no single set of institutions that will go well with all the

countries, economic institutions including structure of property rights and the presence and perfection of markets are of primary importance. These are important because they not only influence the structure of economic incentives, but they also help to allocate resources to their most efficient uses. Furthermore, they also determine a range of economic outcomes including the distribution of resources including distribution of wealth, physical capital or human capital (Acemoglu et al. 2005b).

While economic institutions are important in determining the aggregate growth potential of an economy, political institutions are also crucial since they play an important role in determining the economic institutions. Economic institutions are determined as a collective decision by the society at large, but since all groups and individuals will not prefer the same set of institutions there is a conflict of interest. This is where political power plays an important role. The main question that arises is that why do individuals not agree to the same set of institutions that will maximize growth and are in the interest of the society at large? Why does the use of political power lead to economic inefficiencies? This is the case of most developing countries where the individuals in power exploit their positions for their own gain. This gives rise to poor quality institutions which are considered as the root cause of many economic problems. According to Rodrik (2000), poor countries lack a well defined system of property rights; regulations to control fraud, anti-competitive behaviour and moral hazard; trust and social cooperation in the society and above all social and political institutions that manage social conflict and the rule of law. In this case, even if human capital accumulation takes place it will not be able to deliver results or have a significant impact on growth. Therefore, it is important to take into account the role of institutions since they not only have a direct impact on growth rather there is an indirect effect (through human capital) as well.

A similar paper by Dias & Tebaldi (2012) emphasizes on the importance of the interaction between human capital and institutions for explaining the development process. They argue that if early institutions are poor, the knowledge accumulation process will be slow as the process of transferring knowledge to non-educated people will be affected through lower rates of return to education. Consequently, this will affect the long run economic performance. As institutions improve, this would reflect in more knowledge creation through increased rate of return to education thus accelerating human capital accumulation and growth. Our analysis differs from this as we go deeper into this idea and determine if there are threshold effects of institutional quality and level of development on the impact of human capital on the growth process. It is largely accepted that good institutional quality is not only associated with increased economic growth but also helps

input factors including human capital to have a greater impact. However, to the best of our knowledge we have not come across a study which examines the non-linear relationship between human capital and economic growth based on the level of development and institutional quality.

In a recent paper Rogers (2008) also focused on country characteristics such as corruption to explain why returns to human capital may vary across countries. He argued that schooling does not find its way into productive use automatically and poor results are expected since countries vary greatly in their ability to use schooling productively. His findings showed that impact of schooling on growth is substantially higher in countries that have lower levels of corruption and consider to use schooling productively. However, his specification can be criticized for a number of reasons. *Firstly*, he has split the sample between high and low corruption based on its median value and shown that human capital has positive significant (negative or insignificant) effect on economic growth in a sample of low (high) corruption countries. *Secondly*, the use of 1996 corruption index to split the sample for estimating a growth regression over the period 1960-2000 may have led to reverse causality from growth to corruption. Also it may show that impact of growth on corruption rather than estimating how corruption affects the impact of human capital on growth. *Thirdly*, it was simply a cross-section study that did not contain any dynamics of time series. In our analysis we estimate the threshold parameter based on a dynamic threshold regression model using the techniques by Hansen (1999) and Caner & Hansen (2004), explained in the following sections. Our analysis adequately addresses the above criticisms by using panel data and a dynamic threshold model. It also differs from Rogers since we do not take corruption as a proxy for institutional quality for two reasons: *(i)* corruption do not actually quantify the quality of institutions, rather it can be used as a measure that influences institutional quality, *(ii)* our analysis covers the period 1970-2010, for which data on corruption are not available from standard data sources such as Transparency International (TI), International Country Risk Guide (ICRG) or World Bank.

Legal System and Property Rights

The importance of property rights as one of the significant economic institutions and their role in the process of development has been stressed in the literature (Rodrik 2000). Acemoglu & Johnson (2005) findings show that property rights institutions are what matter for growth as they have a first-order effect on long-run economic growth. Moreover,

Baier, Dwyer Jr & Tamura (2004) also show that protection of property rights has a dominant influence on factor productivity, including both labour and capital productivity. They play a vital role in influencing the structure of economic incentives. If property rights are not enforced properly individuals will have little incentive to invest in physical or human capital or adopt efficient technologies (Acemoglu et al. 2005b). The incentive to engage in productive activities is eroded if individuals and business lack confidence that contracts will be enforced and the fruits of their productive efforts protected (Gwartney, Lawson & Hall 2013b). Therefore according to the Economic Freedom Annual Report 2013, this is a crucial area for the efficient allocation of resources and countries who lack this are unlikely to prosper regardless of their policies in the other areas.

Given the discussion above, the important question is why would protection of property rights affect labour productivity and the accumulation of human capital? To answer this, we know that strong property rights institutions protect individuals against expropriation by the government and powerful elites. In the absence of secure property rights human capital either gets wasted or is used for rent-seeking activities which lowers growth and slow down the process of development. According to Baier et al. (2004), in the absence of protection of property rights individuals face two types of risks. Firstly, if individuals fear government expropriation they will try and conceal their assets to decrease the probability of expropriation, which can decrease the efficiency of production. Secondly, some individuals may resort to stealing from individuals who produce goods and services and those who produce will use resources to protect themselves from the predators. Therefore effective protection of property rights will not only reduce stealing but will also lead to resources being allocated to more productive uses. As a result, this makes *legal system and Property Rights* an important measure of institutional quality.

Regulations

Regulations are important as they impact economic freedom of an individual. They tend to reduce economic freedom if they restrict entry into markets and interfere with the freedom of an individual to engage in voluntary exchange (Gwartney et al. 2013b).

Labour market regulations, the most important component of regulations, consist of minimum wage, hiring and firing regulations, working hours regulations and mandated cost of worker dismissal. It measures the extent to which these impacts and restraints upon economic freedom. A higher value of the component rating means that a country allows the market forces to play its role such as to determine wages and establish conditions

for hiring and firing. In the absence of these, there will be poor labour standards. In many developing countries there is no minimum wage for individuals and many individuals receive a wage less than their qualification. This not only discourages individuals to work efficiently but also gives them an incentive to engage in unproductive activities. Also, not having proper hiring and firing regulations along with working hours regulations will affect the performance of individuals. As a result, developing countries are often characterized by weak regulations implying a large informal sector (Boeri, Helppie & Macis 2008).

Democracy

Democracy is an important measure of political institutions however, the extent to which it may matter for countries to achieve economic growth remains inconclusive⁴. On the one hand it is considered as a meta-institution for building good institutions by Rodrik (2000) and having a positive impact on growth (Adelman & Morris 1967, Chatterji, Gilmore, Strunk & Vanasin 1993, Leblang 1997, Tavares & Wacziarg 2001) while on the other hand, researchers argue that it impedes growth (Marsh 1979, Landau 1986) or in some cases does not matter for growth (Dick 1974, Marsh 1988)

Furthermore, looking at evidence from the past we again find mixed examples. While East Asian countries including South Korea, Taiwan and Singapore have experienced significant and rapid economic growth in the absence of democratic institutions there are many more economies including Zaire, Uganda or Haiti which have deteriorated under authoritarianism as a result of lack of democracy and accountability. Similarly, in case of democracy we see examples of countries including Mauritius who have done well under democracy whereas Papua New Guinea and Jamaica have done poorly. This shows that growth cannot systemically depend on the type of political regime. A more valid question is: whether it is safer to live in a democratic regime relative to an autocratic regime? i.e., is the variance in long term growth smaller under democracy? According to the analysis presented by Rodrik (2000) democracies perform better in a number of ways. Firstly, they produce less randomness and volatility. Countries which have long-standing democracies including India, Costa Rica, Malta and Mauritius have experienced less volatility as compared to countries like Syria, Chile or Iran. Secondly, a more democratic a country better it is at managing shocks and lastly democracy yields distributional outcomes that are more desirable.

⁴For a detailed review see Sirowy & Inkeles (1990) and Przeworski & Limongi (1993).

In our study, similar to the findings of Gerring, Bond, Barndt & Moreno (2005), we argue that democracy is an important institutional factor for human capital development and its impact on economic growth. We believe that in poor countries the leaders are not subject to any political or institutional constraints and enjoy having the entire decision making power. As a result, they often resort to socially inefficient and distorsive economic policies for their own benefits. The more democratic a political regime is, the more the process and the process of choice of policies are transparent so the risk of undertaking the policies which aim to serve the leaders personal interests is reduced. Similar to this, Baum & Lake (2003) also find evidence that democracy leads to improvements in education and public health due to the electoral incentive of the political elite to improve the quality of life of the people which is not present much in case of authoritarian regimes. Furthermore, Dreze, Sen et al. (1991) and Feng (2005) also show that democratic rule leads to improvements in a country's human capital resources. As a result, we include democracy in our analysis with the notion that a more democratic a country is, greater is the impact of human capital on economic growth.

3.3 Data and Methodology

3.3.1 Data

The relationship between human capital and growth is studied using an unbalanced panel of 126 countries covering the period from 1970-2012. In accordance with standard empirical growth literature, long-run effects on growth are investigated using non-overlapping 5 year averages giving a total of 911 observations and 9 data points⁵. The dependent variable is the growth rate of GDP per capita taken from the World Bank Indicators (WDI) 1960-2013. Human capital is measured as average years of total schooling taken from Barro and Lee (2010) data base. Another common proxy used for human capital is the enrollment rate. However, there are a few short comings that may arise with this proxy. Firstly, enrollment rates do not account for repetition of grades and dropouts. Also, the enrollment rates lack quality since they depend on annual surveys of educational institutions in each country which may be falsely reported. Thirdly, they do not truly represent

⁵Due to the availability of data till 2012, the last data point contains years 2010-2012. Five period averages have been taken to lessen the impact of year to year fluctuations in output (Maasoumi, Racine & Stengos 2007, Durlauf, Kourtellos & Tan 2008, Henderson, Papageorgiou & Parmeter 2008, Kottaridi & Stengos 2010).

the actual number of students who attend school and focus only on those that get enrolled (Barro & Lee 1993).

To control for convergence we include initial GDP per capita from the previous period ($ly0$), taken from World Development Indicators from the World Bank. Gross capital formation as a percentage of GDP (lk) is also taken into account since it has been considered as one of the fundamental determinants of economic growth. Population growth ($popg$) is included to control for the demographic trend. Other control variables which may influence growth include trade openness, ($trade$), which is considered in the literature to have a positive impact on growth (Frankel & Romer 1999, Harrison 1996). We also account for the role of financial development which is measured by money and quasi money ($m2$) as a percentage of GDP ($m2$). Finally, we control for government expenditure as a percentage of GDP ($govt$) which is expected to negatively affect economic growth (Barro 1991, Barro 1996b). All these control variables have been taken from World Bank Indicators (WDI) 1960-2013.

The threshold variable, capital stock per capita, is taken as a proxy for the level of development from Penn World Table 8.0. The definitions and sources of all variables are provided in Appendix B, table B.1

3.3.2 Dynamic Threshold Model: Methodology

In order to estimate the existence of a possible threshold of development that causes the variation in the effect of human capital on economic growth, we focus on a dynamic threshold regression model, which can be represented by:

$$y_{it} = \mu_i + \theta'_1 z_{it} I(q_{it} \leq \gamma) + \theta'_2 z_{it} I(q_{it} > \gamma) + \varepsilon_{it} \quad (3.1)$$

where μ_i is the country specific fixed effects, q_{it} is the threshold variable, γ is the threshold parameter and ε_{it} is the independently and identically distributed (iid) error term with mean zero and variance equal to σ^2 . $I(\cdot)$ is an indicator function specifying the regime based on the threshold variable q_{it} and the threshold level γ . $z_i = (z_{1i}, z_{2i})$ is an m dimensional vector of explanatory variables which contains a subset, z_{2i} , of exogenous variables and a subset, z_{1i} , of endogenous variables correlated with the error term, ε_{it} . The threshold variable, q_{it} , is assumed to be exogenous⁶. The model also contains a k -dimensional

⁶The existence of an endogenous threshold variable will require an alternative estimation approach

vector of instruments, x_{it} , where $k \geq m$

The observations are divided into two regimes depending on whether the threshold variable, q_{it} , is above or below the threshold parameter, γ . The regimes are distinguished by different slope coefficients θ'_1 and θ'_2 and the magnitude of the threshold effect is the difference between these parameters. However, some elements of z_{it} can be constrained to have the same impact in both regimes, i.e., $\theta'_{1,j}$ may be equal to $\theta'_{2,j}$ for some $j \in \{1, \dots, k\}$.

We develop a dynamic threshold model using Hansen (1999) where he introduces econometric techniques appropriate for threshold regression with panel data. However, one of the limitations of Hansen (1999) model is that all regressors are required to be exogenous. In empirical growth models the assumption of exogeneity is a very strong assumption because initial income, being a crucial variable, is endogenous by construction. Previous studies on growth-related thresholds and using Hansen methodology, taking into account the crucial role of initial income for the convergence debate of the economic growth literature, ignored the potential endogeneity bias (Khan & Senhadji 2001, Foster 2006, Bick 2010, Haque & Kneller 2009). David, Pedro & Paula (2005), on the other hand, excluded initial income from their growth regression to avoid the problem of endogeneity. Both these methods of dealing with the problem of endogeneity of initial income may not only lead to biased estimates of the threshold but also lead to misleading conclusions of the impact of human capital on growth.

In our study, following Kremer, Bick & Nautz (2013), we combine the instrumental variable estimation of the cross-sectional threshold model by Caner & Hansen (2004) with the panel threshold model of Hansen (1999). This permits us to estimate the effects of human capital on growth depending on the threshold level of development after taking the endogeneity of initial income into account.

The model developed in this chapter predicts that the relationship between human capital and economic growth will vary with the level of development. The dynamic threshold model in our analysis assumes that the relationship between human capital and growth in a panel of 126 countries can be summarized by the following equation:

$$y_{it} = \mu_i + \theta_1 \hat{hc}I(\hat{k}_{it} \leq \gamma) + \delta_1 I(\hat{k}_{it} \leq \gamma) + \theta_2 \hat{hc}I(\hat{k}_{it} > \gamma) + \phi z_{it} + \varepsilon_{it} \quad (3.2)$$

where y_{it} measures the growth rate of real GDP per capita. Our regime dependent variable which is beyond the scope of this study.

is human capital, measured by average years of total schooling and the threshold variable is capital stock per capita, \hat{k} . The idea is to see if there exists a non-linear relationship between growth and human capital based on a country's level of development. The proxy for the level of development is a country's capital stock per capita, taken from any standard economic growth model. Initial income is considered as endogenous in this mode i.e., $z_{it} = ly_0$ and we use lags of the dependent variable as instruments. This is in accordance with Arellano & Bover (1995) who show that lags of pre-determined variables can be taken as valid instruments in the transformed equation. Following Kremer et al. (2013) we use two benchmark specifications. In the first we use all possible lags of all possible instrument variable and in the second we reduce the count to 1. This is done to avoid the problem of over identification of instruments which may lead to biased coefficient estimates.

Fixed Effects Estimation

The first step in our estimation is to eliminate the country specific fixed effects without violating the distributional assumptions underlying Hansen (1999) and Caner & Hansen (2004). One of the most common methods of eliminating fixed effects is first differencing. While in a non dynamic model the country specific fixed effects, μ_i , can be eliminated using first differencing, in a dynamic model, first differencing leads to inconsistent estimates since the lagged value of the dependent variable will always be correlated with the mean of the individual errors and thus all of the transformed individual errors (Arellano 2003). In order to deal with this problem we use forward orthogonal deviations transformation suggested by Arellano & Bover (1995)⁷. In this method, instead of subtracting the previous observation from the contemporaneous one (as in the case of first differencing), it subtracts the average of all future available observations of a variable. One distinguishing feature of forward orthogonal deviation is that it eliminates individual fixed effects without inducing serial correlation in the transformed error term. A variable that is transformed using forward orthogonal deviation will take the form:

$$w_{it}^* = c_t \left[w_{it} - \frac{1}{T-t} (w_{i(t+1)} + \dots + w_{iT}) \right] \quad (3.3)$$

⁷This extension was first suggested by Kremer et al. (2013) who analyse the non linear relationship between inflation and long term economic growth by Arellano & Bover (1995) estimation. Other papers who use this method is Baum, Checherita-Westphal & Rother (2013).

where the scale factor $c_t = \sqrt{\frac{T-t}{T-t-1}}$ ⁸

Another advantage of this method is that since the lagged observations do not enter the formula they are valid as instruments. In case of the error term, the transformed error term becomes:

$$e_{it}^* = c_t \left[e_{it} - \frac{1}{T-t} (e_{i(t+1)} + \dots + e_{iT}) \right] \quad (3.4)$$

This means that the transformed error term maintains the property of being identically and independently distributed and maintains the uncorrelatedness of the error terms. This is not possible in the case of first differencing, since it makes successive error terms correlated (Roodman 2009a). Using the forward orthogonal deviations transformation ensures that we can apply the estimation method derived by Caner & Hansen (2004) for a cross sectional model to our dynamic panel model in equation 3.2.

Estimating the Model

The dynamic model is estimated following Caner & Hansen (2004). In the first step, we run a reduced form regression of the endogenous variable, z_{1i} , on a set of instruments x_{it} . The predicted values of the endogenous variables, \hat{z}_{1i} estimated from the reduced form, are then substituted in the structural equation 3.2. In step two, we estimate the structural equation 3.2 by least squares for each value of the threshold, γ . The corresponding least square estimates of the parameters and the sum of squared errors, denoted by, $S(\gamma)$ are recorded. This is repeated for each value of the threshold from a strict subset of the threshold variable, q . In the third step, the estimator for the threshold parameter, γ , is chosen which minimizes the sum of squared errors, i.e.,

$$\hat{\gamma} = \arg \min_{\gamma} S_n(\gamma) \quad (3.5)$$

Once the threshold value is found⁹, the next important question is how precise are these

⁸The weighting c_t is introduced to equalize the variances (Arellano & Bover 1995).

⁹One way of checking the significance of the threshold estimate is to compute the p-values by a bootstrap procedure since the value of the threshold is not identified under the null of linearity and therefore classical tests have non-standard distributions (Hansen 1996, Hansen 2000). In this study with an unbalanced panel, to calculate the bootstrap p-values, each country has different number of observations and therefore using a bootstrap will make the estimation complicated and is beyond the scope of this study. Trying to make our panel balanced drops many observations which make the analysis meaningless. However, based on the

estimates. This requires computing a confidence region around the threshold estimate, γ . The tighter the confidence interval lesser is the uncertainty about the threshold level. Following Hansen (2000) and Caner & Hansen (2004) the confidence interval, constructed based on the likelihood statistic $LR(\gamma)$, is given by:

$$\Gamma = \{\gamma : LR_n(\gamma) \leq c(\alpha)\} \quad (3.6)$$

where the likelihood ratio is given by $LR_n(\gamma) = n \frac{S_n(\gamma) - S_n(\hat{\gamma})}{S_n(\hat{\gamma})}$ and the critical values are calculated using the following: $c(\alpha) = 2 \log(1 - \sqrt{1 - \alpha})$. $S_n(\gamma)$ and $S_n(\hat{\gamma})$ are the residual sum of squares with threshold γ and $\hat{\gamma}$ respectively.

The hypothesis in this case is given by $H_0 : \gamma = \gamma_0$ (the true value of γ) and is rejected at an asymptotic level α if $LR_n(\gamma)$ exceeds $c(\alpha)$. This means that the confidence interval or the ‘no-rejection region’, as given in equation 3.6, is the set of values of γ such that $LR_n(\gamma) \leq c(\alpha)$. The best way to illustrate this is plotting the log likelihood ratio, $LR_n(\gamma)$ against γ and drawing a flat line at $c(\alpha)$. The confidence interval is the region below the horizontal line i.e., where $LR_n(\gamma) \leq c(\alpha)$ and the point where $LR_n(\gamma)$ strikes zero is the threshold estimator, $\hat{\gamma}$. The parameter γ_0 is more precisely estimated more peaked is the $LR_n(\gamma)$ graph. According to Caner & Hansen (2004) in samples with strong information about γ , the $LR_n(\gamma)$ graph will have a sharp V shape with clearly delineated minimum whereas in samples with low information about γ , the $LR_n(\gamma)$ graph will tend to have a more irregular shape with not a less clearly defined minimum. This graph is further explained in the next section where we present the results. Once the regression parameter, γ is estimated, GMM is used to estimate the slope parameters.

confidence interval and our slope estimates we show later on that we do indeed get a significant threshold effect. This has also been followed by Kremer et al. (2013) and Khan & Senhadji (2001) who also using an unbalanced panel do not calculate the bootstrap p-value.

3.4 Empirical Results

3.4.1 GMM and FE estimation: Evidence from developed and developing countries

Based on the theoretical discussion in section 3.2.1, the analysis begins with examining the impact of human capital on growth across countries depending on their level of development, using a standard growth regression equation. For this, we split the sample into developed and developing countries based on the World Bank classification. The equation to be estimated is given below:

$$growth_{it} = \alpha_i + \beta_1 human_capital_{it} + \beta_2 ly0 + \sum_j \beta_j z_{jt} + \varepsilon_{it} \quad (3.7)$$

where $growth_{it}$ is the growth rate of GDP per capita, $human_capital_{it}$ is average years of total schooling, $ly0$ is initial GDP per capita at the start of the period and ε_{it} is the error term. z_{jt} include other explanatory variables such as trade as a percentage of GDP, government expenditure as a percentage of GDP, population growth rate and $M2$ as a percentage of GDP.

To begin the analysis, equation 3.7 is estimated for a sample of both developed and developing countries using fixed effects and generalized method of moments (GMM) estimators. Fixed effects estimator is used to estimate equation 3.7 due to the presence of unobserved country-specific effects. Fixed effects averages equation 3.7 over time for each i and subtracts it from equation 3.7 to remove the country-specific effects. However, in case of growth models one of the concerns in estimating these models is the presence of endogeneity which is controlled by using GMM estimation. Results are summarised in tables 3.2 and 3.3.

Table 3.2: GMM and FE Estimation for Developing Countries

	(1)	(2)	(3)
	GMM_before_outliers	GMM_after_outliers	FE_after_outliers
human capital	0.259 [0.786]	0.716 [0.459]	-0.012 [0.192]
Investment	3.151 [1.513]**	4.027 [1.256]***	3.416 [0.578]***
Trade	-0.206 [1.860]	-0.016 [1.910]	1.052 [0.575]*
M2/GDP	-0.243 [1.657]	-0.833 [1.514]	-0.729 [0.312]**
Government Size	-3.168 [6.414]	-10.058 [6.476]	-3.125 [1.556]**
Population Growth	-1.546 [0.843]*	-2.616 [0.493]***	-0.675 [0.238]***
ly0	-0.149 [1.606]	-2.170 [1.496]	-2.420 [0.577]***
Constant	14.718 [27.590]	60.004 [32.251]*	24.211 [8.954]***
Observations	612	572	572
R^2			0.355
F	9.946	9.647	17.194
hansenp	0.362	0.341	
ar1p	0.016	0.000	
ar2p	0.959	0.979	
No of Countries	80.000	79.000	79.000
No of Instruments	23.000	23.000	

Notes: Standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is growth rate of GDP per capita. Columns (1) and (2) are estimated by one-step system GMM estimator. Column (1) is without excluding outliers and column (2) is after taking into account outliers. Column (3) is estimated by fixed effects estimation. The Hansen test is distributed as χ^2 under the null hypothesis that the over identifying restrictions are valid.

Table 3.3: GMM and FE Estimation for Developed Countries

	(1)	(2)	(3)
	GMM_before_outliers	GMM_after_outliers	FE_after_outliers
human capital	1.437 [0.916]	1.863 [0.934]*	0.514 [0.200]**
Investment	4.643 [3.365]	4.512 [3.724]	4.652 [1.249]***
Trade	1.696 [2.584]	-0.556 [2.865]	2.450 [0.732]***
M2/GDP	-1.853 [3.095]	-0.133 [2.056]	-0.642 [0.575]
Government size	-10.320 [4.829]**	-8.695 [5.342]	-6.965 [2.299]***
Population growth	-0.613 [0.742]	-0.164 [0.446]	-0.611 [0.152]***
ly0	-2.457 [1.442]*	-1.060 [1.769]	-4.016 [0.460]***
Constant	50.297 [29.743]*	27.951 [39.615]	47.095 [10.954]***
Observations	296	278	278
R^2			0.457
F	13.930	7.063	21.040
hansenp	0.324	0.306	
ar1p	0.141	0.002	
ar2p	0.693	0.756	
No of countries	46.000	46.000	46.000
No of Instruments	23.000	23.000	

Notes: Standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is growth rate of GDP per capita. Columns (1) and (2) are estimated by one-step system GMM estimator. Columns (1) is without excluding outliers and column (2) is after taking into account outliers. Column (3) is estimated by fixed effects estimation. The Hansen test is distributed as χ^2 under the the null hypothesis that the over identifying restrictions are valid.

Across the 3 regressions in each table, we augment the econometric method. The overall results, in table 3.2, show that human capital has an insignificant effect on growth in developing countries in case of both GMM and fixed effects estimation. In column (1) with GMM estimation and without taking into account the outliers we find a low and insignificant coefficient of human capital. However, the magnitude of the coefficient increases when we take out outliers (column (2)) but it still remains insignificant. Column (3) shows the results for fixed effects estimation, where the coefficient for human capital becomes negative and remains insignificant. Table 3.3, on the other hand, summarizes the impact of human capital on growth in case of developed countries. Column (1) shows an insignificant effect of human capital on growth, however, after accounting for outliers

(column (2)), the human capital coefficient not only increases in magnitude but also becomes significant at 10%. In case of fixed effects estimation (column (3)), the impact of human capital on economic growth is again positive and significant at 5%.

Thus, we can conclude that the impact of human capital is rather insignificant in case of developing countries, while it becomes positive and significant for the sample of developed countries. Similar findings are put forward by Galor & Moav (2004) who argue that at early stages of development, physical capital is the main growth engine, whereas at later stages of development, it is human capital which drives economic growth. Our results above also shed light on the argument that less developed countries experience little or no impact of human capital on growth whereas the countries at a higher level of development experience a positive and significant impact. Moreover, This is also in accordance with the observations discussed in section 3.2.1, where we discuss the recent shift of developed countries towards ‘knowledge-based capital’ whereas developing countries rely more on physical capital.

3.4.2 Dynamic Panel Threshold Model of Human Capital and Growth

The heterogeneous impact of human capital on economic growth across developed and developing countries found above motivates us further to examine the link between human capital and growth. We develop a dynamic threshold model and try to find a certain threshold level that can explain the non-linear relationship between human capital and growth. The important feature of this model is that it allows us to capture the heterogeneous impact of human capital on growth based on two different regimes. Our findings for the benchmark model, presented in table 3.4, show that the marginal impact of human capital on growth is regime specific with a significant capital stock per capita threshold value of around 9.4998, which falls into 95% confidence interval ranging from [9.427-10.037]. The confidence intervals are very tight which implies that the threshold has been precisely estimated (Hansen 2000, Khan & Senhadji 2001).

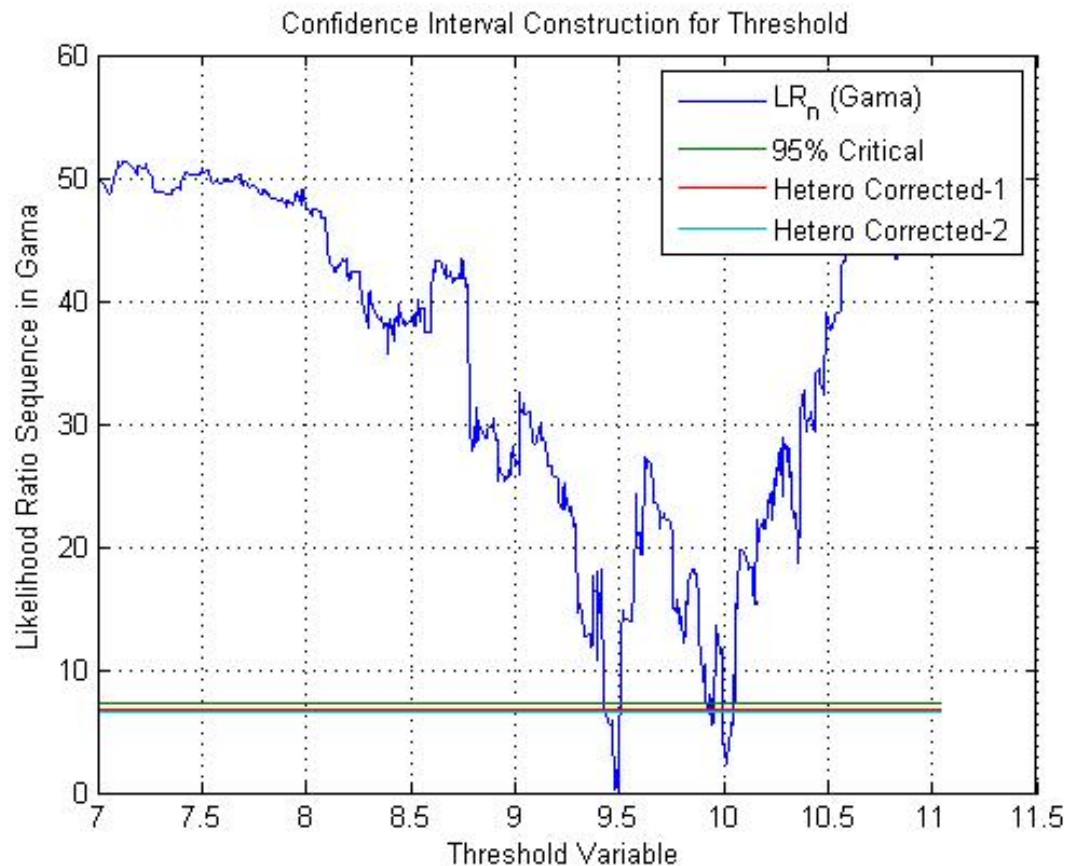
Table 3.4: Dynamic Panel Threshold Model of Human Capital and Growth (1970-2012)

Variable	
Threshold Estimate	
$\hat{\gamma}$	9.4998
95% confidence Interval	[9.4269 10.0365]
Regime-Dependent Variables	
$\hat{\theta}_1$	0.2716 (0.2287)
n	433
$\hat{\theta}_2$	0.9509*** (0.3187)
n	478
Regime-Independent Variables	
ly0	-13.1468*** (1.5778)
Investment	3.6496*** (0.8201)
Population growth	-0.3561 (0.2968)
Trade	4.8129*** (0.9535)
Government size	-4.6470*** (1.1047)
M2/GDP	2.4594*** (0.6822)
$\hat{\delta}_1$	2.7267 (1.7968)
<i>N</i>	911
<i>Hansen J</i> (p-values)	0.4479

Notes: Standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is growth rate of GDP per capita. The regime dependent variable is average years of total schooling and the threshold variable is log of capital stock per capita. Following Hansen (1999), each regime contains at least 5% of all observations. The Hansen test is distributed as χ^2 under the the null hypothesis that the over identifying restrictions are valid.

Another way to assess the estimate and its precision is to look at figure 3.2 which plots the log likelihood ratio, $LR_n(\gamma)$ against the threshold estimate, γ . The graph shows two main ‘v’ shaped peaks where the threshold level is at 9.4998, where $LR_n(\gamma)$ strikes zero. The threshold value splits the sample into 428 observations for less than the threshold value regime and 483 observations for above the threshold value regime. The p-value for the hansen J test is 0.4479 implying that we do not reject the null that the instruments are valid. The results show that the impact of human capital on growth is dependent on the level of development of a country. Countries who have the capital stock per capita greater

Figure 3.2: Confidence Interval Construction for Threshold)



than the threshold level (these include OECD and high income countries) experience positive and significant effects of human capital whereas there is an insignificant link between growth and human capital below this threshold level (these include African countries such as Burundi, Benin, Ghana, Cambodia and less developed South Asian countries such as Bangladesh, Pakistan and Nepal).

Thus, this model shows that human capital does not have an insignificant impact on growth, in fact there is a threshold level of development above which human capital has its desired positive and significant effects.

Other control variables also come with expected signs and significance except for population growth which is negative but insignificant. Initial income carries a significant negative sign which is consistent with the technology catch-up hypothesis of neoclassical growth models. The estimated coefficients for both investment as a percentage of GDP and trade as a percentage of GDP, consistent with our expectations, are positive and highly

significant, implying that increases in investment and trade tend to raise the growth rate of an economy. The coefficient for M2 as a percentage of GDP is also positive and significant. In case of government consumption expenditure, as expected, the coefficient is negative and significant.

3.4.3 Robustness Tests

For robustness test, we take three more measures of human capital. Results are presented in Table 3.5. In column (1) we have the secondary school enrollment ratio from the Barro and Lee education attainment dataset (2010) as a proxy for human capital. The findings show that the impact of human capital on growth is indeed regime specific. The impact of human capital below the threshold level is insignificant with a coefficient of 1.2142 whereas above the threshold level the impact is positive and highly significant at 1% with a high value coefficient of 4.4637. However, one of the disadvantages of the enrollment ratio is that it does not take into account the drop out ratio. To control for this, we also take the secondary school completion ratio as a proxy for human capital. The results, summarized in column (2), again show the insignificant impact of human capital on growth below a certain threshold level of development and a positive and statistically significant impact of human capital above the threshold level of development. These findings are also robust to our third proxy for human capital, average years of secondary schooling, where again we see the regime specific impact of human capital on growth, differing according to the level of development. Below the threshold level, human capital has no effect on growth whereas above the threshold level the estimated coefficient for human capital is positive and statistically significant at 10% level of significance.

In column (4), we have an interesting proxy for human capital taken from the Penn World Table, Version 8.0. This human capital index is constructed based on a country's average years of schooling from Barro & Lee (2013) and an assumed rate of return based on Psacharopoulos (1994). This gives us an opportunity to not only look at the input variable

Table 3.5: Robustness Test: Different Human Capital Variables

Variable	secondary education enrollment ratio	secondary education completion ratio	average years secondary schooling	hc_penn
Threshold Estimate				
$\hat{\gamma}$	9.4998	9.4998	10.0173	10.0173
Confidence Interval	[9.4269 10.0486]	[9.4508 - 10.0556]	[9.4733 10.0556]	[9.4549 10.0556]
Regime- dependent variables				
$\hat{\theta}_1$	1.2142 [1.1838]	0.6985 [0.5887]	0.1442 [0.4964]	0.1589 [0.3922]
N	433	433	533	533
$\hat{\theta}_2$	4.4637 [1.6073]***	1.7474 [0.5507]***	2.3734 [1.2367]*	2.1062 [0.9146]**
N	478	478	378	378
Regime-Independent Variables				
ly0	-13.0284 [1.5665]***	-13.2580 [1.6251]***	-12.3635 [1.3608]***	-12.4262 [1.3486]***
Investment	3.6088 [0.8165]***	3.6478 [0.8365]***	3.0938 [0.7642]**	3.1398 [0.7649]***
Population growth	-0.3581 [0.2935]	-0.4236 [0.3018]	-0.4646 [0.3242]	-0.4466 [0.3195]
Trade	4.8635 [0.9547]***	4.7753 [0.9409]***	5.1039 [0.9106]***	5.0823 [0.8950]***
Government size	-4.6615 [1.0964]***	-4.5369 [1.0413]***	-4.5369 [1.2290]***	-4.5254 [1.2012]***
M2/GDP	2.4847 [0.6815]***	2.4744 [0.6386]***	2.6917 [0.8375]**	2.6601 [0.8223]***
δ_1	5.6150 [2.8760]*	0.3505 [1.2528]	5.8900 [4.5475]	3.4576 [2.7894]

Notes: Standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is growth rate of GDP per capita. The regime dependent variable changes across all four columns. The threshold variable is log of capital stock per capita. Following Hansen (1999), each regime contains at least 5% of all observations.

Table 3.6: Robustness Test: Lagged explanatory variables

Variable	average years of total schooling	secondary education enrollment ratio	secondary education completion ratio	average years secondary schooling	hc_penn
Threshold Estimate					
$\hat{\gamma}$	9.2847 [9.2583 9.2951]	9.2847 [9.2583 9.2951]	9.2847 [9.2684 9.2951]	9.2847 [8.9148 10.2964]	9.2847 [9.2583 9.2951]
Confidence Interval					
Regime- dependent variables					
$\hat{\theta}_{1_1}$	0.3612 [0.2119]*	0.2603 [0.4497]	0.1454 [0.3522]	0.9480 [0.5825]	1.9681 [1.0879]*
N	351	351	351	351	351
$\hat{\theta}_{2_1}$	0.8093 [0.2591]***	2.1125 [0.8321]**	1.9074 [0.6038]***	1.4005 [0.4522]***	4.1047 [1.2957]***
N	434	434	434	434	434
Regime-Independent Variables					
ly0	-11.5049 [1.4422]***	-10.8708 [1.3124]***	-10.9370 [1.2888]***	-11.5404 [1.4831]***	-11.5642*** [1.4356]***
Investment_1	0.6867 [0.7596]	0.2451 [0.7169]	0.2434 [0.7068]	0.5662 [0.7631]	0.7257 [0.7575]
Population growth_1	-0.5981 [0.2487]**	-0.6462 [0.2780]**	-0.6311 [0.2732]**	-0.6376 [0.2567]**	-0.5837 [0.2439]
Trade_1	4.0838 [0.9953]***	4.3793 [0.9661]***	4.3961 [0.9456]***	4.1031 [0.9945]***	4.0630 [1.0001]***
Government size_1	-5.5166 [1.2576]***	-5.6664 [1.1323]***	-5.6519 [1.1131]***	-5.4106 [1.3338]***	-5.5755 [1.2300]***
M2/GDP_1	2.3386 [0.5175]***	2.5225 [0.6053]***	2.5194 [0.5922]***	2.4188 [0.4972]***	2.3322 [0.5130]***
$\hat{\delta}_1$	1.4716 [1.5964]	4.7150 [2.7699]*	2.9560 [1.5168]*	-0.5005 [1.1375]	3.4218 [2.7214]

Notes: Standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is growth rate of GDP per capita. The regime dependent variable changes across all four columns. The threshold variable is log of capital stock per capita. Following Hansen (1999), each regime contains at least 5% of all observations.

for human capital (years of schooling) but also look at an output variable, i.e., returns to education. The results again support our findings that human capital does not have its impact at lower levels of development, however, beyond a threshold level the impact becomes statistically significant and positive ¹⁰.

For further robustness test we focus a bit more on the issue of endogeneity, which is one of the common concerns in empirical growth models. A particular source of endogeneity which may be found in our baseline model is reverse causality. In addition to using GMM estimation¹¹, to overcome this, we re-estimate the threshold regression in table 3.4 and table 3.5 with all explanatory variables lagged one year. As can be seen in all 5 columns of table 3.6, our previous findings remain largely robust. However, in column (1) and (5), the estimated coefficient for human capital below the threshold becomes statistically significant at 10%, the value of the human capital estimate above the threshold level is more than double than the value below the threshold level of capital stock per capita and is also statistically significant at 1%. This implies that human capital has a much greater impact at higher levels of development i.e., higher capital stock per capita as compared to economies with lower level of development i.e., lower capital stock per capita.

The coefficient estimates of trade openness, government spending and liquidity ratio retain their signs and significance thus reinforcing our previous findings. The coefficient of population growth, however become significant at 5% across all 5 regressions and indicate a negative impact on growth whereas the coefficient of gross capital formation loses its significance across all 5 regressions. But since this is not the main focus of our study, we do not take this into account.

Another important point in empirical studies is that the results may depend on the number of instruments used (Roodman 2009b). In finite samples there might be an efficiency bias trade off (Kremer et al. 2013). To overcome this, we use two different specifications with one including all the possible lags as the instrument and the other with just one lag. Results are presented in table B.4. In column (1), to increase the efficiency we use all possible lags of the instrument variable. In column (2) we reduce the count to one to overcome the problem of over-identification of instrumented variables which may lead to biased estimates. Our results show that the choice of instruments have no major impact

¹⁰Average years of total schooling and secondary education are used following the standard approach in literature when using the stock and flow of human capital (Barro (1991); Barro (1996b); Levine & Renelt (1992); Murphy, Shleifer & Vishny (1990); Englander & Gurney (1994)).

¹¹see Caselli, Esquivel & Lefort (1996) who propose the use of GMM estimation in context of panel growth regressions to deal with the issue of endogeneity. Also see Aghion & Durlauf (2005) for further related discussion.

on our previous results.

To sum up our results remain robust and are in line with our notion that the impact of human capital is in fact non-linear with lower or, in most cases, insignificant effect at lower levels of development and a positive significant effect at higher levels of development ¹².

3.5 Role of Institutions

The preceding analysis shows that there is a non-linear relationship between human capital and economic growth depending on a country's level of development. As opposed to some of the previous empirical studies that report an overall insignificant impact of human capital on growth, our empirical results show that there exists a threshold level of capital stock per capita below which human capital is insignificant and above which there is a positive significant impact of human capital on economic growth.

In order to take the analysis a step further in this section, we investigate whether institutional quality causes certain level of development to act as threshold below which human capital can exert no impact on growth, but above which it shows significant effect. For institutional quality, we take data on legal system and property rights, regulations and democracy to examine whether Prichett's question 'where has all the education gone?' can be answered in the context of institutions¹³. Is it possible to have the desired effects in the absence of adequate institutions? We re-estimate 3.2, given below:

$$y_{it} = \mu_i + \theta_1 \hat{h}cI(\hat{k}q_{it} \leq \gamma) + \delta_1 I(\hat{k}q_{it} \leq \gamma) + \theta_2 \hat{h}cI(\hat{k}q_{it} > \gamma) + \phi z_{it} + \varepsilon_{it} \quad (3.8)$$

where y_{it} measures the growth rate of real GDP per capita, μ_i is the country specific fixed effect and our regime dependent variable is human capital, measured by average years of total schooling. Institutional quality is taken into account in the threshold variable which is now an interaction term of capital stock per capita and institutional quality i.e., $kq_{it} = \text{capital stock per capita} \times \text{institutional quality}$. This interaction term has four options: (1) low level of development (lower capital stock per capita) and low institutional quality; (2) on the way to development and low institutional quality; (3) Low level of

¹²For further robustness, one may try to look at the impact of human capital over different decades; however, this is not possible in our case where we will be left with only 2 data points.

¹³One of the most common measure of institutional quality are the World Bank Governance Indicators for which the data is available from 1996 onwards whereas our analysis begins from 1970. Therefore to maintain consistency we cannot use this measure.

development and high institutional quality and (4) high level of development and high institutional quality. The first two options will give us a low interaction term. The third option seems nearly impossible because less developing countries invariably have low institutional quality whereas the fourth option will give a high interaction term (which includes all OECD countries).

The data on *legal system and Property Rights* is taken from the index of economic freedom available from *Fraser Institute*¹⁴ and covers the period 1970-2011¹⁵. It comprises of nine components which indicate how effectively the protective functions of government are performed: rule of law, security of property rights, an independent and unbiased judiciary, and impartial and effective enforcement of the law. The primary sources for these are the International Country Risk Guide, the Global Competitiveness Report, and the World Banks Doing Business project. The value of the index ranges from 0 to 10 with a high value corresponding to high quality of efficiency level.

The second measure for the quality of institution is *Regulations* which is a composite index of *credit market regulations, labour market regulations and business market regulations*. The data are taken from *Fraser Institute* with the value of the index ranging from 0 to 10, a high value corresponding to an institution of high quality. In our analysis, the most important type of regulation is labour market regulation, however since there is not enough data available for labour regulations we take the composite index only. To study the relation between human capital and growth, it is crucial to understand the structure of the labour market since it decides how and where human capital is deployed.

The democracy index, obtained from the Freedom House, measures the political rights and civil liberties. Both are measured on a 1 to 7 scale, with one representing the highest degree

¹⁴Fraser Institute provides an index called the Index of Economic Freedom (EFW) published in the Economic Freedom of the world which measures the degree of economic freedom in five broad categories: (1) Size of the Government; (2) Legal system and Property Rights; (3) Sound Money; (4) Freedom to Trade Internationally; (5) Regulation. According to Fraser Institute, individuals have economic freedom when property they acquire without the use of force, fraud, or theft is protected from physical invasions by others and they are free to use, exchange, or give their property as long as their actions do not violate the identical rights of others. An index of economic freedom should measure the extent to which rightly acquired property is protected and individuals are engaged in voluntary transactions (Gwartney, Lawson & Block 1996). In this analysis we consider only two of the categories which are related to our analysis.

¹⁵The last data point contains years 2010-2011.

Table 3.7: Dynamic Panel Threshold Model of Human Capital and Growth: Institutional quality-development interaction thresholds (1970-2012)

Variable	lkpc* legal system & property rights	lkpc* regulations	lkpc* democracy
Threshold Estimate			
$\hat{\gamma}$	24.7256	52.7454	46.6919
Confidence Interval (95%)	[18.5370 29.4193]	[43.8902 57.8684]	[42.4990 49.5364]
Regime-Dependent Variables			
$\hat{\theta}_1$	0.3099	0.3074	0.5411
	[0.2123]	[0.2068]	[0.2328]**
n	576	261	608
$\hat{\theta}_2$	0.5503	0.6016	0.8566
	[0.2536]**	[0.2007]***	[0.3752]**
n	335	530	292
<i>Hansen J</i>	8.6757	29.3725	6.9693
pvalue	0.1227	0.0000	0.2229

Notes: Standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is growth rate of GDP per capita. The regime dependent variable is average years of total schooling. The threshold variable differs across all three columns and is the interaction term between capital stock per capita and each of the institution variable terms. The Hansen test is distributed as χ^2 under the null hypothesis that the over identifying restrictions are valid. Following Hansen (1999), each regime contains at least 5% of all observations.

of freedom and seven the lowest. However, to make the interpretation easy we take the inverse of these values. So, in our analysis, one represents the lowest degree of freedom and seven represents the highest degree of freedom. The value of this index starts from 1973, so the value from 1973 is taken to be the average value for the data point 1970.

Table 3.7 summarizes the results when we re-estimate the model after incorporating institutional quality. Each column represents a different threshold variable which is now an interaction term between capital stock per capita and each of the three measures of institutional quality: *legal system and property rights*, *regulations* and *democracy*. A higher value of threshold variable, kq_{it} , means a higher level of development and improved institutional quality. This is shown by the correlation matrix in table B.5 which shows high correlation between kq_{it} and capital stock per capita and kq_{it} and each of the institutional quality measure. This shows that a higher value of the interaction term would mean higher capital stock per capita (higher level of development. In column (1) the threshold variable is $kq_{it} = \text{legal system and property rights} \times \text{capital stock per capita}$. The coefficient estimate for human capital below the threshold level is insignificant. However, beyond the threshold level the coefficient estimate not only becomes significant at 5% but also the magnitude increases (0.5503). This implies that the impact of human capital on economic growth is much greater where we have stronger legal system and property rights thus better quality institutions. These include high income and OECD countries whereas below the threshold level we have the less developed countries including Mozambique, Burundi, Cambodia, Nepal and Bangladesh.

Column (2) contains regulations as a proxy for institutional quality. We see that the coefficient estimate for human capital below the threshold level (including African countries such as Benin, Burundi, Cameroon, Ghana and Uganda and South Asian countries such as Bangladesh Nepal and Pakistan) is insignificant whereas it is not only positive and significant at 1% but the coefficient estimate also doubles in magnitude above the threshold level. Column (3) summarizes the results for democracy. Although the coefficient estimate for human capital is positive and significant at 5% in both regimes, but the coefficient estimate above the threshold estimate is much greater in magnitude. This shows that having a less democratic regime is not bad for human capital to have its impact, however, having a more democratic regime relatively creates an environment in which human capital is able to have a greater impact. These results are in line with other empirical studies which also argue that democracy is important for human capital development and its impact on growth (Baum & Lake 2003, Dreze et al. 1991, Feng 2005)¹⁶.

¹⁶In two among the three measures of institutional quality, Hansen test accepts the null. But as the null

3.6 Conclusion

The accumulation of human capital is considered as an important determinant in the process of economic growth. Despite a large literature there is still an ambiguity on its role in growth and development as a number of empirical studies find an insignificant, in some cases even negative, impact of human capital on growth. However, the focus of these studies has been more on issues related to the use of data and methodology and they assume that the impact of human capital is the same across countries. The study in this chapter differs in the following ways. *Firstly*, we empirically test the non-linearity in the relationship between human capital and economic growth. For this we use the dynamic panel threshold model introduced by Hansen (1999) and Caner & Hansen (2004), which has not been used before in this context. *Secondly*, we investigate further to see whether there are any country-specific characteristics that play any role in shaping this non-linear relationship. For this, we have used several proxies for institutional quality. Institutions are a crucial determinant of growth and there is a vast set of literature that deals with its positive effects on long-term growth. They are important because they not only influence the economic incentives of individuals but they also help to allocate resources to their most efficient use. As a result, it becomes necessary to incorporate the role of institutions when studying the relationship between human capital and growth.

The empirical analysis begins with estimating the impact of human capital on economic growth for a sample of developed and developing countries using fixed effects and GMM estimation. The human capital variable, in case of developing countries, enters with an insignificant coefficient across both estimation methods. This implies that human capital accumulation does not play its role in the process of growth at lower levels of development. On the other hand, in case of developed countries the coefficient estimate is not only positive but also significant thus reinforcing the argument by Galor & Moav (2004) who argue that human capital becomes the main driver of growth at later stages of development. The analysis then extends further and estimates the dynamic panel threshold model that can explain this heterogeneous impact. Estimating a dynamic panel threshold model using Hansen (1999) and Caner & Hansen (2004) our results confirm the non-linearity in the relationship between human capital and economic growth. The threshold variable is the the level of development proxied by capital stock per capita. The results show that the impact of human capital is indeed regime specific, differing according to a country's level

cannot be rejected in the case of regulation index, the result on this variable remains inconclusive even though it indicates the similar impacts of human capital in different regimes.

of development. At lower levels of development, the impact of human capital is insignificant whereas it is positive and significant above the threshold level. These results remain robust for various robustness tests including use of different proxies for human capital.

Once we determine the non-linear relationship between human capital and economic growth a bigger question arises: Why is human capital not able to have the same impact across countries? Is it the level of development only or do the specific characteristics of a country also have a role to play along with the level of development? Using *legal system and property rights, regulations* and *democracy* as proxies for institutional quality, we re-estimate our dynamic panel model with a different threshold variable i.e., an interaction term between capital stock per capita and institutional quality. The analysis confirms that institutions play a role in shaping the way human capital affects economic growth. It is not just the economic development but the inefficiency in the institutions coupled with low level of development hinders the developing countries to get the most out of their resources. Poor institutional quality in less developed countries acts as an impediment to growth since individuals are likely to divert resources to unproductive uses. If their property rights are not properly protected and regulations act as a restraint upon economic freedom individuals are more likely to engage in activities which are beneficial for themselves and not for the society at large. Therefore human capital accumulation may be necessary for an economy to grow but it is clearly not sufficient. At the policy level, the government needs to focus on improving the institutional quality to have more productive effect of rising human capital in developing countries.

Chapter 4

Thesis Conclusion

The thesis is based on two chapters which contribute to different literatures. Broadly speaking, the first chapter sought to contribute to the literature on human capital, corruption and development while the second chapter extends the existing literature on human capital, institutions and economic growth .

There are many theoretical analysis which provide explanations for the negative relationship between corruption and growth by addressing various issues relating to macroeconomics of misgovernance. However, the effects of corruption are not confined to aggregate outcomes alone, rather they extend to distributional outcomes as well. It is this further aspect of of development which occupies our principal concern in this thesis. The specific policy focus of our analysis is the government's provision of public goods and services designed to improve human development, especially amongst the poor. The cornerstones of this provision are public expenditures on education and health which are presumed to enhance human capital and, with this, the functionality and productivity of individuals.

The first chapter discusses how public malfeasance undermines the provision of public services which are designed to reduce poverty and inequality in an economy. The emphasis is on the acquisition of human capital- defined broadly to include both education and healths status- which increases an individual's productivity and income. Education and health services are provided by both the public and private sectors, the latter of which may be accessed to either substitute or supplement the use of the former through various types of personal expenditures. The ability to do this depends on an individual's wealth status which determines whether or not he requires a loan to finance such expenditure,

and whether or not he is eligible for a loan as a consequence of capital market imperfections. Corruption manifests as the appropriation of public funds by public officials, the immediate impact of which is a reduction in the provision of public education and health services. Individuals who rely on such provision for acquiring human capital are then faced with the prospect of lower wage earnings because of their lower productivity. This is the wealth effect of corruption. In addition, the same individuals face a higher threshold level of wealth for loans to be granted, meaning that more of them are constrained in their ability to borrow. This is the credit effect of corruption. Our analysis shows how these two effects combine to adversely affect both distributional and aggregate outcomes in an economy.

The analysis above shows the importance of good governance and its impact on the society in general. It illustrates how corruption undermines the effectiveness of public services by causing a wastage of government expenditure through embezzlement and overspending. This compounds another well-known effect of corruption, which is the reduction of such funding to begin with due to the misallocation of public expenditures, the composition of which is distorted away from pro-development areas (like education and health) towards less productive areas (such as defense and infrastructure) (e.g., De la Croix & Licandro (1999); Gupta, Verhoeven & Tiongson (2002); Mauro (1997) and Delavallade (2006)). For these reasons, corruption can significantly impede human development, especially amongst the poor who may find themselves denied of basic public services which may offer their only means of escaping from their plight. In this way, corruption may foster both inequality and poverty.

In many cases it is noticed that it is easy for policy makers and government to increase public spending on education and health in an attempt to improve these services however, according to our findings, in absence of good governance one cannot achieve these targets. While this corruption hurts the society in general the greatest burden is borne by the poor since they rely on public services of education and health the most. Therefore, it is necessary to focus on policies that will combat corruption if we want the poor people to come out of their poverty traps.

The second chapter presents an analysis of the threshold effects of human capital on economic growth. Human capital, over decades, has been considered as an important factor for economic growth. However, empirical evidence since mid 1990s has started focusing on the insignificant, and in some cases negative, effect of human capital on growth. While these studies focus on issues of data and methodology to explain the insignificance

of human capital, our chapter examines the non-linearity in the relationship between human capital and growth. Estimating a dynamic panel threshold model the thesis provides evidence for the non-linearity in the relationship between human capital and economic growth. The results show that the impact of human capital is indeed regime specific, differing according to a country's level of development. At lower levels of development, the impact of human capital is insignificant whereas it is positive and significant above the threshold level. The chapter then attempts to explore the possible reasoning behind this. A significant contribution of the study is that it provides a new perspective to explain why there are threshold effects of human capital on growth. Why do countries not have the same impact of human capital? The thesis focuses on the importance of quality of institutions. To the best of my knowledge, this has so far been neglected in the context of threshold effects of human capital on economic growth. The chapter shows that low institutional quality is detrimental to growth as it impedes the impact of human capital on growth. It is not just the economic development but the inefficiency in the institutions coupled with low level of development hinders the developing countries to get the most out of their resource. If their property rights are not properly protected and regulations act as a restraint upon economic freedom individuals are more likely to engage in activities which are beneficial for themselves and not for the society at large. This is undoubtedly true in the developing countries context where many countries have poor institutional quality which provides individuals with incentives to divert resources to unproductive uses.

An important conclusion is that developing countries should adopt policies that improve institutional quality as human capital accumulation may be necessary for an economy to grow but it is clearly not sufficient. In particular, these countries should work on improving the legal system, property rights and the regulatory system. Improving this will not only improve the economic incentives but they will also help to allocate resources to their more efficient use. The problem which is not addressed in many developing countries.

Appendices

Appendix A

Figure A.1: Timeline

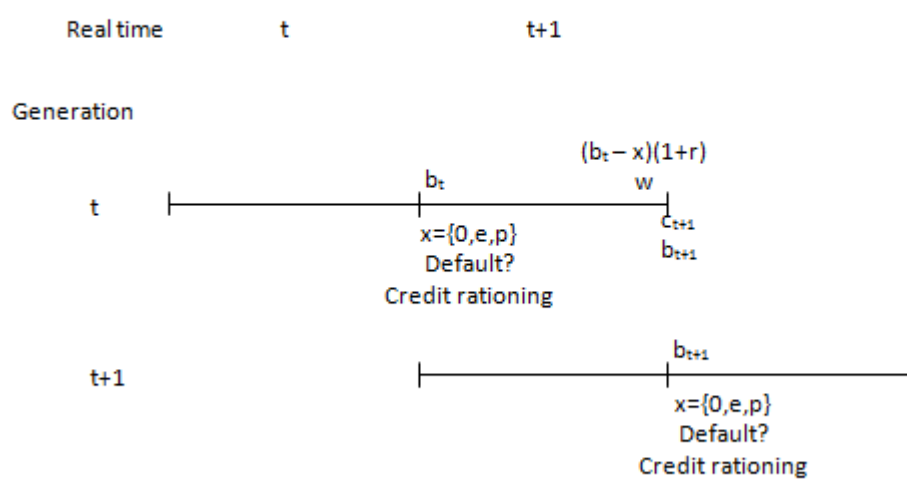
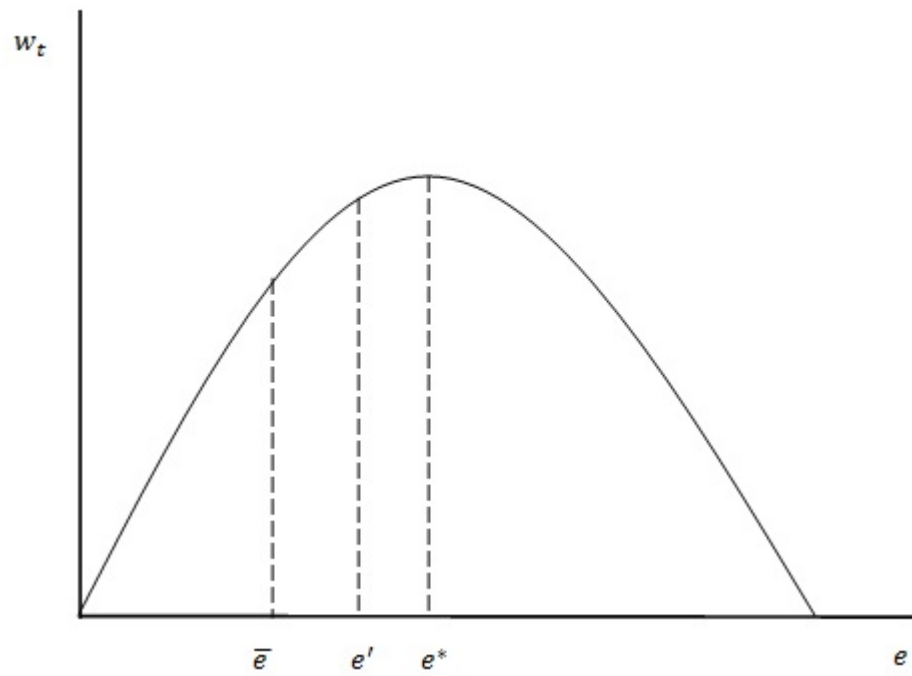


Figure A.2: Endogenous Expenditure



Appendix B

Table B.1: Description of variables and data sources

Variables	Description	Source
gdpcc	Growth rate of real GDP/capita (annual %)	WDI 1960-2013
human capital	Avg yrs of total schooling	Barro & Lee data (1950-2010)
average years of secondary schooling	Avg yrs of secondary schooling	Barro & Lee data (1950-2010)
secondary education enrollment ratio	Total % of population (aged 15 and over) who went for secondary education	Barro & Lee data (1950-2010)
secondary education completion ratio	Total % of population (aged 15 and over) who completed secondary education	Barro & Lee data (1950-2010)
hc_penn	Index of human capital/person based on yrs of schooling & returns to education	Barro & Lee data (2012) & Psacharopoulos (1994)
ly0	Log of initial GDP/capita	WDI 1960-2013
kpc	Log of capital stock/ capita	Penn World Table 8.0
Investment	Log of gross capital formation as a % of GDP	WDI 1960-2013
Trade	Log of trade as a % of GDP	WDI 1960-2013
Government size	Log of govt expenditure as a % of GDP	WDI 1960-2013
M2/GDP	Log of money and quasi money (M2) as % of GDP	
Population growth	Population growth rate (annual %)	WDI 1960-2013
Institutions variable		
ls_pr	Legal System & Property rights: comprises of 9 components: (i) rule of law (ii) security of property rights (iii) Judicial independence (iv) impartial courts (v) Integrity of the legal system (vi) Legal enforcement of contracts (vii) Reliability of police (viii) Business costs of crime (ix) Regulatory restrictions on the sale of real property	Index of Economic Freedom, Fraser Institute
reg	Regulations: comprise of (i) Business regulations (ii) Labour Market regulations (iii) Credit Market regulations	Index of Economic Freedom, Fraser Institute
Dem	Democracy Index: measured by political rights and civil liberties	Freedom House

Table B.2: List of Sample Developing Countries

1	Albania	41	Mali
2	Argentina	42	Mauritania
3	Armenia	43	Mauritius
4	Bangladesh	44	Mexico
5	Benin	45	Moldova
6	Belize	46	Mongolia
7	Bolivia	47	Morocco
8	Botswana	48	Mozambique
9	Brazil	49	Namibia
10	Bulgaria	50	Nepal
11	Burundi	51	Niger
12	Cambodia	52	Pakistan
13	Cameroon	53	Panama
14	China	54	Paraguay
15	Colombia	55	Peru
16	Congo	56	Philippines
17	Costa Rica	57	Romania
18	Cte d'Ivoire	58	Rwanda
19	Dem. Rep. Congo	59	Senegal
20	Dominican Republic	60	Serbia
21	Ecuador	61	Sierra Leone
22	Egypt	62	South Africa
23	El Salvador	63	Sri Lanka
24	Fiji	64	Sudan
25	Gabon	65	Swaziland
26	Ghana	66	Syrian Arab Republic
27	Guatemala	67	Tajikistan
28	Honduras	68	Tanzania
29	Hungary	69	Thailand
30	India	70	The Gambia
31	Indonesia	71	Togo
32	Iran	72	Tunisia
33	Jordan	73	Turkey
34	Kazakhstan	74	Uganda
35	Kenya	75	Ukraine
36	Lesotho	76	Venezuela
37	Liberia	77	Vietnam
38	Libya	78	Yemen
39	Malawi	79	Zambia
40	Malaysia	80	Zimbabwe

Table B.3: List of Sample Developed Countries

1	Australia	24	Kuwait
2	Austria	25	Latvia
3	Bahrain	26	Lithuania
4	Barbados	27	Luxembourg
5	Belgium	28	Macao SAR China
6	Brunei	29	Malta
7	Canada	30	Netherlands
8	Croatia	31	New Zealand
9	Cyprus	32	Norway
10	Czech Republic	33	Poland
11	Denmark	34	Portugal
12	Estonia	35	Qatar
13	Finland	36	Russia
14	France	37	Saudi Arabia
15	Germany	38	Singapore
16	Greece	39	Slovenia
17	Hong Kong SAR China	40	Spain
18	Iceland	41	Sweden
19	Ireland	42	Switzerland
20	Israel	43	Trinidad and Tobago
21	Italy	44	United Kingdom
22	Japan	45	United States
23	Korea	46	Uruguay

Table B.4: Regression Results: One lag and All lags

Variable	(1)	(2)
Threshold Estimate		
$\hat{\gamma}$	9.4750	9.4750
95% confidence Interval	[9.4269 10.0486]	[9.4269 10.0556]
Regime- dependent variables		
$\hat{\theta}_1$	0.2605 [0.2284]	0.2967 [0.2214]
N	428	428
$\hat{\theta}_2$	0.9168 [0.3185]***	0.9871 [0.3093]***
N	483	483
Regime-Independent Variables		
ly0	-13.3787 [1.5826]***	-12.6955 [1.4927]***
Investment	3.6155 [0.8163]***	3.6766 [0.7878]***
Population growth	-0.3682 [0.2970]	-0.3273 [0.2891]
Trade	4.8983 [0.9464]***	4.6269 [0.9289]***
Government size	-4.6960 [1.1161]***	-4.5852 [1.0790]***
M2/GDP	2.5601 [0.6781]***	2.2561 [0.6595]***
$\hat{\delta}_1$	2.5806 [1.7279]	2.8013 [1.6417]*

Notes: Standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is growth rate of GDP per capita. The regime dependent variable is average years of total schooling and the threshold variable is capital stock per capita. Each column represents different number of instruments. Following Hansen (1999), each regime contains at least 5% of all observations

Table B.5: Correlation Matrix

Variable	lkpc	ls_pr	reg	dem
lkpc_ls_pr	0.8109	0.9727		
lkpc_reg	0.6760		0.9129	
lkpc_dem	0.6530			0.9776

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