Essays on Human Capital, Institutions and Economic Growth

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TABLE OF CONTENTS

List of Tables

List of Figures

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ABSTRACT

This thesis provides both theoretical and empirical evidence to identify why the effect of human capital on economic growth differs across countries.

Chapter 1 provides a theoretical explanation of the weak effects of human capital on economic growth in a dynamic general equilibrium model of corruption and growth where the bureaucrats acts as the agents of government to administer public policy. Corruption in this model arises from the incentive of the bureaucrat to appropriate (steal) public resources, thereby reducing the provision of public services. The decision of the corruptible bureaucrat affects public finances and hence the capital accumulation in the economy. Education has two opposing effects, a positive productivity enhancing effect and a negative bureaucratic stealing efficiency of corrupt bureaucrats. If the latter dominates the former the net effect may result in an insignificant (or even negative) effect of human capital on growth.

The second chapter explains empirically why previous studies do not find link between human capital and economic growth, again looking at the role of corruption. In this chapter, we provide cross sectional evidence on this issue by explicitly introducing the role of corruption together its interaction with human capital. The empirical analysis first revisits the Rogers (2008) study, where he uses an arbitrary level of corruption to divide the full sample of countries into subsamples of high and low corruption countries and concludes that human capital matters only in low corruption countries. However, using a range of corruption data and sample periods, our results do not confirm his findings. Our preferred specification allows the effects of human capital to be conditional on the level of corruption, which is implemented through the inclusion of both a corruption measure and its interaction with human capital. Although we generally find the expected positive sign on human capital and a negative sign on the interaction term, these often lack in significance. We repeat the analysis using instrumental variable estimation and find a similar pattern of results, and hence conclude that cross sectional evidence is uninformative for empirical analysis of the role of human capital in economic growth.

In the third chapter, we employ panel data analysis to investigate the relationship between human capital and economic growth by considering an exhaustive range of institutional measures, along with corruption. These various institutional measures are used to capture different aspects of institutions on the impact of human capital on economic growth. Our growth regressions include the interaction of institution and human capital, in addition to the direct effect of institution and human capital. The coefficient on interaction term can be interpreted as showing whether human capital and institutions appear to be compliments or substitutes for their impact on growth. Our results generally show positive and significant coefficients on human capital and institutions, with a negative coefficient on the interaction term. The results suggest that, for policy purposes, the government needs to carefully identify the level of human capital to be pursued in relation to the quality of institutions.

Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Babar Hussain received B.Sc (Honours) degree in 2001 and M.Sc in 2002 from International Islamic University Islamabad (IIUI) Pakistan. He completed his M.Phil degree in 2005 from Quaid-i-Azam University Islamabad Pakistan. He started his professional career in 2003 by joining as a lecturer in 2003 at Karakoram International University Gilgit, Pakistan. He then joined the same post at University of Sargodha, Sargodha, Pakistan in 2004. As a member of teaching staff, undertaking PhD was more of necessity. He started his PhD Economics in October 2007 at University of Manchester, UK and also gained the international teaching experience by working as GTA.

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THESIS INTRODUCTION AND OVERVIEW

The last two decades have observed voluminous research on the role of human capital in economic growth. Micro-economic studies based on Mincerian human capital functions observe significant returns to schooling (see Card, 1999, for a review). Theoretically, the macroeconomic studies also recognise the contribution of human capital in growth. The seminal contribution of Lucas (1988) sparked the interest in this literature. He suggested that human capital accumulation leads to endogenous growth due to the existence of positive externality. Later on, Romer (1990) considered human capital as playing a role of determining the nations' ability to innovate new technologies which are more suited for domestic production and it also influences the speed of technological catch up and diffusion (Nelson and Phelps, 1966).

The microeconomic literature observe clear evidence on significant returns to increases in education and also the theoretical macroeconomic literature consistently found intuitively positive impact of human capital on economic growth, the empirical evidence on the contribution of human capital on growth is surprisingly mixed. The empirical macroeconomic literature based on early papers that rely on cross sectional analysis (Barro 1991; Mankiw Romer and Weil, 1992) use enrolment rates as the proxy for human capital, report large and significant effects of human capital on economic growth. However, other cross country studies (Kyriacou, 1991, Benhabib and Spiegel, 1994, Nonneman and Vanhoudt, 1996, Pritchett, 2001) not only report insignificant relationships but also show a negative impact of human capital. The weak or counterintuitive results of human capital are not limited to cross sectional studies. There are also various panel data studies that report insignificant or negative impact of human capital on economic growth (Kumar, 2006, Bond, Hoeffler and Temple, 2001, Caselli, Esquivel and Lefort, 1996; Islam, 1995).

Many researchers have attempted to provide explanations for the weak effects of human capital on economic growth. One line of research argues that a measurement error (Krueger and Lindahl, 2001) is the primal reason behind the conflicting results of human capital on growth literature. Following this line of argument other studies (de la Fuente and Domenech, 2000 and 2002, Soto, 2006; Cohen and Soto, 2007, Bassanini and Scarpetta, 2001) also notice that the poor data may be the cause of conflicting results. Other explanations include the use of alternative estimation methodology (Bassanini and Scarpetta, 2001, 2002; Freire-Serean, 2002), the existence of influential outliers in the sample of heterogeneous countries (Temple, 1999), the collinearity between physical and human capital (Soto, 2006), the socially unproductive use of human capital (Pritchett, 2001) and parameter heterogeneity in a large sample of countries (Temple, 2001).

Some studies also suggest that the conventional factors of production such as physical capital, human capital and technology are not the only driving forces behind the growth performance and they may only partially explain cross country differences in growth (Easterly and Levine, 2001). It therefore appears that countries differ in growth rates not only due to the differences in physical and human capital but also due to the way these factor inputs are combined. Countries differ in the efficiency of the factor accumulation and this may account for the large cross country income differences (see Acemoglu, 2009, Ch 1). We contend that studies should recognise factors other than proximate causes of growth. We suggest that among these other causes of growth, institutions and corruption may also be considered as the important factors affecting the impact of human capital on economic growth.

There is a strand of literature that recognises the adverse effects of corruption on economic growth. The theoretical literature suggests that the bureaucratic corruption may take place through different channels, for example it may be due to the bribery and tax evasion (i.e., Blackburn, Bose, and Haque 2006) to stealing of government resources by public officials (Mauro, 2004), or to misinforming the government about the costs and quality of public goods (Haque and Kneller 2007). The empirical literature based on the rent seeking activities and the allocation of talent was first highlighted by Baumol (1990) and by Murphy, Shleifer, and Vishny (1991). A negative relationship between corruption and growth (Baumol, 1990, Murphy, Shleifer, and Vishny, 1991, Shleifer, and Vishny, 1993) is observed in countries that create incentives for highly talented individuals to diverge towards rent-seeking activities instead of productive activities. The indirect negative effects of corruption on growth occurs due to decrease in investment (Mauro, 1995), due to reduction in expenditure on education and health (Mauro, 1997), due to increase in public investment but its low productivity (Tanzi and Davoodi, 1997) due to higher military spending (Gupta, de Mello and Sharan, 2000).

There is another strand of literature that recognizes the importance of institutions in economic growth and suggests that institutions are one of the major causes of long run growth (see Hall and Jones, 1999; Acemoglu et al., 2001; Rodrik et al. 2004; Easterly and

Levine, 2003; and many others). Acemoglu et al. (2004) argue that institutions are important because they influence the structure of incentives in the economy. For example, poor property rights not only discourage investment in physical and human capital but also make it difficult to innovate to more efficient technologies.

The objective of this thesis has been to explain and identify the additional channels through which human capital effects economic growth that essentially contributes towards two strands of literatures on corruption and economic growth as well as the literature on institutions and economic growth.

In the first chapter, we provide theoretical explanation on the weak effects of human capital on growth by introducing bureaucratic corruption. We consider a three period overlapping generations (OLG) model in an economy with three players such as households, bureaucrats and government. The bureaucrats are designated as the agents of government for the implementation of the public policy and are exempted from paying the taxes while households are liable to taxation. Corruption arises due to the incentives of bureaucrats to appropriate some portion of the public funds for themselves and thereby limiting the public resources. Our dynamic general equilibrium model shows that the human capital has two opposing effects; a positive productivity enhancing effect and a negative bureaucratic stealing effect. In addition to the positive productivity effects of education, it may also increase the bureaucratic stealing efficiency and decrease the cost of concealment of illegal income which may result in lower growth. The model shows that there may be development regions where some countries may observe a higher stealing efficiency of corruptible bureaucrats than the productive efficiency due to the accumulation of human capital, the net effect of which may be that human capital has little or even negative effect on growth.

The second chapter builds on the theoretical analysis of chapter 1 and provides for the first time the cross sectional evidence that explicitly introduces the additional channel of corruption on the impact of human capital on growth. The empirical analysis in this chapter first revisits the Rogers (2008) findings and then suggests a new interaction methodology. The Rogers (2008) study is based on the cross sectional evidence that divides full sample of countries into sample of low and high corrupt countries by using the corruption index for a single year. He concludes that human capital has significant and positive effect in the sample of low corrupt countries while it is insignificant for the sample of high corrupt countries. The study can be criticized for its arbitrary use of corruption index of 1996 where the period of study is 1960-2000. This indicates that the results may suffer from the problem of endogeneity. And also the sample splitting may result in loss of important information. We first revisit Rogers's results by following his methodology by using the decadal regressions as well as the regression for twenty years but could not find support for his hypothesis. Instead of relying on a particular corruption data and sample splitting, we consider more appropriate estimation methodology by including regressions based on dummy variables. This specification has an advantage over the Rogers specification for not losing the important information due to sample splitting. We also consider additional corruption data from three sources; Business International, International Country Risk Guide and Transparency International and repeat the analysis but could not confirm the Rogers hypothesis. And sometime, we also find the results contrary to the Rogers hypothesis. Moreover, we considered the explicit role of corruption and also its interaction with human capital in the growth equation in another specification to explain that the weak effect of human capital. In our preferred specification of interaction methodology we expected that effect of human capital is conditional on the level of corruption (i.e., the impact of human capital on growth reduces by increase in the level of corruption). Although, we generally find the expected positive sign on human capital and negative signs on both corruption and interaction term but they lack in significance. We repeat the analysis with the instrumental variable estimation and found similar pattern of results and conclude that the cross sectional evidence is uninformative for the important role of human capital in economic growth.

The chapter three builds on the cross sectional evidence and looks into more deep analysis by employing panel data technique and by using the host of exhaustive institutional variables along with corruption as another measure. In this chapter, we employ eight measures of institutions [i.e., quality of governance; Law and Order; economic freedom of the world; democracy; corruption index from International Country Risk Guide; corruption index from Transparency International; market regulation and sound money index to capture various aspects of institutions on the link between human capital and economic growth. The analysis begins with estimating the base line model excluding institutional variables and regressing growth in capital per worker and human capital on growth in capital per worker and reports an insignificant or even negative coefficient on human capital. In our preferred specification, we also include the institutional variable and the interaction of institution and human capital to also investigate the joint importance of both institutions and human capital in addition to the direct effect of institution and human capital. Our one-step system GMM results generally show positive and significant coefficient on human capital and institutional measures while the negative coefficient on the interaction term which suggests that there is trade off between human capital and institutions on their joint impact on economic growth. We also repeat the analysis for the sample of developing and developed countries and also disaggregating the full sample of countries into different income and regional groups and find the similar results.

This thesis provide for the first time the macroeconomic theoretical explanation of bureaucratic corruption on the link between human capital and economic growth and also the empirical evidence using corruption and institutions.

CHAPTER ONE

EFFECT OF HUMAN CAPITAL ON GROWTH: DOES CORRUPTION HAVE ROLE TO PLAY?

1.1 Introduction

The role of human capital is well recognized in the microeconomic literature (please see Card, 1999). Yet we do not see any special role is assigned to human capital in the standard Solow (1956) model, until the seminal contribution of Lucas (1988). The finding of seminal work of Solow (1956) is that huge amount of growth is left unexplained and cannot be attributed to labour and capital alone. This has not only raised a big question in the field of economic growth but at the same time stimulated immense research in the area of economic growth. The augmented neoclassical model of Mankiw, Romer and Weil (MRW, 1992) accounted the direct effects of human capital on growth by explicitly introducing it as an additional input in the production function. The main weakness of the augmented neoclassical growth model is that the growth rate was determined outside the model. The endogenous growth models (such as Lucas, 1988; Romer, 1990; Nelson and Phelps, 1966) suggested that human capital can generate long term sustained growth. Theoretically, endogenous growth literature has no doubt on the important role of human capital in growth process but the empirical literature is surprisingly mixed and conflicting in nature.

The discouraging results of both cross sectional (Benhabib and Spiegel, 1994 and Pritchett, 2001) and panel data studies (Kumar 2006; Bond, Hoeffler and Temple, 2001; Caselli, Esquivel and Lefort, 1996; Islam 1995; and others) on the effect of human capital and economic growth has motivated a great interest in exploring the possible explanations. The possible explanations include measurement errors (Krueger and Lindahl, 2001), data quality (de la Fuente and Domenech, 2000 and 2002, Cohen and Soto, 2007, Bassanini and Scarpetta, 2001) while others have worked with alternative estimation methodologies (Bassanini and Scarpetta, 2001, 2002; Freire-Serean, 2002). But to the best of our knowledge there is no macro-theoretical explanation on why such is the case. We provide such a possible explanation on the link between human capital and growth by introducing the explicit role of corruption.

In order to achieve the above, this chapter utilizes the literature on the harmful effects of corruption on economic growth. According to this literature, the bureaucratic corruption may take place through different channels, for example it may be due to the bribery and tax evasion (i.e., Blackburn, Bose, and Haque 2006), due to the stealing of government resources by public officials (Mauro, 2004) or by misinforming government about the costs and quality of public goods (Haque and Kneller 2007).

In the literature of human capital and economic growth very limited attention is given to the role of corruption as observed in a recent empirical analysis by Rogers (2008). He implicitly uses corruption, the black market premium on foreign exchange and extent of brain drain as the indicators of unproductive use of schooling for developing countries. We are particularly interested on the role of corruption in his analysis. He uses corruption 1996 index from Kaufmann et al (2005) to divide the full sample of 76 countries into sub-samples of high and low corrupt countries for the growth period of 1960-2000. He concludes that human capital matters in the sample of low corrupt countries while it does not have an effect on growth in the sample of high corrupt countries.

The objective of this chapter is to provide a theoretical model on the role of corruption in explaining the effect of human capital on growth. We consider three period overlapping generations (OLG) model with human capital externality in the spirit of Lucas (1988) model and productive use of government expenditures in the spirit of Barro (1990). According to the theoretical predictions of the model, impact of human capital may be retarded by the bureaucratic stealing efficiency. Education has two opposing effects on growth; it may increase the bureaucratic stealing efficiency that reduces the cost of concealment of illegal income or it may have positive productivity effects. If the negative effect of bureaucratic stealing dominates the positive productivity effects, education may retard or even lower growth.

The remaining of the chapter is organized as follows. The brief review of literature is presented in section 1.2. In the next section the objective of study is briefly discussed. The section 1.4 presents the general framework of the model economy that is prone to bureaucratic corruption. In section 1.5 we consider the economy with no education while introduce education in section 1.6. In section 1.7 we study in details how corruption might affect the development of the economy with education as compared to the case of no education. In section 1.8 we make few concluding remarks.

1.2. Brief Literature Review

In this section we briefly discuss the literature on human capital and economic growth, the literature on corruption and economic growth and the literature on human capital, corruption and economic growth.

The starting point for the surprising results for role of human capital in empirical growth literature can be referred to the influential work by Benhabib and Spiegel (1994). They were among the first to notice insignificant and often negative coefficient on human capital. Another noteworthy contribution in the literature was put forward by the influential work of Pritchett (2001). He was among the first in reconciling the micro estimates of the returns to schooling with the aggregate evidence on education and growth. He has also found the weak effect of human capital in growth process. These two studies were cross sectional in nature.

The conflicting results are not limited to the cross sectional regression analysis. Apart from the conflicting results found in the cross sectional studies there are number of cases in which the studies based on panel data could not find positive and significant effect of human capital (Kumar 2006; Bond, Hoeffler and Temple, 2001; Caselli, Esquivel and Lefort, 1996; Islam 1995).

From the above brief review of some non-exhaustive literature on the weak effect of human capital and economic growth, several studies have provided different explanations in response to the disappointing results found in the literature. One line of research argues that measurement errors (Krueger and Lindahl, 2001) are the possible explanation for the conflicting results found in the literature. Following this line of argument other studies (de la Fuente and Domenech, 2000 and 2002, Cohen and Soto, 2007, Bassanini and Scarpetta, 2001) have notices that the poor data may be the causing conflicting results. Other group of researchers argue about the estimation methodology to be responsible for the poor results (Bassanini and Scarpetta, 2001, 2002; Freire-Serean, 2002). Another possible explanation is that results may be influenced by a few influential countries. The study by Temple (1999) emphasize on the robustness of the results. He argues that in a large numbers of heterogeneous countries the possibility of some influential countries may be driving the surprising results. He recommends least trimmed squares (LTS) for identifying and eliminating the possible outliers and hence focusing on the more coherent part of the sample. He applied LTS to Benhabib and Spiegel (1994) and showed that results have been radically changed.

There is also huge literature measuring the impact of corruption on growth. Most of the theoretical and empirical research has claimed that corruption has harmful effects on growth. In explaining the adverse effects of corruption they have adopted different mechanisms for the existence of corruption. The bureaucratic corruption may take place through different channels, for example it may be due to the bribery and tax evasion of public officials (bureaucrats), private agents or stealing of government resources by public officials, misinforming government about the costs and quality of public goods. On theoretical side, the most recent and more influential contribution is undertaken by Blackburn, Bose, Haque, (2006). The study considers a dynamic general equilibrium model of growth for the joint determination of economic development and bureaucratic corruption. The latter mechanism is emphasized in Mauro (2004) through the existence of strategic complementarity where the corruption becomes inevitable and also discussed by Blackburn, Bose, and Haque, (2004). Another view is put forward by Haque and Kneller (2007), in their analysis although corruption increases public investment but it lowers the returns to public investment and hence retarding the economic development.

In addition to the aforementioned arguments our study will highlight another important issue which is relatively unknown in the literature. The attempt is made to discuss an additional channel which had received no or very little attention in the literature. The relatively unexplored channel in the literature of the effect of human capital and growth is that the effect of human capital may operate through corruption. On the theoretical side there is no such work in the literature while in case of empirical work there is only one exception. The study by Rogers (2008) gives cursory attention to this channel, he uses Kaufmann et al. (2005) corruption index for 1996 to create the subsamples of high and low corruption countries during 1960-2000. He uses cross sectional analysis to investigate the effect of human capital on growth for the group of 76 countries and finds significant effect of human capital on economic growth in sample of low corrupt countries while insignificant effect of human capital for the sample of high corrupt countries. The corruption index is only used to create sub-samples and results may suffer from the problem of endogeneity by using corruption 1996 index for growth period 1960-2000. Moreover, the sample splitting results in loss of information.

1.3. Objective of the Study

The aim of the study is to bridge a gap in the literature on the link between human capital and growth through introducing the role of corruption.

In this study we present a theoretical model to investigate the disappointing effects of human capital on growth. We use three period overlapping generation model (OLG) model with labor augmenting neoclassical model in spirit of Barro (1990) and the human capital technology in spirit of Lucas (1988). In this model the effect of human capital depends on two opposing forces, bureaucratic efficiency and productive efficiency. The effect of former is expected to be negative whilst the effect of latter is assumed to be positive. In the first period of life, individuals decide whether to acquire education or work for the home production, supplies skilled or unskilled labor in the middle-age and consumes in the third period. With more human capital the bureaucrats become efficient in context of reducing the cost of concealment by hiding their money as well as their identity as corrupt. The concealment costs are the costs associated with the corrupt bureaucrat that are necessary to incur for becoming indistinguishable to government and incurring the costs to hide the illegal money earned through stealing of government resources because if caught the money will be confiscated by the government as fine. In this manner human capital may have harmful effects on economic growth through increased bureaucratic stealing efficiency.

For example, higher human capital leads to higher bureaucratic efficiency which can be used to appropriate government resources (e.g. stealing) resulting in loss of government revenue and hence retarding the economic growth. On the flip side of the argument is the view that human capital may have positive effect on growth. For example increase in human capital may lead to higher production efficiency. As the individual is simultaneously working as well as acquiring education. Education has a direct positive effect on growth and it may further create positive externality to other co-workers by learning by doing and hence generating positive production effects of human capital. The effect of human capital on growth is contingent upon the relative shares of negative bureaucratic efficiency effects and positive production efficiency effects. If the negative bureaucratic efficiency effects surpass the positive production efficiency effects then in nutshell the human capital may retard or even have negative effects on growth.

1.4. Basic Framework

Time is discrete and indexed by t = 0…∞. All the agents live for three-periods with constant population and belong to overlapping generations (OLG) of dynastic families. The agents of each generation are divided into two groups of citizens- households (or workers), of whom there is a fixed proportion of m, and bureaucrats (or civil servants), of whom there is a fixed proportion of $n < m$. We suppose that all individuals are born with one unit of labour endowment, and among them bureaucrats and unskilled workers are exempt from paying tax. Taxes are lump sum and are collected by bureaucrats who are held responsible for the administration of the public policy, which requires funding for public expenditures.

Households work for firms in the production of output in return for wage rate while bureaucrats work for government in implementing the public policy in return for salary. Public policy comprises of a package of taxes and expenditures designed to provide public goods and services which contribute to the efficiency of output production. Corruption arises from the incentive of bureaucrat to appropriate (steal) public resources thereby reducing the provision of public services. We assume that a fraction, $v \in (0, 1)$, of bureaucrats are corruptible while the remaining fraction, $1 - v$, are non-corruptible, with unobservable identity of the bureaucrats by government. All agents are risk neutral, acquiring education or working for home production when young, only working (skilled/unskilled) in the middle-age and consuming when old. All markets are perfectly competitive.

1.4.1. The Government and Public Services

We consider the role of government as providing public goods and services which function as inputs to private production (e.g., Barro 1990). The government expenditures comprise of public goods (services) and bureaucrats' salaries. Any bureaucrat (corruptible or non-corruptible) can work for a firm by supplying one unit of labour to receive a non-taxable income equal to the market wage paid to households. Any bureaucrat who is willing to accept a salary less than this wage must be expecting to gain through appropriation (stealing) of public resources and is immediately identified as being corrupt. As in other analyses (e.g., Acemoglu and Verdier 1998; Blackburn et al. 2006; Blackburn and Forgues-Puccio 2005), we assume that a bureaucrat who is discovered to be corrupt is subject to the maximum fine of having all of his legal income (salary) confiscated (i.e., he is fired without pay). Given this, no corruptible bureaucrat would ever expose himself in the way as discussed earlier. The government ensures complete bureaucratic participation and minimizes its costs by setting the salaries of all bureaucrats equal to the wage paid by firm to the households.

We assume that one unit of public spending is transformed into one unit of productive public service. Each bureaucrat is provided with public fund g. If the bureaucrat does not steal the fund, then he spends the whole amount that he has been allocated. In the case where all bureaucrats decide not to be corrupt (i.e., not to steal), then government can provide total public services that are equal to $\hat{G} = n$g. Conversely, if all the bureaucrats steal a fraction, $\theta < 1$, of public fund that they are responsible for, then the total productive public services in the economy would be equal to $\tilde{G} = (1 - v\theta)n$g, where '$\theta$' is proportion of government resources stolen by the corrupt bureaucrats and lies between 0 and 1.

The government in each period finances its expenditures by running a continuously balanced budget. Its revenue consist of taxes collected from households, plus any fine imposed on bureaucrats' who are discovered engaging in corruption. We assume that the households are endowed with $\lambda > 1$ units of labor and are liable to taxation, while the bureaucrats are endowed with only one unit of labor and are exempt from paying tax. We denote τ_{t+1} the lump-sum tax levied on each household in the middle age of their life. We assume that government knows about the amount of tax revenue in absence of corruption (as it knows the number of households), any shortfall of public funds below this amount reveals that some funds are being misappropriated as considered in Blackburn and Forgues-Puccio (2005). Under this scenario, the government investigates the behaviour of bureaucrats using costly monitoring technology which is positive function of the human capital accumulated by the corrupt bureaucrats. This technology entails d units of additional resources and implies that a bureaucrat who is corrupt faces a probability, $p \in (0, 1)$, of being caught, and a probability, $1 - p$, of avoiding detection. We assume that government incurs higher monitoring costs when bureaucrats are educated as compared to the case when they are not educated. The more educated bureaucrats posses more stealing efficiency than the less or uneducated bureaucrats and hence the monitoring costs to the government increases with education of bureaucrats.

1.4.2. Households

Each household of generation t saves all of its income to acquire a final wealth of x_{t+2} when it reaches old-age. Households consume part of this wealth and bequeath the remainder to its offspring (i.e., is altruistic). Its lifetime utility is defined as, $U_t = x_{t+2} - b_{t+2} + u(b_{t+2})$, where $x_{t+2} - b_{t+2}$ is consumption, $b_{t+2}$is the bequest and $u(.)$ is a strictly concave function that satisfies the usual Inada conditions. The utility is maximized by setting $u'(.) = 1$, implying an optimal fixed size of bequest from one generation to the next that is $b_{t+2} = b$ for all t. The expected utility of a household is determined when its expected wealth is determined.

Each household when young has an option to acquire education and supply skilled labor (i.e., $H_{t+1} = (1 + h_{t+1})l_{t+1}$) in the middle age of his life or engage in home production and supply raw labor in the middle age of his life. Every household receives bequest b_t and is liable to pay lump-sum taxes of τ_{t+1}. Household saves its entire net income$(1 + r^e)b + \lambda(1 + h_{t+1})w_{t+1}^e - \tau_{t+1}$ if educated, or, $(1 + r^{ne})(b + \lambda\overline{w}) + \lambda w_{t+1}^{ne} - \tau_{t+1}$ if not educated, in order to finance retirement consumption and bequests to its own offspring.

We assume that the household derives linear utility from consumption and makes bequests according to the warm-glow/joy–of-giving motive. The lifetime utility of the household who acquire education and supply skilled labor is given as, $u_t^{h,e} = [(1 + r^e)b + \lambda(1 + h)w_{t+1}^e - \tau_{t+1}^e](1 + r^e) - b + v(b)$ while the lifetime utility for the household who do not acquire education and supply raw labor is, $u_t^{h,ne} = [(1 + r^{ne})(b + \lambda\overline{w}) + \lambda w_{t+1}^{ne} - \tau_{t+1}^{ne}](1 + r^{ne}) - b + v(b)$, the utility is maximized by setting $v'(.) = 1$, implying an optimal fixed size of bequest from one generation to the next: that is $b_{t+2} = b$ for all t, where $v(.)$ is strictly concave function that satisfies the usual Inada conditions.

1.4.3. Bureaucrats

Each bureaucrat of generation t saves all of its income to acquire a final wealth of x_{t+2} when it reaches old-age. For convenience, we assume that a bureaucrat consume all of this wealth (i.e., is non-altruistic), derive lifetime utility of $V_t = x_{t+2}$. As earlier, a bureaucrat's expected utility is fully determined when his expected wealth is determined.

Each bureaucrat when young is endowed with one unit of labor, which he uses either to acquire education and accumulates human capital, $H_{t+1} = (1 + h_{t+1})l_{t+1}$ in the middle age of his life or works for the home production when young and supplies raw labor in the middle age of the life. The bureaucrats are designated as the role of as an agent for the government in the administration of the public policy. In performing this role, a bureaucrat is delegated with the responsibility for controlling the public funds. It is due to this designation of authority that corruption might occur as the bureaucrat may be interested to appropriate (steal) some of the public funds for himself. As indicated earlier, we assume that there are some public officials who are corruptible in this way, and others who are non-corruptible.

By definition a bureaucrat who is non-corruptible is never corrupt and will never participate in the appropriation (stealing) of public funds. The final wealth of such a bureaucrat is w_{t+1}^{e}if educated and $(1 + r^{ne})\overline{w} + w_{t+1}^{ne}$ if not educated. In contrast, a bureaucrat who is corruptible may or may not comply with the rules of public office. If he does, then his income is w_{t+1}^{e} if educated and $(1 + r^{ne})\overline{w} + w_{t+1}^{ne}$ if not educated, as before. If he does not, then his income is uncertain and depends on the amount of fund he appropriates, the chances of being caught and the penalties incurred if he is exposed. Such a bureaucrat engages in appropriation of public funds. Although the bureaucrat receives g in public funds, he spends and provides the economy with $(1 - \theta)$g amount of public services. Thus 'θg' is the amount of funds that a bureaucrat may appropriate. The corrupt individuals may try to remain unobtrusive by concealing their illegal income in hiding if he is not being caught. In this way, the bureaucrat is assured of retaining illegal income whether he is caught or not and loses only his legal income when caught. By doing so, he can make sure that he can consume this illegal income when he is old. Due to the imprecise government monitoring with probability p, the bureaucrat may get caught and punished for his legal income (i.e., salary) and left with only the illegal income.

With probability $(1-p)$, the individual escapes detection and mange to save the amount $(1-p)[w_{t+1}^{e}+\theta \mathrm{g}-C^{e}]$ if educated and $(1-p)[(1+r^{ne})\overline{w}+w_{t+1}^{ne}+\theta \mathrm{g}-C^{\mathrm{ne}}]$ if not educated. Where 'C' is the cost of concealment a corrupt bureaucrat has to incur for hiding the amount he appropriated from public funds. We assume that the act of being corrupt is not entirely costless, but entails some disutility for the individual. For example, a bureaucrat may need to spend some resources for concealing his illegal activities. It is plausible to imagine that these costs are directly proportional to the appropriated fund and inversely related to the level of human capital. Thus the cost of concealment to the corrupt bureaucrat is $C^{e}=[1-\phi(1+h)]\theta \mathrm{g}$ if educated and $C^{ne}=[1-\phi]\theta \mathrm{g}$ if not educated. Accordingly, his income when educated and non-corruptible is $(1+h)w_{t+1}^{e}$ while that of corruptible is $\theta \mathrm{g}-C^{e}$ with probability p, and $[w_{t+1}^{e}+\theta \mathrm{g}-C^{e}]$ with probability $(1-p)$, implying an expected income of $[(1-vp)w_{t+1}^{e}+\theta \mathrm{g}-C^{e}]$ or $[(1-vp)w_{t+1}^{e}+\phi(1+h)\theta \mathrm{g}]$. Similarly, the income of non-corruptible bureaucrat when not educated is $(1+r)\overline{w}+w_{t+1}^{ne}$ while that of corruptible is $(1+r^{ne})\overline{w}+\theta \mathrm{g}-C^{\mathrm{ne}}$ with probability p, and $[(1+r^{ne})\overline{w}+w_{t+1}^{ne}+\theta \mathrm{g}-C^{\mathrm{ne}}]$ with probability $(1-p)$, implying an expected income of $[(1+r^{ne})\overline{w}+(1-vp)w_{t+1}^{ne}+\theta \mathrm{g}-C^{\mathrm{ne}}]$ or $[(1+r^{ne})\overline{w}+(1-vp)w_{t+1}^{ne}+\phi\theta \mathrm{g}]$.

1.4.4. Firms

The representative firm combines $(1 + h_{t+1})l_{t+1}$units of skilled labor with k_{t+1} units of capital to produce y^e_{t+1} units of output according to

$$y^e_{t+1} = A[(1 + h_{t+1})l_{t+1}]^\alpha k^{1-\alpha}_{t+1} K^\alpha_{t+1} G^\alpha \tag{1.1}$$

(A > 0, α∈(0,1)) where K_{t+1} denotes the aggregate stock of capital. The firm hires labour from households at the competitive wage rate w_{t+1} and rents capital from all agents at the competitive interest rate r_{t+1}. Firm uses the economy-wide capital as in Romer (1986) and productive public good as in Barro (1990). Profit maximization implies that wage, $w^e_{t+1} = \alpha A(\lambda m)^{\alpha-1}(1 + h_{t+1})^\alpha k_{t+1} G^\alpha$. Since $l_{t+1} = l = \lambda m$ and $k_t = K_t$, we may write these conditions as

$$w^e_{t+1} = \alpha A(\lambda m)^{\alpha-1}(1 + h_{t+1})^\alpha k_{t+1} G^\alpha \tag{1.2}$$

$$r^e_{t+1} = (1 - \alpha)A(\lambda m)^\alpha (1 + h_{t+1})^\alpha G^\alpha \tag{1.3}$$

Similarly, the representative firm combines l_{t+1} units of raw labor with k_{t+1}units of capital to produce y^e_{t+1}units of output according to

$$y^{ne}_{t+1} = A l^\alpha_{t+1} k^{1-\alpha}_{t+1} K^\alpha_{t+1} G^\alpha \tag{1.4}$$

Profit maximization implies that the wage rate and interest rate is given as,

$$w^{ne}_{t+1} = \alpha A(\lambda m)^{\alpha-1} k_{t+1} G^\alpha \tag{1.5}$$

$$r^{ne}_{t+1} = (1 - \alpha)A(\lambda m)^\alpha G^\alpha \tag{1.6}$$

1.4.5. The Incentive to be Corrupt

A corruptible bureaucrat will appropriate public funds if his expected utility is from doing so is no less than his utility from not doing so. From the preceding analysis, we may write this condition for an economy with education as $E\left(\tilde{z}_{t+2}^{b,e}\right) \geq E\left(\hat{z}_{t+2}^{b,e}\right)$ if educated or $E\left(\tilde{z}_{t+2}^{b,ne}\right) \geq E\left(\hat{z}_{t+2}^{b,ne}\right)$ if not educated

The above conditions can also be written as

$$[(1-p)w_{t+1} + \phi(1+h)\theta \mathrm{g}](1+r_{t+2}) \geq w_{t+1}(1+r_{t+2}) \tag{1.7}$$

and

$$[(1+r)\bar{w} + (1-p)w_{t+1} + \phi\theta \mathrm{g}](1+r_{t+2}) \geq [(1+r)\bar{w} + w_{t+1}](1+r_{t+2}) \tag{1.8}$$

Rearranging,

$$pw_{t+1} \leq \phi(1+h)\theta \mathrm{g} \tag{1.9-a}$$

$$pw_{t+1} \leq \phi\theta \mathrm{g} \tag{1.9-b}$$

Intuitively, a bureaucrat is more likely to corrupt the more he expects to gain in illegal income if he evades the detection. The key feature of the incentive condition (1.9) is that it depends on the economy-wide variable w_{t+1}. The wage is determined by current event in the economy, which in turn is a function of the aggregate level of corruption. This reflects that higher wages of the agents imply higher costs to bureaucrats if they are caught. This means that the motivation for each corruptible bureaucrat to be corrupt depends on the number of other bureaucrats who are expected to be corrupt. Consequently, bureaucratic decision-making entails strategic interactions, which may result in multiple equilibria. We begin to explore this possibility by studying the incentive of an individual corruptible bureaucrat to be corrupt under two alternative scenarios- one in which no other bureaucrat is corrupt and the other in all other bureaucrats are corrupt. Recall in equilibrium, $l_{t+1} = l = \lambda m$ and from (1.2), we have $w_{t+1}^{e} = \alpha A(\lambda m)^{\alpha-1}(1+h_{t+1})^{\alpha} k_{t+1} G^{\alpha}$. Thus as mentioned earlier, w_{t+1} is determined by the level of capital stock, $k_{t+1}$and by the total public service, G, both of which are determined by the aggregate level of corruption.

Equation (1.9-a) can be used to determine the critical level of capital for an economy with education as

$$\phi(1+h)\theta \mathrm{g} \geq p\alpha A(\lambda m)^{\alpha-1}(1+h_{t+1})^{\alpha} k_{t+1} G^{\alpha}$$

or

$$k_{t+1}^{e} \leq \frac{\phi(1+h)\theta \mathrm{g}}{p\alpha A(\lambda m)^{\alpha-1}(1+h)^{\alpha} G^{\alpha}} \cong \kappa^{e} \qquad (1.10)$$

Consider the case where no bureaucrat is corrupt. Total government expenditure on public good is $G = ng$, while the total public service obtained from this spending is $\hat{G} = n\mathrm{g}$. Under this situation, wage rate is $\hat{w}_{t+1}^{e} = \alpha A(\lambda m)^{\alpha-1}(1+h_{t+1})^{\alpha}(n\mathrm{g})^{\alpha} k_{t+1}$ and the incentive condition in (1.9-a) becomes

$$\phi(1+h)\theta \mathrm{g} \geq p\alpha A(\lambda m)^{\alpha-1}(1+h_{t+1})^{\alpha} k_{t+1} (n\mathrm{g})^{\alpha}$$

or,

$$\hat{k}_{t+1}^{e} \leq \frac{\phi(1+h)\theta \mathrm{g}}{p\alpha A(\lambda m)^{\alpha-1}(1+h)^{\alpha}(n\mathrm{g})^{\alpha}} \cong \hat{\kappa}^{e} \qquad (1.11)$$

For the case in which bureaucrats are corruptible, the total productive services in the economy will be, $\tilde{G} = n[v(1-\theta)\mathrm{g} + (1-v)\mathrm{g}] = (1-v\theta)n\mathrm{g}$, under such situation, the wage rate in (1.2) is $\tilde{w}_{t+1}^{e} = \alpha A(\lambda m)^{\alpha-1}(1+h_{t+1})^{\alpha}(1-v\theta)^{\alpha}(n\mathrm{g})^{\alpha} k_{t+1}$ and the incentive condition in (1.9-a) becomes

$$\phi(1+h)\theta \mathrm{g} \geq p\alpha A(\lambda m)^{\alpha-1}(1+h_{t+1})^{\alpha} k_{t+1} (1-v\theta)^{\alpha}(n\mathrm{g})^{\alpha}$$

or,

$$\tilde{k}_{t+1}^{e} \leq \frac{\phi(1+h)\theta \mathrm{g}}{p\alpha A(\lambda m)^{\alpha-1}(1+h_{t+1})^{\alpha}(1-v\theta)^{\alpha}(n\mathrm{g})^{\alpha}} \cong \tilde{\kappa}^{e} \qquad (1.12)$$

We may observe that, since $\theta < 1$, it is easily verifiable that $\tilde{w}_{t+1}^{e} < \hat{w}_{t+1}^{e}$: that is, for any given stock of capital, k_{t+1} wages are lower under corruption than under non-corruption.

Similarly, the incentive condition in an economy with no education as given in (1.9-b) can be written as

$$p\alpha A(\lambda m)^{\alpha-1}k_{t+1}G^{\alpha} \leq \phi\theta \mathrm{g}$$

or,

$$k_{t+1}^{ne} \leq \frac{\phi\theta \mathrm{g}}{p\alpha A(\lambda m)^{\alpha-1}G^{\alpha}} \cong \kappa^{ne} \quad (1.13)$$

As discussed earlier, the case where no bureaucrat is corrupt. Total government expenditure on public good is $G = ng$, while the total public service obtained from this spending is $\hat{G} = n\mathrm{g}$. Under this situation, wage rate is $\widehat{w}_{t+1}^{ne} = \alpha A(\lambda m)^{\alpha-1}(n\mathrm{g})^{\alpha}k_{t+1}$ and the incentive condition in (1.9-b) becomes

$$p\alpha A(\lambda m)^{\alpha-1}k_{t+1}(n\mathrm{g})^{\alpha} \leq \phi\theta \mathrm{g}$$

$$\hat{k}_{t+1}^{ne} \leq \frac{\phi\theta \mathrm{g}}{p\alpha A(\lambda m)^{\alpha-1}(ng)^{\alpha}} \cong \hat{\kappa}^{ne} \quad (1.14)$$

Also in case of the economy with education, in the case in which bureaucrats are corruptible, the total productive services in the economy will be, $\tilde{G} = n[v(1-\theta)\mathrm{g} + (1-v)\mathrm{g}] = (1-v\theta)n\mathrm{g}$, under such situation, the wage rate in (1.5) is $\widetilde{w}_{t+1}^{ne} = \alpha A(\lambda m)^{\alpha-1}(1-v\theta)^{\alpha}(n\mathrm{g})^{\alpha}k_{t+1}$ and the incentive condition in (1.9-b) becomes

$$p\alpha A(\lambda m)^{\alpha-1}k_{t+1}\big((1-v\theta)n\mathrm{g}\big)^{\alpha} \leq \phi\theta \mathrm{g}$$

or,

$$\tilde{k}_{t+1}^{ne} \leq \frac{\phi\theta \mathrm{g}}{p\alpha A(\lambda m)^{\alpha-1}\big((1-v\theta)ng\big)^{\alpha}} \cong \tilde{\kappa}^{ne} \quad (1.15)$$

1.4.6. Equilibrium

The preceding analysis identifies the conditions for an individual bureaucrat to be corrupt, given that all other bureaucrats are corrupt or not. It is also observed that the incidence of the aggregate level of corruption affects aggregate economic outcomes such as wages and public services. We know proceed to determine whether or not corruption forms part of equilibrium depends on the level of development of the economy.

The essential conditions for determining equilibrium behaviour are given in (1.11), (1.12), (1.14) and (1.15) and shown in figure (1.1). It is evident that in both non-corrupt and corrupt environment the critical value of capital with no education is higher than the critical value of capital with education (i.e., $\hat{\kappa}^{e} < \hat{\kappa}^{ne}$ and $\tilde{\kappa}^{e} < \tilde{\kappa}^{ne}$ as $\hat{w}^{e}_{t+1} > \hat{w}^{ne}_{t+1}$ & $\tilde{w}^{e}_{t+1} > \tilde{w}^{ne}_{t+1}$).

It is also evident that in both cases when bureaucrats are educated or uneducated, the critical level of capital under no corruption will be smaller than under corruption (i.e., $\hat{\kappa}^{e} < \tilde{\kappa}^{e}$ and $\hat{\kappa}^{ne} < \tilde{\kappa}^{ne}$ as $\tilde{w}^{e}_{t+1} < \hat{w}^{e}_{t+1}$ & $\tilde{w}^{ne}_{t+1} < \hat{w}^{ne}_{t+1}$).

Finally, it is revealed that the critical value of capital in a corrupt environment is higher than the non-corrupt environment when bureaucrats are educated as $\hat{w}^{e}_{t+1} > \tilde{w}^{e}_{t+1}$. It implies that the economy with all educated and all corrupt would provide more incentive for an individual to be corrupt than under the economy with all educated but all non-corrupt bureaucrats.

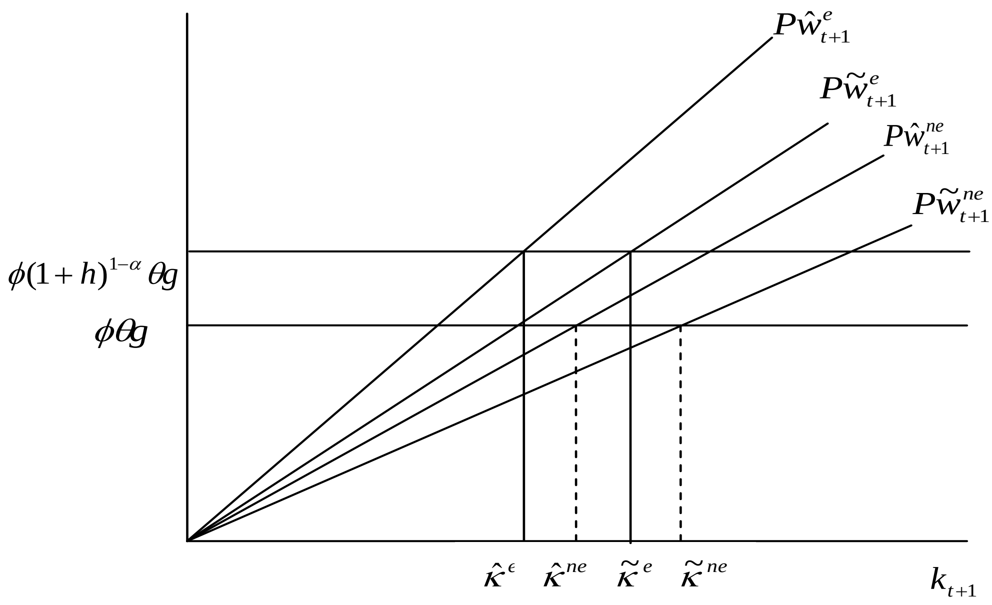

Figure (1.1): Corruption and Development

The interesting situation occurs in an economy with all educated and all corrupt the incentive condition for an individual to be corrupt may go either way and may provide more/less incentive for an individual to be corrupt than under an economy with all non-corrupt and non-educated. It may be true that some development region the sample of countries may assume the values of the parameter that indicate that $\hat{w}^{ne}_{t+1} > \tilde{w}^{e}_{t+1}$, implying that in an economy with all educated and all corrupt the incentive for an individual to be corrupt may provide more incentive for an individual to be corrupt than under the economy with all non-educated and all non-corrupt bureaucrats.

1.4.7. Public Finance

So far we have discussed the extent of corruption depends on the level of development but it is also true that the development process itself is affected by corrupt activity. This process is described by the path of capital accumulation that can be obtained from the equilibrium condition that the total demand for capital is equal to the total supply of savings. To study how corruption affects savings, it is essential to know how corruption affects public finances as the government's decides the level of taxes required to maintain balance budget. Recall that $v(1-v)$ is the fraction of bureaucrats who are corruptible (non-corruptible) and that $p(1-p)$ is the fraction of corrupt bureaucrats who fail (succeed) in evading detection.

Consider the economy with education when corruption is absent. The government obtains the tax revenue $m\tau_{t+1}$ which is used to finance its expenditures on public services $(n\text{g})$ and bureaucratic salaries$[n\widehat{w}_{t+1}^{e}]$.

$$m\hat{\tau}_{t+1}^{e} = n\text{g} + n\widehat{w}_{t+1}^{e} \tag{1.16}$$

While in an economy with no education and no corruption, the level of taxes in this case is therefore given as

$$m\hat{\tau}_{t+1}^{ne} = n\text{g} + n\widehat{w}_{t+1}^{ne} \tag{1.17}$$

Now consider the case in which corruption is present. We assume that there exists a fraction of corruptible (non-corruptible) bureaucrats $v(1-v)$ in the economy with probability $p(1-p)$ of being detected (escaped). The government investigates the activities of the corrupt bureaucrat by employing an imprecise monitoring technology that is increasing function of the human capital accumulated by the bureaucrats and is defined as $d^{e} = \gamma(1+h)n\text{g}$ under education and $d^{ne} = \gamma n\text{g}$ under no education. We suppose that government has to incur additional resources to monitor the corrupt bureaucrats if they are educated as compared to the bureaucrats with no education. Education increases the stealing efficiency of the corrupt bureaucrats and allows them to reduce the concealment costs and hence it also increases the monitoring costs to the government.

The tax revenue of the government $(m\tau_{t+1})$ is used to finance the expenditures on public services $(n\mathrm{g})$, the salaries of the fraction of non-corrupt bureaucrats $[n(1-v)w^{e}_{t+1}]$, the salaries of the corruptible bureaucrats who escape detection $[n(1-p)vw^{e}_{t+1}]$ and the monitoring cost (d).

$$m\tilde{\tau}^{e}_{t+1} = n(1-vp)\widetilde{w}^{e}_{t+1} + n\mathrm{g} + \gamma(1+h)n\mathrm{g} \tag{1.18}$$

The level of taxes in an economy with no education and corruption is

$$m\tilde{\tau}^{ne}_{t+1} = n(1-vp)\widetilde{w}^{ne}_{t+1} + n\mathrm{g} + \gamma n\mathrm{g} \tag{1.19}$$

A comparison of (1.16)-(1.18) and (1.17)-(1.19) reveals that for any given w_{t+1} and G, taxes are higher in a corrupt environment than in non-corrupt environment. This is true because corruption leads to loss of public resources and increase in government expenditure.

1.5. Capital Accumulation Under no-education

The capital accumulation in the economy with no education, k_{t+2}^{ne}, is equal to the total savings of households plus total savings of bureaucrats which depends on whether corruption exists or not as discussed earlier. In the absence of corruption, each household saves $(1+\hat{r}^{ne})(b+\lambda\overline{w})+\lambda\widehat{w}_{t+1}^{ne}-\hat{\tau}_{t+1}^{ne}$ and each bureaucrat saves $(1+\hat{r}^{ne})\overline{w}+\widehat{w}_{t+1}^{ne}$, implying total savings in an economy with no education and no corruption, $\hat{s}_{t+1}^{ne}=m(1+\hat{r}^{ne})(b+\lambda\overline{w})+\lambda m\widehat{w}_{t+1}^{ne}-m\hat{\tau}_{t+1}^{ne}+n(1+\hat{r}^{ne})\overline{w}+n\widehat{w}_{t+1}^{ne}$.

In the presence of corruption, households save $(1+\tilde{r}^{ne})(b+\lambda\overline{w})+\lambda\widetilde{w}_{t+1}^{ne}-\tilde{\tau}_{t+1}^{ne}$ while non-corruptible bureaucrats' saves $[(1+r)\overline{w}+w_{t+1}^{ne}]$ and corruptible bureaucrat saves either $[(1+r)\overline{w}+\theta\mathrm{g}-C^{\mathrm{ne}}]$ with probability p of being detected or $[(1+r)\overline{w}+w_{t+1}^{ne}+\theta\mathrm{g}-C^{\mathrm{ne}}]$ with probability $(1-p)$ of avoiding the detection, the total savings of the bureaucrats equals $(1+r)\overline{w}+(1-vp)w_{t+1}^{ne}+v\phi\theta\mathrm{g}$. Combining the savings of households and bureaucrats the total savings in an economy with no education and corruption ($i.e.$, $\tilde{s}_{t+1}^{ne}$) are given as $m(1+\tilde{r}^{ne})(b+\lambda\overline{w})+\lambda m\widetilde{w}_{t+1}^{ne}-m\tilde{\tau}_{t+1}^{ne}+n(1+r)\overline{w}+n(1-vp)\widetilde{w}_{t+1}^{ne}+nv\phi\theta\mathrm{g}$.

These results can be used to determine two alternative paths of capital accumulation. We recall the expression for $\widehat{w}_{t+1}^{ne},\widetilde{w}_{t+1}^{ne},m\hat{\tau}_{t+1}^{ne}$ and $m\tilde{\tau}_{t+1}^{ne}$ from (1.5), (1.17) and (1.19). The capital accumulation in the absence of corruption and education is described by

$$\hat{k}_{t+2}^{ne}=\alpha Bk_{t+1}+[1+(1-\alpha)B][mb+(\lambda m+n)\overline{w}]-n\mathrm{g} \tag{1.20}$$

Where $B=A(\lambda m)^{\alpha}(n\mathrm{g})^{\alpha}$.

The capital accumulation in the presence of corruption and no education is obtained by combining the savings of households and bureaucrats as given below

$$\tilde{k}_{t+2}^{ne}=\alpha(1-v\theta)^{\alpha}Bk_{t+1}+[1+(1-\alpha)(1-v\theta)^{\alpha}B][mb+(\lambda m+n)\overline{w}] \\ -n\mathrm{g}-(\gamma-v\phi\theta)n\mathrm{g} \tag{1.21}$$

Where $B=A(\lambda m)^{\alpha}(n\mathrm{g})^{\alpha}$.

The equations (1.20) and (1.21) exhibit the stationary points associated with the steady state levels of capital as

$$\hat{k}^{ne^*} = \frac{[1+(1-\alpha)B][mb+(\lambda m+n)\bar{w}]-n\mathrm{g}}{(1-\alpha B)}$$

and

$$\tilde{k}^{ne^*} = \frac{[1+(1-\alpha)(1-v\theta)^{\alpha}B][mb+(\lambda m+n)\bar{w}]-n\mathrm{g}-(\gamma-v\phi\theta)n\mathrm{g}}{[1-\alpha(1-v\theta)^{\alpha}B]}$$

It is quite obvious that $\tilde{k}^{ne^*} < \hat{k}^{ne^*}$ for any given k_t. The capital accumulation is lower under no-education and corruption than under no-education and no-corruption. It shows that corruption has detrimental effect on economic development. The results suggest that corruption and development is negatively related and there exist multiple development regimes and multiple long run equilibrium. The incentive condition to be corrupt defines the corruption occurs for any level of capital, k_t, below (above) the critical level, κ^{ne}. Under such conditions, the economy is in a low (high) development regime. For a given initial capital stock $k_0 < \kappa^{ne}$, the final outcome of the economy depends whether $\kappa^{ne} < \tilde{k}^{ne^*}$ or $\kappa^{ne} > \tilde{k}^{ne^*}$.

We explain this in figure (1.2) and (1.3). Assume that $\kappa^{ne} < \tilde{k}^{ne^*}$then the economy evolves along $\tilde{k}^{ne}_{t+2}$ until it reaches κ^{ne} and then it approaches $\hat{k}^{ne}_{t+2}$ and reaches $\hat{k}^{ne^*}$. This process describes the process of transition from the low development regime with high corruption to the high development regime with low corruption. Now consider $\kappa^{ne} > \tilde{k}^{ne^*}$, the economy is locked forever on $\tilde{k}^{ne}_{t+2}$, converging forever towards to $\tilde{k}^{ne^*}$. In this case there is no transition and the economy remains poor and corrupt forever.

1.6. Capital Accumulation with education

Like before, he capital accumulation in the economy, k_{t+2}^{e}, is equal to the total savings of households plus total savings of bureaucrats which depends on whether corruption exists or not. In the absence of corruption, each household saves $(1+\hat{r}^{e})b+\lambda\widehat{w}_{t+1}^{e}-\hat{\tau}_{t+1}^{e}$ and each bureaucrat saves $\widehat{w}_{t+1}^{e}$, implying total savings in an economy with education and no corruption, $\hat{k}_{t+2}^{e}=m(1+\hat{r}^{e})b+\lambda m\widehat{w}_{t+1}^{e}-m\hat{\tau}_{t+1}^{e}+n\widehat{w}_{t+1}^{e}$.

In the presence of corruption, savings of households are $(1+\tilde{r}^{e})b+\lambda\widetilde{w}_{t+1}^{e}-\tilde{\tau}_{t+1}^{e}$ while each non-corruptible bureaucrat saves $\widetilde{w}_{t+1}^{e}$ and corruptible bureaucrat saves either $\theta\text{g}-C^{\text{e}}$ with probability p of being detected or $w_{t+1}^{e}+\theta\text{g}-C^{e}$ with probability $(1-p)$of avoiding the detection, implying total savings in an economy with education, $s_{t+2}^{e}=m(1+\tilde{r}^{e})b+\lambda m\widetilde{w}_{t+1}^{e}-m\tilde{\tau}_{t+1}^{e}+n(1-vp)\widetilde{w}_{t+1}^{e}+nv\phi(1+h)\theta\text{g}$.

These results can be used to determine two alternative paths of capital accumulation. Using equation (1.2) and (1.16), the capital accumulation in the absence of corruption and education is described by

$$\hat{k}_{t+2}^{e}=\alpha B(1+h_{t+1})^{\alpha}k_{t+1}+[1+(1-\alpha)(1+h)^{\alpha}B]mb-n\text{g} \tag{1.22}$$

Where $B=A(\lambda m)^{\alpha}(n\text{g})^{\alpha}$.

The capital accumulation in the presence of corruption and education is described by

$$\tilde{k}_{t+2}^{e}=[1+(1-\alpha)B(1+h)^{\alpha}(1-v\theta)^{\alpha}]mb+[\alpha(1+h)^{\alpha}(1-v\theta)^{\alpha}Bk_{t+1}]$$
$$-n\text{g}-(1+h)(\gamma-v\phi\theta)n\text{g} \tag{1.23}$$

Where $B=A(\lambda m)^{\alpha}(n\text{g})^{\alpha}$.

The equations (1.22) and (1.23) exhibit the stationary points associated with the steady state levels of capital

$$\hat{k}^{e^*} = \frac{[1 + (1-\alpha)(1+h)^{\alpha}B]mb - n\text{g}}{[1 - \alpha B(1+h)^{\alpha}]}$$

and

$$\tilde{k}^{e^*} = \frac{[1 + (1-\alpha)B(1+h)^{\alpha}(1-v\theta)^{\alpha}]mb - n\text{g} - (1+h)(\gamma - v\phi\theta)n\text{g}}{[1 - \alpha(1+h)^{\alpha}(1-v\theta)^{\alpha}B]}$$

Like the earlier case with no education, $\tilde{k}^{e^*} < \hat{k}^{e^*}$for any given k_t. The capital accumulation is lower under an economy with education and corruption than under the economy with education non-corruption. Thus corruption continues to impede capital accumulation and growth. The effect of corruption is greater under current circumstances with education.

With education the loss of resources is higher as bureaucrat acquires more skills to steal and government has to incur high monitoring costs. In this way, human capital defined as the education increases bureaucratic stealing efficiency and may depress economic growth if the negative bureaucratic stealing effect of human capital exceeds the positive productivity enhancing effect. Our results are consistent with the recent empirical findings of Rogers (2008) which notes the adverse effect of human capital on economic growth for the sample of high corrupt countries as compared to the sample of low corrupt countries. The relationship between corruption and development remains negative as there exist multiple development regimes and multiple long run equilibria. For any capital stock, k_t, below (above) the critical level, κ^e, the economy is in a low (high) development regime and displaying a high (low) incidence of corruption. For a given initial capital stock $k_0 < \kappa^e$, the transition between regimes may or may not be feasible depending on the final outcome of the economy whether $\kappa^e < \tilde{k}^{e^*}$ or $\kappa^e > \tilde{k}^{e^*}$. In the case of the latter, initial conditions determines the outcome defined as the poverty trap equilibrium.

1.7. Education, Corruption and Growth: An Evaluation

The results obtained hitherto show how the corruptness and education of an economy might be important factors in explaining various outcomes. The result also suggest that the effect of corruption depend on whether or not the economy has acquired education, while the effects of education (human capital) depends whether or not the economy is corrupt.

The capital accumulation in equations (1.20), (1.21), (1.22) and (1.23) suggests $\hat{\Omega}^e > \hat{\Omega}^{ne}$, $\hat{\Omega}^e > \tilde{\Omega}^e$, $\tilde{\Omega}^e > \tilde{\Omega}^{ne}$, $\hat{\Omega}^{ne} > \tilde{\Omega}^{ne}$ (as $(1+h)^{1+\alpha} > 1$ and $(1-v\theta) < 1$) and $\hat{\Omega}^e > \tilde{\Omega}^{ne}$(as $\hat{\Omega}^e > \hat{\Omega}^{ne}$ and $\hat{\Omega}^{ne} > \tilde{\Omega}^{ne}$). It shows that $\hat{\Omega}^e > \hat{\Omega}^{ne} > \tilde{\Omega}^e > \tilde{\Omega}^{ne}$. The comparison of intercepts show that $\hat{I}^e < \hat{I}^{ne}$ if $(\lambda m + n)\bar{w} > mb[(1+h)^\alpha - 1]$ suggesting that when there is no capital, still the unskilled individuals have opportunity to earn home wage and also that at low level of capital, unskilled workforce starts with higher income. Also $\hat{I}^e > \tilde{I}^e$ (as $(1-v\theta) < 1$ and $(\gamma - v\phi\theta) > 0$), $\hat{I}^{ne} > \tilde{I}^e$(as $\hat{I}^{ne} > \hat{I}^e > \tilde{I}^e$), $\hat{I}^{ne} > \tilde{I}^{ne}$, $\tilde{I}^{ne} > \tilde{I}^e$, $\hat{I}^e > \tilde{I}^{ne}$ (as $\hat{I}^e < \hat{I}^{ne}$, $\hat{I}^{ne} > \tilde{I}^e$ and $\tilde{I}^{ne} > \tilde{I}^e$). The comparison of intercepts reveals that $\hat{I}^{ne} > \hat{I}^e > \tilde{I}^{ne} > \tilde{I}^e$.

Education has number of implications as the economy develops. First, it increases the efficiency of production, it causes the transition function to become steeper, irrespective of whether or not corruption exists (i.e., $\hat{k}^e_{t+2} > \tilde{k}^e_{t+2}$ and $\hat{k}^{ne}_{t+2} > \tilde{k}^{ne}_{t+2}$). Second, it increases the stealing efficiency of bureaucrats and also the monitoring costs incurred by the government, exacerbates the effect of corruption in the transition function downwards (i.e., $\tilde{I}^e < \tilde{I}^{ne}$).

In figures (1.2) we suppose that $\kappa^{ne} < \tilde{k}^{ne^*}$ implies that transition between development regimes is feasible in an economy under no education and $\tilde{k}^{e^*} < \tilde{k}^{ne^*}$ in figure (1.2) showing that the long-run equilibrium of a corrupt economy with education is worse than the long-run equilibrium of a corrupt economy under no education. Recalling the earlier discussion, we consider three cases - $\kappa^{ne} < \kappa^e < k_{t+1}$, $\kappa^{ne} < k_{t+1} < \kappa^e$ and $k_{t+1} < \kappa^{ne} < \kappa^e$.

Consider the first case $\kappa^{ne} < \kappa^{e} < k_{t+1}$, corruption is not an issue because the incentive condition of corruption is violated. Under such situation, the effect of education is to increase the efficiency of production thereby increasing growth. For any initial value of $k_0 < k_{t+1}$, the economy is on $\hat{k}^{ne}_{t+2}$ path, progressing towards $\hat{k}^{ne^*}$, the economy with education has the higher path $\hat{k}^{e}_{t+2}$ and converges towards $\hat{k}^{e^*}$. The results indicate that education in the absence of corruption is unambiguously good for economic growth.

For the case in which $\kappa^{ne} < k_{t+1} < \kappa^{e}$, corruption is not an issue for an economy with no education but becomes an issue for an economy with education because in the change in the incentive condition. In an economy with education, the bureaucrats now engage in the corrupt practices and the economy now achieves the transition path $\tilde{k}^{e}_{t+2}$. The final outcome depends whether $\kappa^{e} < \tilde{k}^{e^*}$or $\kappa^{e} > \tilde{k}^{e^*}$: if the former conditions holds then the incentive condition is reversed and economy moves back to $\hat{k}^{e^*}$ at κ^{e}, and approaches the $\hat{k}^{e^*}$, a situation with no corruption; if latter, then the economy remains on $\tilde{k}^{e}_{t+2}$ and converges towards $\tilde{k}^{e^*}$ describing a poverty trap equilibrium. These results show that education in the presence of bureaucratic corruption can be costly to economic growth.

Finally, for the case in which $k_{t+1} < \kappa^{ne} < \kappa^{e}$, corruption matters for both economies with and without education as the incentive condition for corruption is always satisfied. In the case of an economy with education, the bureaucratic stealing efficiency is enhanced. The economy is initially located on $\tilde{k}^{ne}_{t+2}$ with corruption. If there is no economy with education, then the economy progresses to $\hat{k}^{ne}_{t+2}$ at $\kappa^{ne}$and then converges to $\hat{k}^{ne^*}$ without corruption. By contrast, the economy with education causes a downward shift to $\tilde{k}^{e}_{t+2}$ with the final outcome being dependent on whether $\kappa^{e} < \tilde{k}^{e^*}$ or $\kappa^{e} > \tilde{k}^{e^*}$as mentioned earlier: in the case of former, the incentive condition reversals at $\kappa^{e}$and corruption disappears and capital accumulation progresses along $\hat{k}^{e}_{t+2}$ towards $\hat{k}^{e^*}$, in the latter case the economy remains on $\tilde{k}^{e}_{t+2}$and converges towards $\tilde{k}^{e^*}$with a poverty trap equilibrium. These results, like those earlier, show that education in the presence of corruption can have adverse effects on economic growth.

The foregoing analysis shows that bureaucratic corruption can be important factor in determining the impact of education on economic growth. It also indicates that corruption may rise in the presence of education as the bureaucratic stealing efficiency increases with education. We notice that although education has positive effect on economic growth in the absence of corruption but in the presence of corruption, education may not have significant effect on economic growth. In addition to the positive productivity enhancing effect of education, it may have negative impact on growth in the presence of corruption because education may enhance the stealing efficiency of the corrupt bureaucrats which may in turn have negative impact on economic growth. The total effect of education on growth is dependent on whether the positive productivity enhancing effect is stronger than the negative growth reducing effect by increasing the stealing efficiency of corrupt bureaucrats.

Figure (1.3) shows that corruption dampens the effect of education such that it causes the economy to reach at a steady-state which is lower than what the economy could reach at even without education while there is no corruption.

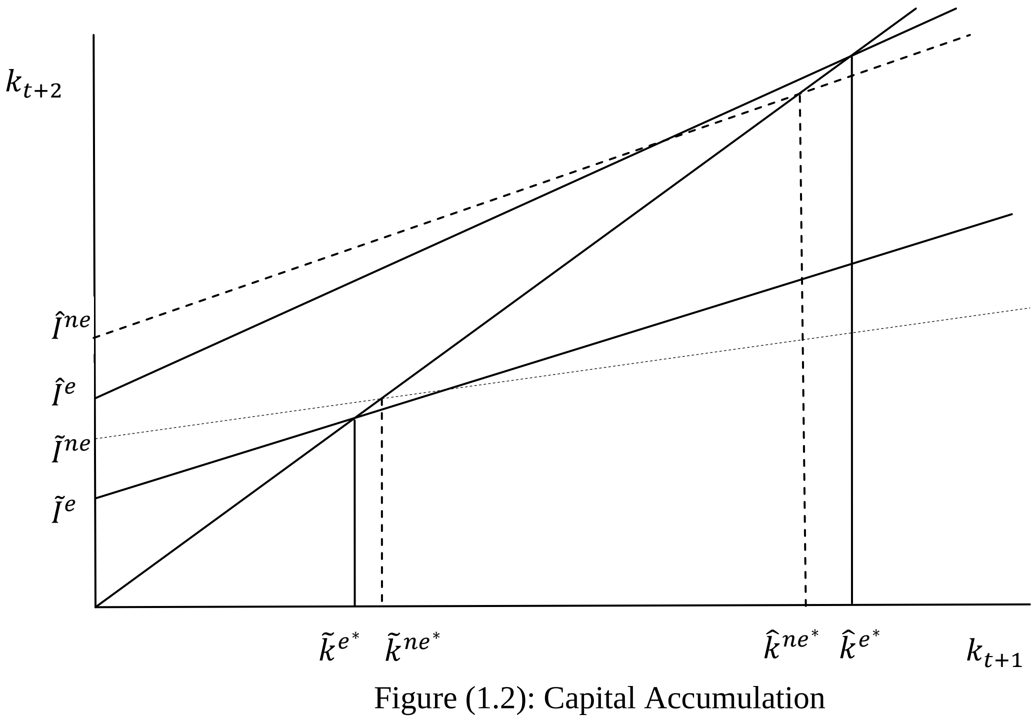

Figure (1.2): Capital Accumulation

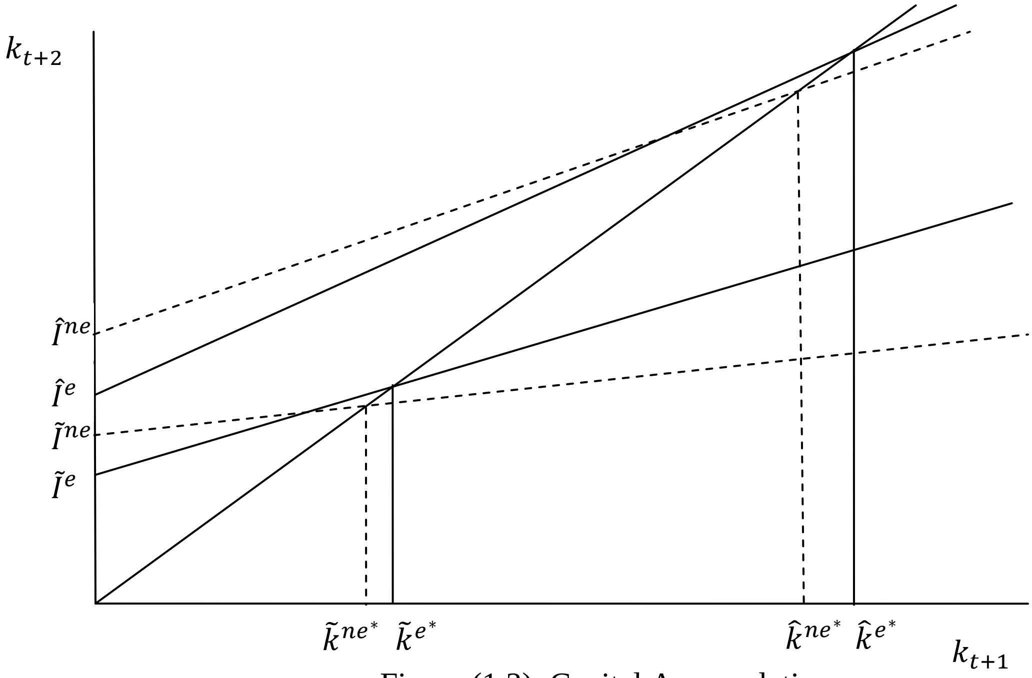

Figure (1.3): Capital Accumulation

1.8. Conclusion

The literature on the impact of human capital on economic growth often reports insignificant and even negative coefficient on human capital. Many researchers came up with alternative explanations including quality of data, econometric technique etc. According to our best of knowledge no study has introduced the role of governance in terms of corruption except the recent work by Rogers (2008). The cross sectional study by Rogers (2008) uses the corruption index only to obtain the sub-sample of high and low corrupt countries and suggest that the impact of human capital is higher in the sub-sample of low corrupt countries as compared to the sub-sample of high corrupt countries. There is no theoretical work explaining the link of corruption between human capital and growth. In this chapter we considered three period over-lapping generation model with two groups of agents- households and bureaucrats. The households pay lump-sum tax while the bureaucrats hold the public office and are responsible for taxation. Corruption arises through appropriation (stealing) of public funds by the bureaucrats.

We consider the dynamic general equilibrium model where the decision of corruptible bureaucrat affects the public finances and hence the capital accumulation in the economy. It is also shown that the human capital accumulated by the corrupt bureaucrat increases the stealing efficiency in terms of lower concealment costs. Our results are straightforward; the capital accumulation under education is always higher than the capital accumulation under no education no matter whether bureaucrat engage in corrupt activities or not, the most striking result is the comparison of the capital accumulation in an economy between corrupt and non-corrupt environment while all bureaucrats are educated. The results show that the capital accumulation under no corruption and education is higher than corruption and education.

Human capital has two opposing effects, positive productivity enhancing effect and negative stealing efficiency of corrupt bureaucrats. There may be some development regions where some sample of countries may observe a higher stealing efficiency of corruptible bureaucrats than the productive efficiency due to the accumulation of human capital, the net effect of which may result in the insignificant effect of human capital on growth.

CHAPTER TWO

HUMAN CAPITAL AND ECONOMIC GROWTH: ROLE OF CORRUPTION

2.1 Introduction

The Role of human capital in economic growth is well recognized in the growth literature. While theoretical literature is unambiguous on the important role of human capital on economic growth, the empirical literature remains largely inconclusive and often come out with weak effects of human capital on the growth process.

In the empirical literature, the unexpected results for the impact of human capital can be found in both cross sectional and panel data studies. Important cross sectional studies with disappointing results on the role of human capital on growth include Benhabib and Spiegel (1994) and Pritchett (2001). Similar evidence is also observed in panel data studies (Kumar, 2006; Bond, Hoeffler and Temple, 2001; Caselli, Esquivel and Lefort, 1996; Islam, 1995).

As a result of these findings, various authors have attempted to provide explanations for the puzzling effects of human capital on economic growth. One possible reason is measurement errors, as put forward by Krueger and Lindahl (2001). Other studies have also identified data quality as the primal cause of the weak effect of human capital in growth process (de la Fuente and Domenech, 2000 and 2002, Cohen and Soto, 2007, Bassanini and Scarpetta, 2001). Poor results have also been attributed to the use of inappropriate econometric approaches (Bassanini and Scarpetta, 2001, 2002; Freire-Serean, 2002).

The weak relationship between human capital and economic growth has also been explained by Temple (1999). He revisits the counterintuitive results found in Benhabib and Spiegel (1994) and highlights the existence of influential outliers in a sample of heterogeneous countries as the primal cause of poor results. The author suggests that one should focus on the more coherent part of the dataset by employing robust estimator of least trimmed squares (LTS) to identify the influential outliers. He applies LTS to a sample of 78 countries over 1965-1985, detects and eliminates 14 outliers and reports a positive and significant effect of human capital on economic growth. We build on theoretical chapter and provide the cross sectional analysis by introducing the explicit role of corruption.

In contrast to the above explanations for the puzzling relationship between human capital and economic growth, this study suggests an additional channel to investigate the contribution of human capital by highlighting the possible role of institutional efficiency measured by the level of corruption. Earlier papers have also used corruption in their overall measure of institution (see Mauro, 1995; Hall and Jones, 1999; Knack and Keefer, 1995; and many others). Cross-country differences in growth rates may be attributed to some combination of differences in technology, physical capital and human capital. The efficiency of these causes of growth depends on the country characteristics which may be affected by the institutional efficiency and policies in each country. These country characteristics in the form of differences in the policies and institutional efficiency result into different growth rates among nations. The literature on human capital and economic growth ignores differences in country characteristics by not taking into account the differences in institutional efficiency and policies across different nations. An important indicator of institutional inefficiency is corruption.

We suggest that the relationship between human capital (usually defined as the average years of schooling in the population over age 25) and economic growth is not straightforward and might be conditional in nature. More specifically, the effect of human capital on growth could be dependent on the level of corruption in the economy and may be explained by considering corruption and its interaction with schooling in growth equation. No study to date has provided a comprehensive examination of this issue. The only exception is the recent study by Rogers (2008), who divides the full sample of countries into sub-samples of high and low corruption countries and finds a significant and higher coefficient on schooling for the sample of low corruption countries as compared to the sample of high corruption countries.

The empirical analysis in the present study builds on Rogers (2008). Unlike Rogers, we introduce an explicit role of corruption and also for the channel through which corruption affects the relationship between human capital and economic growth. Our empirical strategy is innovative in this context that it uses all available information and does not require splitting the sample into two parts as done by the Rogers (2008), thereby resulting in a large sample size. In addition to the direct effects of schooling and corruption on growth, the conditional effects of schooling on growth dependent on the level of corruption are captured by the introduction of interaction term in the growth equation. Other papers have also used the interaction term to consider the conditional effects (i.e. Rajan and Zingales, 1998; Brambor et al., 2006; Ahlin and Pang, 2008; and others). We anticipate a negative coefficient on the interaction term indicating that the effect of schooling on growth might be reduced by the increase in the level of corruption.

Our study adds to the literature on a number of margins. First, through the use of different measures of corruption, we are able to consider the robustness of our empirical analysis. Second, our results contribute to the general literatures on whether human capital as well as corruption matter for economic growth. Most importantly, however, we investigate whether failing to take full account of corruption is the cause of the puzzling empirical results for the effect of human capital on growth.

The remainder of the chapter is organized as follows. The next section outlines the empirical literature on the impact of human capital on economic growth. Section 2.3 details the data and empirical methodology used in this study. Sections 2.4 present the empirical results. In section 2.5 we offer some concluding remarks.

2.2 Literature Review

The role of human capital in the growth process receives strong theoretical support. Micro-economic studies that rely heavily on a Mincerian human capital function notice significant returns to schooling (see Card, 1999, for a review). The role and importance of human capital is also well documented in the endogenous growth literature.

Human capital plays varying role in different theories of economic growth. There is no special role of human capital is in the production of output in the traditional neoclassical growth model (Solow 1956). Human capital is given a more central role in the endogenous growth models. It was due to the Solow's seminal work (1956) that highlighted that huge proportion of output growth is left unexplained and made it clear that the growth of real income per capita cannot be fully be attributed to the increase in the quantities of capital and labor alone. The study stimulated a great amount of work in the 1960's for considering both education and research and development in the analysis.

The study by Mankiw, Romer and Weil (MRW, 1992) was among the first to analyze the contribution of schooling in the growth regressions. In their influential contribution, they present a simple extension to the standard neoclassical growth model developed by Solow (1956) by introducing human capital as a separate input in the production function. They considers a standard economy where the aggregate production function is represented by the Cobb Douglas technology that exhibits constant returns to scale but diminishing returns to reproducible factors. Like the textbook Solow model, the population and the level of technology grow at the constant exogenous rates. The more crucial assumptions of the augmented neoclassical growth model are 1) People invest a fraction of their income in human capital just like they invest in physical capital. 2) Same rate of depreciation for both human and physical capital. 3) The output can be used for consumption or investment in either type of capital.

MRW (1992) derive a convergence equation relating the increments of output for both types of capital (physical and human). The proportion of working age population in secondary school is used as a proxy for the rate of human capital accumulation. By using the log of income per capita during the period 1960 to 1985 as the dependent variable, their cross-country regression confirms the existence of a direct effect of human capital on economic growth. The study may be criticized for using the enrolment data as a proxy for human capital, by assuming the same rate of depreciation for both physical and human capital and limiting the analysis to cross country regressions.

Another unsatisfactory feature of the MRW model is that, like the Solow model, it considers only the level effect and there is no rate effect. The long run growth rate is exogenous to the model. The empirical results of the influential paper by MRW however may be challenged by not only focusing on narrow proxy of human capital but also due to the failure for controlling the endogeneity of the investment rate.

Other articles have also analyzed the effect of human capital in income growth by modifying some aspect of the framework originally introduced by MRW. The study of Nonneman and Vanhoudt (1996) extended the analysis of MRW model by also augmenting with the accumulation of technological know-how. They use the share of GDP invested in the education as a proxy for human capital variable and report an insignificant coefficient on human capital.

In contrast to the exogenous growth models, 'New growth theory' attempted to "endogenize" sources of growth and hence the rate of growth is determined within the model instead of driven by exogenous technological progress. There are two distinct approaches in the endogenous growth literature for incorporating human capital. The first endogenous growth model which regards the accumulation of human capital as an engine of growth is by Lucas (1988). The human capital enters in the production function in labor augmenting form as in the Solow model. The model departs from the constant return to scale assumption by modelling the individual educational investment decisions and allowing for external effects of human capital. The second approach is due to Romer (1990) and Nelson and Phelps (1966). They consider direct effect of human capital levels on aggregate factor productivity and regard the role of human capital stock in the process of innovation and adoption of new technologies.

In Romer (1990), human capital directly affects productivity and it plays a role of determining the nation's ability to innovate to new technologies that are more suited to domestic production and hence leading to endogenous growth. The Nelson and Phelps (1966) model assigns the role of human capital levels in influencing the speed of technological catch up and diffusion. An additional channel through which human capital can affect growth is explored by Benhabib and Spiegel (1994). In their opinion human capital has second order effects on the growth process by attracting physical capital investment. They emphasize the role of human capital in domestic innovation of technology and its role in facilitating the adoption of technology from abroad rather than entering as a separate input in the production function.

The empirical evidence on the contribution of human capital on growth, however, is surprisingly mixed. Early papers that rely on the cross sectional analysis (Barro 1991; Mankiw Romer and Weil, 1992) and choose enrolment rates as the proxy for human capital, report large and significant effects. However, other cross country studies (Kyriacou, 1991, Benhabib and Spiegel, 1994, Nonneman and Vanhoudt, 1996, Pritchett, 2001) not only report insignificant relationship but also show a negative impact of human capital on income. Similar patterns of results can also be observed in panel data studies (Kumar, 2006, Bond, Hoeffler and Temple, 2001, Caselli, Esquivel and Lefort, 1996; Islam, 1995).

The study conducted by Benhabib and Spiegel (1994) was among the first to implement a cross country growth accounting approach and to notice the lack of a significant relationship between changes in schooling and growth. The study also questions empirically the conventional way of incorporating human capital as an additional explanatory variable in the production function, arguing that by doing so the role of human capital may be mis-specified in economic growth. They argue that the level of human capital may be seen as the determinant of changes in total factor productivity. In a cross country regression of income growth on changes in the logarithm of schooling for the period 1965-1985, they find that human capital not only has insignificant effect on per capita output growth but often enters with a negative coefficient. In another specification they also confirm the effect of human capital on technological catch up and innovation.

An important contribution to the literature is that of Pritchett (2001), which is amongst the first attempts to reconcile micro estimates of the return to schooling with aggregate evidence on education and growth. He replicates Benhabib and Spiegel (1994) by using a different measure of human capital, his analysis is built on the Mincer (1974) wage regression by assuming the return to education as 10% and by using the average years of schooling from Barro and Lee (1993). The author observes an insignificant coefficient on the change in schooling on growth and suggests three possible reasons for the discouraging results: i) low quality of education is not resulting in more human capital; ii) the returns to education decline because the supply of educated labor exceeds the demand for it; iii) educated workers goes for the privately remunerative but socially unproductive activities.

Temple (2001) investigates the impact of schooling on growth by re-examining the Pritchett (2001) results and by using Mankiw Romer and Weil (MRW, 1992) type production with alternative definitions of human capital. The study utilizes the cross country data of Benhabib and Spiegel (1994) and highlights the problem of parameter heterogeneity or model misspecification. The author challenges the empirical research on growth that draws conclusions about the majority of countries by noticing that in a large sample of countries it is inappropriate to assume that parameters will remain the same across all courtiers. He suggests least trimmed squares (LTS) as a suitable estimator for investigating parameter heterogeneity and model specification. The study concludes with the observation that there involves a great deal of uncertainty in measuring the impact of human capital on growth.

The lack of significant coefficient on change in schooling is also found by Krueger and Lindahl (2001) in a cross country analysis. The study finds positive and significant effect of increase in average years of schooling on growth in a low frequency data (over periods of ten or twenty years) while the change in schooling looses its impact on growth with high frequency data (over 5 years). The authors highlight measurement errors in schooling data in high frequency changes for the puzzling impact of human capital on economic growth.

Apart from the conflicting results found in the cross sectional studies there are a number of cases in which studies based on panel data could not find positive and significant effects of human capital (Kumar, 2006; Bond, Hoeffler and Temple, 2001; Caselli, Esquivel and Lefort, 1996; Islam 1995).

The study by Soto (2006) uses 10 year averages over 1960-1990 periods for 83 countries, employs OLS, GMM level, GMM difference and GMM system estimator, and highlights the collinearity between physical and human capital as an additional explanation for discouraging results of human capital in panel data estimates. The OLS estimates shows insignificant coefficient on both physical and human capital but after dealing with the collinearity problem the coefficient on schooling in levels as well as in first differences become positive and significant. Similar results are observed by using GMM levels and system estimation. The study also highlights return heterogeneity in macro Mincerian regressions and argues that quality of education is a significant determinant of heterogeneity in social returns across countries and ignoring the quality of schooling may result in overestimation of the macro Mincer coefficient.

Islam (1995) uses a panel data approach and considers the convergence equation originally developed by Mankiw, Romer and Weil (1992) with two modifications. First, the study uses average years of schooling in the population as a proxy for the stock of human capital from Barro and Lee (1993). Second, the study adopts panel data estimation to account for the country specific effects and to allow for heterogeneity in production technology across economies. Under these two modifications he finds that the role of human capital is not significant in the growth process.

So far we have discussed the literature of human capital and economic growth, as highlighted earlier that the relationship between human capital and economic growth is not straightforward and may depend on the country characteristics or institutional efficiency measured by corruption index. We first highlight the literature on corruption and economic growth and then combine the literature on human capital and economic growth and the literature on corruption and economic growth.

There is also a huge literature that recognizes the adverse impact of corruption on growth. Most theoretical and empirical research claims that corruption has harmful effects on growth and adopts different mechanisms for investigating the role of corruption in the growth process. Bureaucratic corruption may take place through different channels, for example it may be due to bribery and tax evasion of public officials (bureaucrats), private agents or stealing of government resources by public officials, and misinforming government about the costs and quality of public goods.

On theoretical side, a recent contribution by Blackburn, Bose and Haque (2006) considers a dynamic general equilibrium model for the joint determination of economic development and bureaucratic corruption, where households bribe the bureaucrat to avoid taxes. In the study by Mauro (2004), corruption becomes inevitable due to the existence of strategic complementarity. Another view is put forward by Haque and Kneller (2007). In their analysis corruption increases public investment but it lowers the returns to public investment and hence reduces economic development.

The hypothesis of a connection between rent seeking and the allocation of talent was first suggested by Baumol (1990) and by Murphy, Shleifer, and Vishny (1991). The countries which create incentives for highly talented individuals to go toward rent-seeking activities rather than innovative/productive activities observe a negative relationship between corruption and growth (Baumol, 1990, Murphy, Shleifer, and Vishny, 1991, Shleifer, and Vishny, 1993). According to Shleifer and Vishny (1993) corruption may be costly to development due to the two reasons. Firstly, the weakness of governments provides the bureaucracies an incentive to appropriate bribe from private agents. Secondly, the distortions of resources due to the diversion of resources from highest value projects (health and education) towards less value projects (defence and infrastructure) implies that latter provides better opportunities for secret corruption.

It has also been suggested that indirect negative effects of corruption on growth apply due to a decrease in investment (Mauro, 1995), due to reduction in expenditure on education and health (Mauro, 1997), due to increase in public investment but its low productivity (Tanzi and Davoodi, 1997) due to higher military spending (Gupta, de Mello and Sharan, 2000).

This brief review of the literature suggests that there is huge literature in the area of human capital and economic growth, as well as on the topic of corruption and economic growth. Our study tries to combine these two different strands of literatures. There is no study to date according to our best of knowledge which considers the explicit role of corruption in examining the impact of human capital on economic growth. The only exception is the empirical study by Rogers (2008) which implicitly considers the role of corruption in explaining the impact of schooling on growth. In Rogers study corruption index is used more arbitrarily in dividing the whole sample into sub-samples of high and low corruption countries. The study shows that change in schooling enters positively and with highly significant coefficient for low corruption countries, in contrast to the sub-sample of high corruption countries.

2.3 Data and Estimation Methodology

2.3.1 Empirical Approach

Our empirical approach is based on the growth accounting specification in which growth in output per worker is regressed on growth in capital per worker and growth in human capital per worker as follows:

$$gypw = \alpha_0 + \alpha_1 gkpw + \alpha_2 ghc + \varepsilon_t \qquad (2.1)$$

Where

$gypw$ = growth in output per worker,

ghc = growth in human capital.

In equation (2.1), growth in human capital can be defined by using the following human capital accumulation process as used in Rogers (2008).

$$logh_t = \theta logh_{t-1} + rS_t \qquad (2.2)$$

where r is the return to an additional year of schooling and S is years of schooling. Equation (2.2) allows us to distinguish whether a change in schooling or the level of schooling affects the growth rate, depending on the value of θ. We focus on the change in schooling by assuming $\theta = 0$, as in Pritchett (2001) and Bils and Klenow (2000).

By substituting $\theta = 0$ in equation (2.2), the growth in human capital is defined as $r\Delta S_t$. Hence by assuming that r is constant and $\theta = 0$, the growth in human capital equals the change in schooling. Substituting the growth in human capital as the change in schooling in equation (2.1) results in

$$gypw = \alpha_0 + \alpha_1 gkpw + \alpha_2 \Delta S + \varepsilon_t \qquad (2.3)$$

Equation (2.3) is referred to as the growth accounting specification which may be criticized for not considering the catch-up effect indicating that all countries will grow at same rate. We add initial output per worker as the proxy for the catch up effect to the equation (2.3) suggesting that poor countries grow faster than the rich countries.

The specification used by Rogers (2008) can be criticized for a number of reasons. First, it assumes that corruption has a threshold effect, with the threshold arbitrarily set as the median sample value. Second, the specification uses the 1996 corruption index for splitting the growth for 1960-2000 which may reduce the sample size and result in loss of information. Third, the use of corruption index of 1996 is almost end of the growth period 1960-2000 which may result in the potential endogeneity of the corruption and may show the impact of growth to corruption not the other way around.

We first replicate the Rogers (2008) results by estimating equation (2.3) for sub-samples of countries divided into high and low corruption according to the medium of the corruption index. This specification is equivalent to estimating the regression;

$$gypw = \alpha_1(gkpw * d1) + \alpha_2(\Delta S * d1) + \alpha_3 d1$$
$$+ \alpha_4(gkpw * d2) + \alpha_5(\Delta S * d2) + \ \alpha_6 d2 + \varepsilon_t \qquad (2.4)$$

where d1 is the dummy variable for the sample of low corrupt countries and d2 is dummy variable for the sample of high corrupt countries.

The impact of human capital on economic growth may be affected by country characteristics. The country characteristics vary across the nations implying that ignoring such information from the growth equation may not truly represent the contribution of human capital in economic growth. Corruption is one of the important types of heterogeneity among different countries. We introduce the role of corruption and its interaction with change in schooling to show that corruption has a negative effect on growth and to explain that the impact of change in schooling on growth may be diluted by an increase in corruption.

Unlike the Rogers (2008), we do not split the full sample into sub-samples of high and low corruption countries but explicitly allow the corruption index as well as the interaction term of change in schooling and corruption as follows;

$$gypw = \alpha_0 + \alpha_1 lnypw + \alpha_2 gkpw + \alpha_3 \Delta S$$
$$+ \alpha_4 Corrupt + \alpha_5(\Delta S * Corrupt) + \varepsilon_t \qquad (2.5)$$

where $lnypw$ is initial output per worker. Equation (2.5) relates to equation (2.4) that it takes into account all the available information by including all countries rather than splitting the sample. In addition, equation (2.5) also consider the explicit role of corruption and the conditional effects of schooling on growth dependent on level of corruption by introducing the interaction term. We expect the coefficient on the interaction term to be negative indicating that the impact of schooling on growth is reduced by an increase in corruption, a negative coefficient on corruption suggesting that corruption has a negative effect on growth and a positive coefficient on the change in schooling.

The empirical analysis is based on OLS with heteroscedasticity consistent standard errors. However, OLS technique does not take account of the endogeneity of the explanatory variables. To address this issue, we use the method of instrumental variable estimation and use ethnolinguistic fractionalization (i.e., ethfrac) and voice and accountability (i.e., VA) for corruption while share of population aged under 15 (i.e., pop15), the share of education spending on GDP (i.e., Edugdp) as instruments for schooling and the lag of the natural log of output per worker as an instrument for the initial output. Mauro (1995) introduced ethnolinguistic fractionalization as instrument for corruption and argue that it is highly correlated with corruption and institutional variables. Other studies have used ethnolinguistic fractionalization in their empirical analysis (Easterly and Levine, 1997; Mauro, 1998; Aidt et al., 2008; and many others) and voice and accountability index (Aidt et al., 2008). Earlier papers have included demographic variables (Higgens, 1998; Cook, 2002; Durlauf et al. 2005; Rogers, 2008) and ratio of education spending to GDP (Klasen, 2002; Rogers, 2008). The instrument for the interaction term is created by the multiplication of the relevant instruments used in the regression.

The voice and accountability index aggregates indicators of various aspects of the political process, civil liberties, and political rights with the purpose of measuring the extent to which citizens of a country are able to participate in the selection of their government and media. The index lies in the interval 0 (weak institutions) to 1 (strong institution). The ethnolinguistic fractionalization index measures the probability that two randomly selected persons from a given country will not be coming from the same ethnolinguistic group (see Taylor and Hudson, 1972). The higher value of the ethnolinguistic fractionalization index show more fragmentation.

2.3.2 Data

The data on GDP per worker, capital per worker and schooling over 1960-2000 is from Baier et al (2006). The data is available at intervals of 10 years for a large sample of 145 developing and developed countries. We use the data at the interval 1980-2000 rather than the time period of 1960-2000 used by the Rogers (2008). There are two reasons for selecting the time periods. First, the corruption data is available for 1980 and afterwards. Second, we choose the earliest available data on corruption to make it sure that causality is running from corruption to growth and not the vice versa.

The empirical analysis employs a range of corruption indices. The data on corruption is mainly from three different sources. The first data source is *Business International and Political Risk Service, Inc* (BI Index). The BI Index has also been used by Mauro (1995), Tanzi and Davoodi (1997). It is available for 68 countries for the 1980-1983 period; one observation on corruption is available for each country. The BI index overlaps with the schooling data for 65 countries, which consists of 28 high income countries, 8 low income countries, 18 lower middle income countries and 11 upper middle income countries.

The second source of corruption data is from *International Country Risk Guide (ICRG)*. The ICRG index publishes annually during 1984 to 2003 period and (depending on the year) is available for up to 140 countries. Combining the corruption data to the schooling and other macro-economic data may also result in the reduction of the sample size as opposed to the figured mentioned above. We construct the average of corruption index for different periods and therefore depending upon which average of corruption index is used, the data ranges for the sample of countries 105 and 140 countries. This index has been used by Knack and Keefer (1995) and many others.

The ICRG data on corruption ranges from 0 (corrupt) to 6 (clean); we rescale the *ICRG* index by deducting it from 6, so that higher values of the index imply higher corruption. The empirical analysis also considers the averages of the ICRG index: the average ICRG index for 1984-1990 (ICRG198490) and the average over 1984 to 2000 (ICRG8400). When using ICRG84, the schooling data coincides for 95 countries which comprise 31 high income countries, 18 low income countries, 28 lower middle income countries and 18 upper middle countries. Using the average index of ICRG over 1984 to 1990 in combination with other dataset increases the number of countries to 111 which are composed of 33 high income countries, 29 low income countries, 30 lower middle income countries and 19 upper middle income countries. The average ICRG index for 1984-2000 (ICRG8400) consist of 112 countries with schooling data and are divided into 33 high income, 29 low income, 31 lower middle income and 19 upper middle income countries.

Third source of corruption data is from *Transparency International (TI)*. The corruption data is available discontinuously for the years 1980-85 and 1988-92; it is available continuously from 1995 onwards. The corruption data from this source is available for the sample of 54 to 133 countries and lies between 0 (clean) to 10 (most corrupt). The empirical analysis also employs three measures of TI index. TI8085 and TI8892 corruption indices are discontinuous and report one observation per country while the TI9500 index is created by taking the average of TI index over 1995 to 2000. For the corruption indices TI8085 and TI8892, the schooling data overlap for 53 courtiers that are composed of 27 high income, 5 low income, 11 lower middle income and 10 upper middle income countries. For the average index of TI9500, the number of overlapping countries with the schooling data rises to 82 countries, of which the number of high income countries is 27, number of low income countries is 16, number of lower middle income countries is 22 and number of upper middle income countries is 17.

The Kaufmann et al. (2005) index of corruption for 1996 is used for the replication of Rogers (2008) results and it is available for 78 countries, ranging from 0 (High corruption) to 100 (low corruption).

Appendix Table A2.1 provides the complete list of countries used for each corruption index and Table A2.2 provides the variables used and the sources of the dataset. In our empirical analysis we use the same source of dataset for the macroeconomic variable and schooling data as used in Rogers (2008). Instead of the Kaufmann et al. (2005) index of corruption 1996 index used in Rogers (2008), we use corruption index from variety of sources and at different time intervals. This not only allows a larger sample of countries as compared to the Rogers (2008) but also considers the corruption data which is most relevant to the growth period as opposed to the Rogers (2008), who considers corruption 1996 data for growth period of 1960-2000 which is inappropriate and suffers from endogeneity.

2.4 Empirical Results

In this section, we investigate the link between human capital and economic growth. The empirical analysis first replicates the Rogers (2008) results and then extends the analysis by using the data on corruption from three different sources, Business international (BI), International Country Risk Guide (ICRG) and Transparency international (TI). Our preferred estimation methodology considers all available information as opposed to the Rogers method of splitting samples into two parts which results into the loss of information and also suffers from the problem of endogeneity by using corruption index at the end of growth period. We use the corruption index which is more appropriate for growth period instead of the corruption index at later times of growth period. Moreover, our estimation methodology directly takes into account the role of corruption as an additional explanatory variable in the regression and also takes the interaction of corruption with the change in schooling in the regression.

2.4.1 Replication and Extension of Rogers (2008) Results

In this subsection, we first replicate the results of Rogers (2008) by dividing the full samples of countries into low corruption and high corruption countries and present the Rogers hypothesis that the impact of schooling is positive and significant in the sample of low corrupt countries whereas it is insignificant in the sample of high corrupt countries. The regression analysis shown in Table 2.1 estimates the growth equation (2.3) over 1960-2000 and also four decades, using the same data as used in Rogers (2008). The number of countries is restricted to the sample of 76 countries for which the Kaufmann et al. (2005) index for corruption for 1996 in panel (a). The full sample is also divided into two sub-sample of high and low corruption countries using the median corruption index value of 41.35.

The first row of Table 2.1 in panel (a) replicates Rogers (2008, Table2, Pp. 365) results with dependent variable of the growth rate in output per worker regressed on a constant, growth in capital per worker and change in schooling over 1960 to 2000. Although not shown, coefficients on the growth in capital and change in schooling are positive and significant for the full sample of countries (only the coefficient on schooling is reported to save the space). The next two cells of row one in Table 2.1 run regression for the sub-samples of high and low corruption countries. For the sample of high corruption countries, the coefficient on growth in capital is higher and significant while the coefficient on change in schooling is insignificant and lower in magnitude compared with the full sample results. The regression for the sample of low corruption countries shows a lower coefficient on the capita growth and a positive coefficient on the change in schooling that is significant at 1% level. Thus change in schooling is greater in magnitude and significant for the sub-sample of low corruption countries as compared to the sub-sample of high corruption countries, in line with the hypothesis put forward by Rogers (2008).

The literature has criticized the simple growth accounting specification for assuming constant catch-up effect across countries as also noticed by Rogers (2008). Regressions 4, 5 and 6 in Table 2.1 include the log of the initial GDP per worker (1960) as an indicator of the size of the technological catch up (suggesting that the poor countries will grow faster in ceteris paribus). The coefficient on the initial GDP per worker is negative, confirming the catch-up interpretation. The coefficient on the change in schooling is again insignificant in high corruption countries while it is positive and significant at 1% level in low corruption countries confirming that the results are robust to the inclusion of the initial output in the growth equation.

Table 2.1 Replication and Extension of Rogers (2008)

Panel (a): Results based on Kaufmann et al. (2005) corruption index of 1996						
	Change in Schooling years (No initial)			Change in Schooling years (With initial)		
growth period	(1) Full (n=76)	(2) High Corrupt (n=38)	(3) Low Corrupt (n=38)	(4) Full (n=76)	(5) High Corrupt (n=38)	(6) Low Corrupt (n=38)
1960-2000	0.1187 (0.0378)***	0.0156 (0.0431)	0.2060 (0.0474)***	0.1813 (0.0587)***	0.0729 (0.0717)	0.2849 (0.0578)***
1960-1970	0.0837 (0.0343)**	0.1411 (0.0805)*	0.0751 (0.0338)**	0.0773 (0.0355)**	0.1281 (0.0847)	0.0825 (0.0328)**
1970-1980	0.0494 (0.0319)	0.0048 (0.0502)	0.0923 (0.0376)**	0.0532 (0.0430)	0.0176 (0.0732)	0.0933 (0.0467)*
1980-1990	-0.0156 (0.0353)	0.0139 (0.0404)	-0.0502 (0.0590)	0.0120 (0.0367)	0.0681 (0.0327)**	-0.0333 (0.0602)
1990-2000	0.1428 (0.0539)***	0.0204 (0.1263)	0.1448 (0.0735)*	0.1540 (0.0543)***	0.1335 (0.1457)	0.1341 (0.0724)*
Panel (b): Results based on Mauro (1995) corruption index of 1980-1983						
	Change in Schooling years (No initial)			Change in Schooling years (With initial)		
growth period	(1) Full (n=33)	(2) High Corrupt (n=16)	(3) Low Corrupt (n=16)	(4) Full (n=33)	(5) High Corrupt (n=16)	(6) Low Corrupt (n=16)
1960-2000	0.0840 (0.0621)	-0.0169 (0.0561)	0.2736 (0.0989)**	0.1212 (0.0593)*	-0.0080 (0.0832)	0.2391 (0.1023)
1960-1970	0.0193 (0.0503)	-0.0504 (0.1116)	0.1674 (0.0696)**	0.0240 (0.0569)	-0.0681 (0.1135)	0.1507 (0.0846)
1970-1980	-0.0272 (0.0429)	-0.0647 (0.0270)**	0.0136 (0.1044)	-0.0244 (0.0455)	-0.0761 (0.0209)***	0.0247 (0.0917)
1980-1990	-0.0349 (0.0402)	-0.0760 (0.0465)	-0.0091 (0.0674)	-0.0175 (0.0339)	-0.0458 (0.0520)	-0.0465 (0.0548)
1990-2000	0.2595 (0.1113)***	0.1830 (0.1002)*	0.2880 (0.0667)***	0.2690 (0.0622)***	0.2304 (0.0812)**	0.2769 (0.0753)***

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Estimates are based on OLS With robust standard errors in brackets. The growth of output per worker is the average annual growth for the corresponding time period; the 'Change in schooling years' is the average annual change in years of schooling in population over 25 years of age between the corresponding time intervals. The 'Schooling years' refers to the average years of schooling in population over age 25. Kaufman et al. (2005) corruption data for 1996 is used to create the subsamples in panel (a) while Mauro (1995) corruption index for 1980-1983 is used to create subsamples in panel (b).The data on output per worker, capital per worker and schooling is from Baier et al. (2006) dataset.

It is necessary to mention here that cross sectional regression analysis of Rogers (2008) for the period 1960-2000 is based on corruption 1996 index which may be suffers from endogeneity and loss of information. Unlike Rogers (2008), we investigate the empirical analysis in more depth by estimating the decadal regressions (i.e., 1960-1970, 1970-1980, 1980-1990 and 1990-2000) in Table 2.1 in rows two through five.

The decadal regressions in panel (a) of Table 2.1 employ exactly the same sample of 76 countries and sub-samples of 38 high and low corruption countries. The decadal regressions in general do not fully support the Rogers (2008) hypothesis. For example, the regression for the period 1960-1970 finds a low magnitude of the change in schooling for the sub-sample of low corruption countries and high value on the sub-sample of high corruption countries, contrary to the Rogers (2008) hypothesis.

The decade of 1970-1980 show that change in schooling loses its significance by including initial output per worker to allow the catch-up effect. The decade of 1980-1990 show a sharp contrast to the Rogers (2008) hypothesis, the change in schooling enters with the wrong sign for the sub-sample of low corruption countries. The only decade that provides weak support for the Rogers hypothesis is 1990-2000. One reason may be that for this time period, the corruption 1996 index is creating less endogeneity problem as compared to the time period 1960-2000. The coefficient on the change in schooling is positive and marginally significant at 10% level for low sub-sample countries while insignificant for the high corruption countries.

To further examine the robustness of Rogers results, we employ different indices of corruption in and again provides the decadal evidence. Panel (b) of Table 2.1 uses corruption index from Mauro (1995) for 1980-1883, overlaps with the schooling data for only 33 countries, resulting in a small sample of countries as compared to the previous case. Using the median value of the corruption index of 5.75 divide the full sample into sub-samples of 16 high and low corruption countries. The results are in the same format as in the panel (a) of Table 2.1. These results are generally sensitive to the inclusion of the initial output per worker in the regression and coefficient on the change in schooling appears with wrong sign for the decade of 1980-1990. This further confirms that the decadal regression do not find support for the Rogers results.

The Rogers specification of sample splitting into high and low corrupt countries results in loss of information. We offer alternative approach by using dummy variables to use full sample of countries. Appendix Table A2.3 replicates Rogers results, estimates equation (2.4) and reports exactly the same coefficients as in row 1 of Table 2.1. In addition, we repeat the same exercise for corruption indices TI9500, ICRG8490 and ICRG 8400 and again the coefficient estimates are same as to the corresponding results in model (4), (5) and (6) in Table A2.4.

The sensitivity of the Rogers methodology and results can also be found in Table A2.4 and Table A2.5. In these two tables we use the growth period at 20 year (1980-2000) and 10 year (1990-2000) by following the Rogers methodology to divide the full samples of countries into high and low corruption countries base on the median value of the corruption index. In these estimations we have used various corruption indices (i.e., BI, TI and ICRG) at different time interval as opposed to the Rogers by using only one corruption index. The results in general do not find the support for the Rogers results.

2.4.2 Cross Sectional Evidence (1980-2000): Applying OLS

In this subsection, we first estimate the base-line model (2.3) corresponding to each of the corruption index over 1980-2000 without including the corruption index for the comparison purposes and then estimate our preferred model (2.5) by including both corruption and the interaction of corruption and change in schooling as additional explanatory variables.

Base line estimates of the regression model (3) are reported in Table 2.2, where there is no division into high and low corruption countries. This uses the same data as used in Rogers (2008), but it relates to the period 1980-2000 instead of 1960-2000. The choice of the time period 1980-2000 is due to the availability of the corruption data from 1980 and afterwards. Although Table 2.2 does not use the corruption index as an explanatory variable but it includes the samples of countries for which different corruption indices are available and will be used as a base line model for later comparison.

Column (1) corresponds to the sample of 65 countries for which Business International (BI) index for 1980-1983 overlaps the schooling data. The coefficient on the growth in capital per worker is positive and highly significant at the 1% level while the coefficient on the change in schooling is not significant. Similar results are observed in other regressions with sample size ranges from 53 to 112 countries. The only exception is the case where the change in schooling is significant at 5% level for the sample corresponding to the TI9500 index of corruption.

Panel (b) of Table 2.2 includes initial output in the regression to allow for the catch up effect and results are not radically changed. Consequently, the base line regression does not find support for the role of schooling in the growth process and leads us to investigate the channel through which schooling affects growth. To explain the impact of schooling on growth we introduce corruption index as well as the product of corruption index with change in schooling variable in the regression analysis.

Table 2.3 estimates model (2.5) using the alternative measures of corruption (i.e., BI8083, TI8085, TI8892, TI9500, ICRG8490 and ICRG8400). The regression equation (1) uses the BI8083 index of corruption and reports a positive coefficient on growth in capital per worker with a magnitude of 0.65 which is significant at 1% level. We expect a negative sign on corruption and its interaction with change in schooling in the growth equation while positive coefficient on growth in capital per worker and change in schooling. All other explanatory variables (i.e., Change in schooling, interaction term of the change in schooling with corruption index and corruption index itself) appear with the expected signs but lack significance.

A similar pattern of results is found by using corruption indices from the other two sources (i.e. Transparency International, TI and International Country Risk Guide, ICRG) and at different time periods (i.e., TI8085, TI8892, ICRG8490 and ICRG8400). The only exception is the TI8085 index for which the interaction term appears with the wrong sign. By including the initial output per worker in the regression alters the sign of the interaction term for majority of the cases. Again the adjusted R^2 is higher for each of the cases as compared to the base line model in Table 2.2. The lack of significance for many coefficients may be due to the problem of multi-collinearity which is very common in the multiplicative interaction models where the interaction term is created by multiplying the constituent terms/explanatory variables included in the model.

Table 2.2 Human Capital and Economic Growth: Baseline Model (1980-2000)

Panel (a): Results Without initial output per worker						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Growth in capital per worker	0.6364 (0.0945)***	0.7198 (0.1054)***	0.7198 (0.1054)***	0.6354 (0.0716)***	0.6205 (0.0991)***	0.6009 (0.0887)***
Change in Schooling	0.0625 (0.0541)	0.1094 (0.0661)	0.1094 (0.0661)	0.1024 (0.0412)**	0.0444 (0.0473)	0.6009 (0.0887)
Constant	-0.0129 (0.0078)	-0.0170 (0.0093)*	-0.0173 (0.0093)*	-0.0140 (0.0050)***	-0.0120 (0.0053)**	-0.0120 (0.0053)**
Observations	65	53	53	82	111	112
Adjusted R^2	0.3604	0.4859	0.4859	0.5295	0.3278	0.3384
Panel (b): Results With initial output per worker						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Growth in capital per worker	0.6364 (0.0911)***	0.7864 (0.1007)***	0.7864 (0.1007)***	0.6384 (0.0681)***	0.6216 (0.0990)***	0.6045 (0.0887)***
Change in Schooling	0.0513 (0.0532)	0.0603 (0.0640)	0.0603 (0.0640)	0.0770 (0.0455)*	0.0308 (0.0539)	0.0290 (0.0543)
Initial Output	0.0021 (0.0029)	0.0078 (0.0024)***	0.0078 (0.0024)***	0.0029 (0.0018)	0.0014 (0.0025)	0.0016 (0.0025)
Constant	-0.0311 (0.0275)	-0.086 (0.0210)***	-0.0860 (0.0210)***	-0.0380 (0.0153)**	-0.0241 (0.0203)	-0.0250 (0.0201)
Observations	65	53	53	82	111	112
Adjusted R^2	0.3668	0.5755	0.5755	0.5454	0.3305	0.3417

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The estimates are OLS with Robust standard errors in the brackets. The dependent variable is average annual growth in output per Worker during 1980-2000. The 'Growth of capital labor ratio' is the average annual growth for 1980-2000; the 'Change in schooling years' variable is the average annual change in years of schooling, in population over 25 years of age, between 1980 and 2000.

The OLS results may be inappropriate if there is potential endogeneity problem. To overcome the problem of endogeneity, we repeat the analysis in Table 2.3 by using the instrumental variable method.

The results in Table 2.3 show that except for the growth in capital per worker, corruption index is the only variable which sometimes enters significantly and with the expected negative coefficient. Consequently, in Table A2.6 we estimate the regression equations by dropping the interaction term to see whether corruption has a role to play in the growth process or not.

All the regressions with different corruption indices BI8083, TI8085, TI8892, TI9500, ICRG8490 and ICRG8400 report negative coefficient on corruption variable which is highly significant at 1%, the results does not change by including the initial output per worker as a proxy for the catch up effect (see Table A2.6). The results in Table A2.6 suggests that although corruption has an important role to play in economic growth but the coefficient appears insignificantly for majority of the cases except for model (3) and (4) where the coefficient on change in schooling is marginally significant at 5 % level. The OLS results are uninformative for the effects of human capital on growth.

Table 2.3 Human Capital, Corruption and Economic Growth: Multiplicative Interaction Model (1980-2000)

Panel (a): Estimation without initial output						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Growth in capital per worker	0.6500 (0.0850)***	0.7439 (0.0802)***	0.7740 (0.0780)***	0.6230 (0.0622)***	0.5840 (0.0990)***	0.5546 (0.0833)***
Change in Schooling	0.0602 (0.0796)	0.0574 (0.0778)	0.1189 (0.0882)	0.0980 (0.0886)	0.1054 (0.0851)	0.0866 (0.1151)
Interaction	-0.0008 (0.0175)	0.0051 (0.0104)	-0.0050 (0.0135)	-0.0040 (0.0158)	-0.0300 (0.0251)	-0.029 (0.0373)
Corruption	-0.0027 (0.0022)	-0.0030 (0.0013)***	-0.0030 (0.0017)*	-0.0020 (0.0020)	-0.0020 (0.0030)	-0.0040 (0.0046)
Constant	-0.0038 (0.0109)	0.0041 (0.0107)	-0.0020 (0.0124)	0.0028 (0.0118)	-0.0040 (0.0114)	0.0027 (0.0153)
Observations	65	53	53	82	111	112
Adjusted R^2	0.4574	0.6678	0.7175	0.6473	0.4173	0.4507
Panel (b): Estimation with initial output						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Growth in capital per worker	0.6494 (0.0937)***	0.7259 (0.0932)***	0.7315 (0.0827)***	0.6034 (0.064)***	0.5752 (0.1020)***	0.5329 (0.0876)***
Change in Schooling	0.0497 (0.0863)	0.0587 (0.0780)	0.1161 (0.0902)	0.0700 (0.0879)	0.1525 (0.096)	0.1106 (0.1213)
Interaction	0.0084 (0.0183)	0.0070 (0.0103)	0.0011 (0.0137)	0.0065 (0.0156)	-0.0378 (0.0263)	-0.0270 (0.0382)
Corruption	-0.0051 (0.0029)*	-0.0040 (0.0017)**	-0.0050 (0.0019)***	-0.0060 (0.0022)***	-0.0023 (0.0033)	-0.0050 (0.0052)
Initial Output	-0.0050 (0.0042)	-0.0020 (0.0036)	-0.0060 (0.0030)**	-0.0060 (0.0024)***	-0.0033 (0.0028)	-0.0040 (0.0029)
Constant	0.0480 (0.0443)	0.0308 (0.0370)	0.0705 (0.0317)**	0.0785 (0.0281)***	0.02348 (0.0274)	0.0422 (0.0324)
Observations	65	53	53	82	111	112
Adjusted R^2	0.4785	0.6713	0.7398	0.6833	0.4281	0.4667

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Estimates are OLS with robust standard errors in the brackets. The dependent variable is average annual growth in output per worker during 1980-2000. The ‘Growth of capital labor ratio’ is the average annual growth for 1980-2000; the ‘Change in schooling years’ variable is the average annual change in years of schooling, in population over 25 years of age, between 1980 and 2000.

2.4.3 Cross Sectional Evidence (1980-2000): IV Estimation

In this subsection, we employ instrumental variable method to investigate the impact of human capital and economic growth. Equation (1) in Table 2.4 uses ethnolinguistic fractionalization as an instrument for the BI8083 index of corruption and for the interaction term resulting in the reduction of sample size to 63 countries. The coefficient on growth in capital per worker is 0.66 and significant at 1% level while the remaining explanatory variables for example change in schooling, interaction of change in schooling with corruption index and corruption index again remains insignificant (as in Table 2.3) and appear with the expected signs. The Wu-Hausman test is used to check the validity of instruments under the null hypothesis that instruments are exogenous. The P-Value of the Wu-Hausman test is 0.96 which accepts the null hypothesis of exogenous instrument and confirms that instruments are valid.

A similar pattern of results are observed by using the corruption indices of TI8085, TI8892, TI9500, ICRG8490 and ICRG8400, the exception of wrong sign on the corruption index. Panel (b) of Table 2.4 includes initial output per worker to account for the catch-up effect. Regression (2) considers the sample of countries for which the data on corruption index for TI8085 is available. This regression uses ethnolinguistic fractionalization as an instrument for corruption while the lagged value of initial output per worker (lnypw70) as an instrument for initial output per worker. The coefficient on growth in capital is 0.81 and highly significant at 1% level. All the remaining variables appear with the expected signs except the corruption variable and are all insignificant. The P-Value of Wu-Hausman is 0.017 which rejects the null hypothesis of exogenous instrument; hence the instruments are not valid for this regression.

The corruption index TI8892 finds the similar evidence but in this case the Wu-Hausman does not rejects the null hypothesis of exogenous instruments at 5% (P-Value=0.0717), the instruments are valid at 5% level. The regression equation based on corruption index ICRG8490 appears with the expected signs on all variables and all are insignificant while the P-Value of the Wu-Hausman test is 0.97 which ensures that the instruments are valid. All the remaining regressions report the expected sign on coefficients except on corruption index and Wu-Hausman test pass the test of validity for instruments.

Table 2.4 Human Capital, Corruption and Economic Growth: Instrument Variable Estimation (1980-2000)

Panel (a) Estimations without initial output						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Growth in capital per worker	0.6627 (0.1332)***	0.8411 (0.2125)***	0.8117 (0.1422)***	0.6199 (0.0650)***	0.6130 (0.1303)***	0.5845 (0.1159)***
Change in Schooling	0.1190 (0.4893)	0.6247 (0.7077)	0.4123 (0.4184)	0.3597 (0.3358)	0.4227 (0.5267)	0.4526 (0.5752)
Interaction	-0.0175 (0.1320)	-0.0969 (0.1295)	-0.0576 (0.0759)	-0.0549 (0.0597)	-0.1389 (0.1741)	-0.1525 (0.1938)
Corruption	-0.0014 (0.0157)	0.0069 (0.0130)	0.0031 (0.0080)	0.0031 (0.0065)	0.0135 (0.0236)	0.0149 (0.0262)
Constant	-0.0090 (0.0608)	-0.0616 (0.0784)	-0.0391 (0.0484)	-0.0296 (0.0389)	-0.0519 (0.0743)	-0.0548 (0.0807)
Observations	63	47	47	72	97	98
Adjusted R^2	0.4041	0.2396	0.5807	0.6353	0.2956	0.3315
Wu-Hausman F test (P-Value)	0.0374 (0.9632)	1.56113 (0.2224)	0.9439 (0.3976)	0.6489 (0.5259)	0.2721 (0.7623)	0.3788 (0.6856)
Panel (b) Estimations with initial output						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Growth in capital per worker	0.6126 (0.3276)*	0.8125 0.1466)***	0.8067 (0.1291)***	0.7419 (0.6795)	0.5862 (0.5470)	0.8169 (1.0465)
Change in Schooling	0.0474 (0.7559)	0.4037 (0.2938)	0.3854 (0.3165)	0.7551 (2.6230)	0.2445 (1.7380)	3.9352 (6.8543)
Interaction	-0.0200 (0.1994)	-0.0646 (0.0582)	-0.0563 (0.0720)	-0.1437 (0.5713)	-0.0669 (0.6667)	-1.2002 (2.1138)
Corruption	0.0088 (0.0334)	0.0070 (0.0115)	0.0045 (0.0156)	0.0279 (0.1431)	-0.0068 (0.1796)	0.1468 (0.3873)
Initial	0.0176 (0.0476)	0.0086 (0.0200)	0.0038 (0.0249)	0.0276 (0.1538)	-0.0102 (0.0836)	-0.0078 (0.0441)
Constant	-0.1949 (0.4940)	-0.1333 (0.2261)	-0.0787 (0.2935)	-0.4025 (2.1022)	0.0928 (1.2270)	-0.4367 (1.6014)
Observations	62	47	47	72	96	63
Adjusted R^2	0.2354	0.4835	0.5565	0.1432	0.2550	0.1342
Wu-Hausman F test (P-Value)	1.2829 (0.2897)	3.8516 (0.0168)	2.5284 (0.0717)	0.9106 (0.4410)	0.0766 (0.9724)	0.7325 (0.5371)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The standard errors are written in parenthesis. Estimates are Instrumental variable estimation with the null hypothesis that instruments are exogenous. We use Ethnolinguistic fractionalization (i.e., ethfrac) and voice and accountablility (i.e., va) for corruption while share of population aged under 15 (i.e., pop15) and the share of education spending on GDP (i.e., Edugdp) as instruments for schooling. The ‘Growth of capital labor ratio’ is the average annual growth for 1980-2000; ‘Change in schooling years’ variable is average annual change in years of schooling in population over 25 years of age during 1980-2000.

2.4.4 Additional Cross Sectional Evidence (1990-2000): OLS

This subsection explores the link between human capital and economic growth by explicitly including both corruption and the interaction of corruption and change in schooling for a growth period from 1990 to 2000. As we consider the decadal growth regression, we can now use corruption measures averaged for more time periods.

As compared to Table 2.3 where the growth period of twenty year is considered, Table 2.5 considers decadal growth regression during 1990-2000 and estimates our preferred model (2.5) by including explicitly both corruption and the interaction of change in schooling and corruption. The results are of quite mixed in nature, for example the coefficient on growth in capital per worker is positive and highly significant at 1% level while the coefficients on the change in schooling is positive for all the cases except with TI9500 where it appears with the wrong sign.

For some of the corruption indices (i.e., ICRG8490, ICRG90 and ICRG9000) the coefficient on the interaction term appears with the expected negative sign indicating that the impact of schooling on growth is reduced by the increase in corruption. But in other cases with corruption indices (i.e., BI8083, TI8085, TI8892 and TI9500) the interaction term appears with the wrong sign. The coefficient on the corruption index variable appears with the expected negative sign for the majority of the cases except for the ICRG8490 and ICRG90 indices of corruption.

The results in Table 2.5 are similar to those in Table 2.3 and do not change by using a relatively small time period. Again, the OLS results are uninformative for the impact of human capital on growth.

Table 2.5 Human Capital, Corruption and Economic Growth (1990-2000): Multiplicative Interaction Model, OLS

Panel (a) Estimation without initial output								
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG84	(6) ICRG8490	(7) ICRG90	(8) ICRG9000
gkpw	0.4546 (0.1358)**	0.6065 (0.1104)***	0.6017 (0.0960)***	0.5458 (0.0915)***	0.5340 (0.0906)***	0.4573 (0.1834)**	0.4433 (0.1799)**	0.4580 (0.1768)**
cschool	0.0776 (0.1351)	0.0766 (0.1421)	0.1207 (0.1298)	-0.0065 (0.1671)	0.1618 (0.1328)	0.3040 (0.1500)**	0.3425 (0.1468)**	0.2087 (0.1752)
Interaction	0.0278 (0.0299)	0.0323 (0.0238)	0.0232 (0.0223)	0.0312 (0.0311	-0.0313 (0.0478)	-0.0776 (0.0542)	-0.0910 (0.0547)*	-0.0490 (0.0723)
Corruption	-0.0069 (0.0032)**	-0.0082 (0.0028)***	-0.0081 (0.0024)***	-0.0071 (0.0032)**	-0.0023 (0.0055)	0.00082 (0.0065)	0.0016 (0.0066)	-0.0037 (0.0083)
Constant	0.0047 (0.0128)	0.0142 (0.0158)	0.0136 (0.0144)	0.0229 (0.0184)	-0.0020 (0.0160)	-0.0172 (0.0182)	-0.0199 (0.0177)	-0.0028 (0.0203)
Obs.	65	53	53	82	95	111	111	112
Adj. R^2	0.3296	0.5637	0.6276	0.4756	0.3430	0.2443	0.2587	0.2588
Panel (b) Estimation with initial output								
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG84	(6) ICRG8490	(7) ICRG90	(8) ICRG9000
gkapw	0.4508 (0.1422)***	0.6059 (0.1116)***	0.5876 (0.0823)***	0.5359 (0.0915)***	0.5268 (0.0871)***	0.4605 (0.1798)**	0.4467 (0.1772)**	0.4609 (0.1733)***
cschool	0.0769 (0.1371)	0.0739 (0.1404)	0.0929 (0.1197)	-0.0572 (0.1770)	0.1627 (0.1277)	0.2936 (0.1466)**	0.3314 (0.1464)**	0.2120 (0.1809)
Interaction	0.0270 (0.0293)	0.0330 (0.0237)	0.0300 (0.0212)	0.0430 (0.0332)	-0.0256 (0.0482)	-0.0766 (0.0536)	-0.0897 (0.0543)	-0.0516 (0.0778)
Corruption	-0.0066 (0.0031)**	-0.0085 (0.0031)**	-0.0107 (0.0027)***	-0.0105 (0.0042)**	-0.0047 (0.0066)	0.0014 (0.0070)	0.0020 (0.0069)	-0.0030 (0.0101)
Initial Output	-0.0007 (0.0043)	-0.0008 (0.0043)	-0.0074 (0.0053)	-0.0067 (0.0047)	-0.0046 (0.0055)	0.0017 (0.0048)	0.0015 (0.0044)	0.0008 (0.0053)
Constant	0.0231 (0.0497)	0.0230 (0.0496)	0.0960 (0.0598)	0.1010 (0.0608)	0.0458 (0.0604)	-0.0328 (0.0524)	-0.0333 (0.0466)	-0.0115 (0.0645)
Obs.	65	53	53	82	95	111	111	112
Adj. R^2	0.5639	0.5639	0.6421	0.4914	0.3506	0.2453	0.2595	0.2590

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The estimates are OLS with robust standard errors written in the parenthesis. The dependent variable is average annual growth in output per worker during 1990-2000. 'Growth of capital labor ratio' is average annual growth for 1990-2000; the 'Change in schooling years' variable is the average annual change in years of schooling, in population over 25 years of age, between 1990 and 2000. Where 'gkpw' is growth in capital per worker.

The poor results may partly be attributed to the problem of multicollinearity in the multiplicative interaction model or the measurement errors. The problem of multicollinearity is very common in the multiplicative interaction models that include constituent terms along with their products.

To further investigate the role of corruption on growth we drop the interaction term and estimate the model by including only the corruption variable instead of its interaction term in the regression. In the Table 2.6, we drop the interaction term and regresses growth in output per worker for the period 1990-2000 on growth in capital per worker, change in schooling and corruption index. Using the corruption index BI8083 in regression (1) show that both the growth in capital per worker and change in schooling variable are positive and significant at 1% level and 5% level respectively while the coefficient of the corruption index is negative and highly significant at 1% level. A similar pattern of results is also observed by using TI8085, TI8892, TI9500 indices of corruption. The regressions based on ICRG8490, ICRG90 and ICRG9000 although report the same result except one difference that the change in schooling now loses its significance but it gains significance by using the initial output per worker as a proxy for the catch up effect.

As compared to the results in Table 2.4, the results in Table 2.6 are consistent with the empirical findings of Krueger and Lindahl (2001), who report that the increase in average years of schooling has a positive and significant effect for the low frequency data (i.e, 10 or 20 years) while there is lack of relationship between schooling and growth at high frequency (i.e., 5 years) data. The authors suggest measurement errors as the possible explanation for such a finding by claiming that the data at high frequency has more measurement errors than the data at low frequency.

Table 2.6 Human Capital, Corruption and Economic Growth (1990-2000): OLS

Panel (a): Estimation without initial output								
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG84	(6) ICRG8490	(7) ICRG90	(8) ICRG9000
gkpw	0.4541 (0.1366)***	0.6136 (0.1092)***	0.6110 (0.0951)***	0.5537 (0.0892)***	0.5385 (0.0921)***	0.4730 (0.1867)**	0.4630 (0.1844)**	0.4650 (0.1773)**
cschool	0.1667 (0.0640)**	0.2417 (0.0520)***	0.2386 (0.0468)***	0.1645 (0.0465)***	0.0691 (0.0651)	0.0794 (0.0495)	0.0829 (0.0496)*	0.0782 (0.0498)
Corruption	-0.0040 (0.0012)***	-0.0040 (0.0011)***	-0.0050 (0.0010)***	-0.0041 (0.0010)***	-0.0050 (0.0018)***	-0.0060 (0.0021)***	-0.0070 (0.0022)***	-0.0080 (0.0025)***
Constant	-0.0043 (0.0077)	-0.0032 (0.0070)	0.0013 (0.0067)***	0.0055 (0.0071)***	0.0076 (0.0081)	0.0050 (0.0068)	0.0060 (0.0067)	0.0105 (0.0080)
Obs.	65	53	53	82	95	111	111	112
Adjusted R^2	0.3167	0.5470	0.6197	0.4683	0.3389	0.2302	0.2383	0.2553
Panel (b): Estimation with initial output								
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG84	(6) ICRG8490	(7) ICRG90	(8) ICRG9000
gkpw	0.4463 (0.1406)***	0.6140 (0.1116)***	0.6018 (0.0841)***	0.5484 (0.0884)***	0.5300 (0.0884)***	0.4764 (0.1827)**	0.4672 (0.1809)**	0.4650 (0.1752)***
cschool	0.1596 (0.0725)**	0.2411 (0.0528)***	0.2440 (0.0439)***	0.1755 (0.0493)***	0.0883 (0.0682)	0.0703 (0.0570)	0.0729 (0.0576)	0.0782 (0.0573)
Corruption	-0.0030 (0.0015)**	-0.0040 (0.0017)***	-0.0070 (0.0015)***	-0.0050 (0.0018)***	-0.0070 (0.0031)**	-0.0057 (0.0032)*	-0.0060 (0.0030)**	-0.0085 (0.0038)**
Initial Output	0.0019 (0.0043)	0.0007 (0.0042)	-0.0059 (0.0050)	-0.0052 (0.0044)	-0.0050 (0.0055)	0.0020 (0.0050)	0.0019 (0.0045)	0.000004 (0.0051)
Constant	-0.0230 (0.0394)	-0.0110 (0.0467)	0.0647 (0.0547)	0.0609 (0.0482)	0.0573 (0.0551)	-0.0137 (0.0489)	-0.0126 (0.0445)	0.0105 (0.0514)
Obs.	65	53	53	82	95	111	111	112
Adjusted R^2	0.3182	0.5472	0.6295	0.4784	0.3479	0.2315	0.2398	0.2553

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Estimates are OLS with robust standard errors written in parenthesis. Dependent variable is average annual growth in output per worker during 1990-2000. The variable gkpw is average annual growth for 1990-2000; cschool is average annual change in years of schooling, in population over 25 years of age, between 1990 and 2000.

2.4.5 Additional Cross Sectional Evidence (1990-2000): IV Estimation

In Table 2.7, we estimate the regression models as in Table 2.6 but now using instrument variable method during 1990-2000. The regression equations (2) and (3) use ethnolinguistic fractionalization as an instrument for corruption index and show expected signs on all the coefficients, the P-Value of Wu-Hausman confirms the validity of the instruments. Similar pattern of results is observed in regressions (4) and (5) using corruption indices of TI9500 and ICRG84 with voice and accountability index as the instrument for corruption. The coefficient on growth in capital per worker appears with the expected positive coefficient and is mostly significant. The coefficient on change in schooling appears with positive sign but enters insignificantly. The interaction term appears with the expected negative sign in most of the cases but enters insignificantly. These regressions also pass the Wu-Hausman test for the validity of the instruments except for model (8) in panel (a).

A similar pattern of results is observed in panel (b) of Table 2.7. The coefficient on capital per worker is positive and significant for majority of the cases except for model (1), (2) and (6). The coefficient on change in schooling is positive but insignificant in all the models. The coefficient on corruption is negative and insignificant for majority of the cases except for model (1) and (7). The regressions passes Wu-Hausman test for the validity of instruments except the model (4), (5) and (8). Overall, the results in Table 2.7 are similar to the results in Table 2.4.

Table 2.7 Human Capital, Corruption and Growth: Instrumental variable Estimation (1990-2000)

	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG84	(6) ICRG8490	(7) ICRG90	(8) ICRG9000
Panel (a): Estimations without initial output								
gkpw	0.2822 (0.8849)	0.5882 (0.3117)*	0.6736 (0.2537)**	0.5649 (0.0896)***	0.5161 (0.0997)***	0.3851 (0.1301)***	0.3689 (0.1305)***	0.4171 (0.1438)***
cschool	0.7213 (3.0285)	0.4020 (0.5855)	0.4659 (0.6623)	0.2829 (0.2499)	0.0736 (0.3480)	0.5535 (0.9088)	0.6858 (0.8285)	0.1622 (1.1190)
Interaction	-0.5731 (2.1659)	-0.0204 (0.0875)	-0.0365 (0.1716)	-0.0235 (0.0449)	-0.0160 (0.1119)	-0.1905 (0.3253)	-0.2330 (0.2962)	-0.0321 (0.4433)
Corruption	0.0612 (0.2471)	-0.0054 (0.0133)	-0.0036 (0.0117)	-0.0033 (0.0045)	-0.0096 (0.0127)	0.0029 (0.0293)	0.0068 (0.0296)	-0.0148 (0.0481)
Constant	-0.0710 (0.3477)	0.0015 (0.0539)	-0.0111 (0.0623)	0.0009 (0.0271)	0.0232 (0.0417)	-0.0193 (0.0878)	-0.0312 (0.0863)	0.0258 (0.1270)
Observations	52	43	47	82	95	97	97	95
Ad. R^2	0.1340	0.2168	0.3638	0.4144	0.2449	0.0618	0.0337	0.1083
Wu-Hausman F-test (P-Value)	0.6129 (0.6102)	0.5343 (0.6618)	1.4018 (0.2580)	2.3468 (0.1026)	3.5104 (0.0341)	0.5464 (0.5809)	0.5340 (0.5880)	4.4954 (0.0055)
Panel (b): Estimations with initial output								
gkpw	0.2699 (0.6813)	0.4583 (0.3013)	0.6413 (0.3140)**	0.5506 (0.0928)***	0.4927 (0.1157)***	0.3217 (0.4440)	0.4227 (0.1479)***	0.4118 (0.1368***
cschool	0.0081 (1.5850)	0.1202 (0.6248)	0.1564 (0.1489)	0.1975 (0.2718)	0.1146 (0.1672)	0.5095 (1.6855)	0.4543 (0.8333)	0.0604 (1.6901)
Interaction	-0.3180 (1.0245)	0.1190 (0.1589)	-0.5110 (0.7265)	-0.0044 (0.0496)	-0.2765 (0.5011)	-0.1650 (0.5772)	-0.1577 (0.2875)	0.0583 (1.0199)
Corruption	0.0407 (0.1355)	-0.0227 (0.0244)	-0.0339 (0.0280)	-0.0108 (0.0075)	-0.0331 (0.0236)	-0.0491 (0.2148)	0.0202 (0.0393)	-0.0300 (0.1450)
Initial	0.0242 (0.0672)	-0.0151 (0.0313)	-0.0354 (0.0428)	-0.0135 (0.0087)	-0.0176 (0.0107)	-0.0375 (0.1671)	0.0129 (0.0265)	-0.0087 (0.0591)
Constant	-0.0710 (0.3477)	0.1813 (0.3525)	0.4729 (0.5286)	0.0009 (0.0271)	0.2508 (0.1612)	0.4519 (2.0362)	-0.1777 (0.3104)	0.1319 (0.7994)
Observations	52	43	47	82	95	97	96	95
Adjusted R^2	0.0756	0.1236	0.1123	0.4155	0.0022	0.0431	0.1079	0.0367
Wu-Hausman F test (P-Value)	0.5117 (0.7273)	0.6978 (0.5989)	1.3480 (0.2732)	3.1813 (0.0288)	6.0192 (0.0009)	0.5916 (0.6220)	0.1725 (0.9146)	3.5825 (0.0095)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The standard errors are written in parenthesis. Estimates are Instrumental variable estimation with the null hypothesis that regressors are exogenous. The instruments of Ethnolinguistic fractionalization (i.e., ethfrac) and voice and accountability (i.e., va) are used for corruption while share of population aged under 15 years (i.e., pop15) and the share of education spending on GDP (i.e., Edugdp) are used as an instruments for schooling. The 'Growth of capital labor ratio' is the average annual growth for 1990-2000; the 'Change in schooling years' variable is the average annual change in years of schooling, in population over 25 years of age, between 1990 and 2000.

2.5 Conclusion

This aim of this chapter is to explain the impact of human capital on economic growth by investigating relatively unexplored channel of corruption. According to the best of my knowledge, this study is the first attempt that considers the explicit role of corruption in the cross country growth regressions and investigates whether the impact of human capital on economic growth is affected by the presence of corruption in the economy. Although Rogers (2008) considers the implicit role of corruption on the impact of schooling on growth, He only uses corruption index to create the sub-samples of high and low corruption countries. Our empirical analysis first replicates the findings of Rogers (2008) analysis and points out several caveats. The cross country study by Rogers considers corruption index of 1996 for the growth regression 1960-2000. He uses the corruption index at very later period of growth and may be considered as inappropriate corruption index. The relative arbitrary use of corruption index for only creating the sub-samples based on the median value of corruption index. By splitting the full sample into two sub-samples of high and low corruption countries results in the loss of information.

Our empirical analysis improves the Rogers methodology by introducing the dummy variables for high and low corruption countries. The results are repeated with different measures of corruption with different time averages for the robustness of the analysis and estimate the growth equation at intervals of 20 year and 10 year intervals. The role of human capital on economic growth may not be same for different countries. In some countries, highly skills peoples may be utilizing their skills more productively hence contributing to economic growth while in other countries more talented peoples may be utilizing their time in rent seeking activities, hence retarding growth. We consider this as the differences in the country characteristics as the institutional efficiency and may be denoted by the level of corruption in the economy.

Our estimation methodology considers the explicit role of corruption in the growth along with its interaction with the change in schooling by recognizing the fact that as individuals gets more human capital they are diverting their resources from productive activities to the non-productive activities such as rent seeking, bribery and tax evasion or stealing. If this is true then it means that the impact of human capital on growth is reduced by increase in corruption.

The empirical methodology adds the interaction term of the change in schooling with the corruption variable as another explanatory variable in addition to the growth in capital per worker and the change in schooling in the regression model. The analysis is innovative in the sense that it considers all possible countries in the sample by considering as much information as possible and by exploiting the different characteristics of the economies.

The empirical analysis is split into two parts. The first part considers the cross sectional analysis over the 20 year interval (1980-2000) while the second part considers the cross sectional analysis at 10 year interval (1990-2000). The results of the multiplicative interaction term appears with insignificant coefficient on change in schooling and interaction term suggesting that corruption may not be an additional channel for explaining the impact of schooling on growth. The coefficient on corruption appears with significance suggesting that corruption has an impact of growth. Overall, the results suggest that although corruption matter for economic growth but it might not explain the impact of human capital on growth. We have also examined the results by considering the endogeneity of corruption and schooling. The results are not affected by the use of instrument variable estimation.

Appendix

Table A2.1 List of Countries

Corruption	List of Countries
BI8083 (n = 65)	Algeria, Angola, Argentina, Australia, Austria, Bangladesh, Belgium, Brazil, Cameroon, Canada, Chile, Colombia, Denmark, Dominican Republic, Ecuador, Egypt, Finland, France, Germany, Ghana, Greece, Haiti, Hong Kong, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Republic of, Kuwait, Liberia, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Peru, Philippines, Portugal, Saudi Arabia, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Trinidad and Tobago, Turkey, United Kingdom, United States, Uruguay, Zimbabwe
TI8085 and TI8892 (n = 53)	Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Cameroon, Canada, Chile, China, Colombia, Czech Republic, Denmark, Ecuador, Egypt, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kenya, Korea, Malaysia, Mexico, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Philippines, Poland, Portugal, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, Uganda, United Kingdom, United States
TI9500 (n = 82)	Angola, Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Cote d`Ivoire, Czech Republic, Denmark, Ecuador, Egypt, El Salvador, Ethiopia, Finland, France, Germany, Ghana, Greece, Guatemala, Honduras, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Republic of, Lesotho, Malawi, Malaysia, Mauritius, Mexico, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Senegal, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Tanzania, Thailand, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Vietnam, Zambia, Zimbabwe
ICRG84 (n = 95)	Algeria, Angola, Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Bulgaria, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Cote d`Ivoire, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Gabon, Germany, Ghana, Greece, Guatemala, Guinea, Guyana, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Republic of, Kuwait, Liberia, Libya, Malawi, Malaysia, Mali, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Senegal, Singapore, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, UAE, Uganda, United Kingdom, United States, Uruguay, Zambia, Zimbabwe

Table A2.1 List of Countries (Continue)

Corruption	List of Countries
ICRG8490 (n = 111)	Algeria, Angola, Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cameroon, Canada, Chile, China, Colombia, Congo, Republic of, Costa Rica, Cote d`Ivoire, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Finland, France, Gabon, Gambia, Ghana, Germany, Greece, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Liberia, Libya, Madagascar, Malawi, Malaysia, Mali, Mexico, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Senegal, Sierra Leone, Singapore, Somalia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, UAE, Uganda, United Kingdom, United States, Uruguay, Vietnam, Yemen, Zambia, Zimbabwe
ICRG8400 (n = 112)	Algeria, Angola, Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cameroon, Canada, Chile, China, Colombia, Congo, Republic of, Costa Rica, Cote d`Ivoire, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Mali, Mexico, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Senegal, Sierra Leone, Singapore, Somalia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, UAE, Uganda, United Kingdom, United States, Uruguay, Vietnam, Yemen, Zambia, Zimbabwe

Table A2.2 Sources of Data

Abbreviation	Variables	Details and Source
gypw	Growth of GDP per worker (1980-2000 and 1990-2000)	Baier et al. (2006)
initial	Log of GDP per worker (1980 for 1980-2000 and 1990 for 1990-2000)	Ibid.
gkpw	Growth in capital per worker	Ibid.
cschool	Change in schooling (1980-2000 and 19990-2000)	Average annual change in schooling years in adult population from Baier et al. (2006).
schooling	Level of schooling (1980 for 1980-2000 and 1990 for 1990-2000)	Ibid.
BI8083	*Business International (BI) and Political Risk Service, Inc*.	The index ranges from 0 (bad) to 10 (good). Mauro (1995)
ICRG84, ICRG8490 and ICRG8400	*International Country Risk Guide (ICRG)*	The index lies between 0 (corrupt) to 6 (clean). We rescaled the index by deducting this index from 6 so that the larger values show higher corruption. Available online at: www.prsgroup.com
TI8085, TI8892 and TI9500	*Transparency International (TI)*	The index ranges from 0 (bad) to 10 (corrupt). It is available online at: www.transparency.org
Corr (1996)	*Corruption*	Kaufmann et al. (2005) corruption index for 1996 . The index lies between 0 (High Corruption) and 100 (low corruption).

Table A2.3 Replication and Extension of Rogers Results using dummy Variable

Panel (a): Estimations without initial output					
		(1) Corr. 96 1960-2000	**(2) TI9500 1980-2000**	**(3) ICRG8490 1980-2000**	**(4) ICRG8400 1980-2000**
Low Corruption	gkpwd1	0.5159 (0.0963)***	0.4609 (0.0767)***	0.4414 (0.1728)**	0.6057 (0.1799)***
	cschoold1	0.2060 (0.0475)***	0.0956 (0.0688)	0.1512 (0.0585)**	0.0324 (0.0778)
	d1	-0.0224 (0.0062)***	-0.0045 (0.0104)	-0.0131 (0.0073)*	-0.0040 (0.0093)
High Corruption	gkpwd2	0.6806 (0.1119)***	0.6679 (0.0849)***	0.6047 (0.1237)***	0.5150 (0.0764)***
	cschoold2	0.0157 (0.0432)	0.0307 (0.0511)	0.0707 (0.0608)	-0.0049 (0.0575)
	d2	0.0110 (0.0081)	-0.0087 (0.0119)	-0.0084 (0.0097)	-0.0094 (0.0112)
	Observations	76	82	89	110
	Adjusted R^2	0.6251	0.6284	0.4462	0.4134
	Wald F-Test (P-Value)	18.44 (0.0000)	20.74 (0.0000)	8.80 (0.0000)	15.68 (0.0000)
Panel (b): Estimations with initial output					
		(1) Corr. 96 1960-2000	**(2) TI9500 1980-2000**	**(3) ICRG8490 1980-2000**	**(4) ICRG8400 1980-2000**
Low Corruption	gkpwd1	0.4292 (0.0904)***	0.4748 (0.0900)***	0.4414 (0.1673)**	0.6105 (0.1704)***
	cschoold1	0.2850 (0.0578)***	0.0994 (0.0706)	0.0795 (0.0532)	-0.0205 (0.0892)
	lnypwd1	-0.0079 (0.0029)***	0.0016 (0.0040)	0.0054 (0.0028)*	0.0069 (0.0038)*
	d1	0.0354 (0.0199)*	-0.0206 (0.0438)	-0.055 (0.0248)**	-0.0619 (0.0306)**
High Corruption	gkpwd2	0.6345 (0.1271)***	0.6361 (0.0835)***	0.6533 (0.1150)***	0.4433 (0.0833)***
	cschoold2	0.0729 (0.0718)	0.0710 (0.0460)*	0.1399 (0.0563)**	0.0853 (0.0630)
	lnypwd2	-0.0050 (0.0036)	-0.0062 (0.0026)**	-0.0156 (0.0038)***	-0.0088 (0.0037)**
	d2	-0.0119 (0.0315)	0.0535 (0.0488)	0.1566 (0.0406)***	0.1142 (0.0417)*
	Observations	76	82	89	110
	Adjusted R^2	0.6754	0.6497	0.5714	0.4760
	Wald F-Test (P-Value)	14.25 (0.0000)	15.22 (0.0000)	11.96 (0.0000)	10.22 (0.0000)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Estimates are OLS with robust standard errors written in the brackets. The regression (1) is for the period 1960-2000 while the remaining are for the period 1980-2000. The dependent variable is average annual growth in output per worker for corresponding time periods. Where d1 (d2) is dummy for low (high) corrupt countries. ‘Growth of capital labor ratio’ is the average annual growth for corresponding time periods; ‘Change in schooling years’ variable is the average annual change in years of schooling, in population over 25 years of age, between the reference time period. Wald F-test is based on null hypothesis of equal coefficients between the two sub-samples.

Table A2.4 Replication and Extension of Rogers Results (1980-2000)

Panel (a): Estimations without Initial Output						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Sample of Low Corrupt Countries						
gkpw8000	0.5784 (0.1023)***	0.5186 (0.0948)***	0.4766 (0.0886)***	0.4609 (0.0767)***	0.4414 (0.1722)**	0.6057 (0.1799)***
cschool8000	0.0282 (0.0720)	0.0911 (0.0997)	0.1011 (0.0933)	0.0956 (0.0688)	0.1512 (0.0583)**	0.0324 (0.0778)
constant	-0.0002 (0.0108)	-0.0046 (0.0147)	-0.0043 (0.0138)	-0.0045 (0.0104)	-0.0140 (0.0073)*	-0.0040 (0.0093)
Obs.	32	29	26	41	49	55
Adjusted R^2	0.3187	0.3498	0.3064	0.3496	0.3653	0.3216
Sample of High Corrupt Countries						
gkpw8000	0.7499 (0.1193)***	0.8372 (0.1433)***	0.9231 (0.1209)***	0.6679 (0.0849)***	0.6047 (0.1242)***	0.5150 (0.0764)***
cschool8000	0.0509 (0.0733)	0.1088 (0.0698)	0.0978 (0.0629)	0.0307 (0.0511)	0.0707 (0.0610)	-0.0049 (0.0575)
constant	-0.0210 (0.0096)**	-0.0265 (0.0087)***	-0.0277 (0.0080)***	-0.0132 (0.0059)**	-0.0224 (0.0065)***	-0.0134 (0.0062)**
Obs.	30	24	27	41	40	55
Adjusted R^2	0.5019	0.6560	0.7247	0.6204	0.3153	0.3023
Panel (b): Estimations with Initial Output						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Sample of Low Corrupt Countries						
gkpw8000	0.5838 (0.0897)***	0.4749 (0.1591)***	0.4665 (0.1410)***	0.4748 (0.0900)***	0.4414 (0.1665)**	0.6105 (0.1704)***
cschool8000	0.0353 (0.0750)	0.0886 (0.1029)	0.1018 (0.0940)	0.0994 (0.0706)	0.0795 (0.0530)	-0.0205 (0.0892)
initial	0.0027 (0.0023)	-0.0019 (0.0049)	-0.0011 (0.0083)	0.0016 (0.0040)	0.0054 (0.0028)*	0.0069 (0.0038)*
constant	-0.0276 (0.0290)	0.0155 (0.0559)	0.0067 (0.0916)	-0.0206 (0.0438)	-0.0549 (0.0247)**	-0.0619 (0.0306)**
Obs.	32	29	26	41	49	55
Adjusted R^2	0.3283	0.3528	0.3070	0.3522	0.4228	0.3844
Sample of High Corrupt Countries						
gkpw8000	0.7882 (0.1205)***	0.8502 (0.1305)***	0.9328 (0.1189)***	0.6361 (0.0835)***	0.6533 (0.1157)***	0.4433 (0.0833)***
cschool8000	0.1553 (0.0737)**	0.0392 (0.0821)	0.0721 (0.0773)	0.0710 (0.0460)*	0.1399 (0.0567)**	0.0853 (0.0630)
initial	-0.0115 (0.0058)*	0.0068 (0.0045)	0.0024 (0.0038)	-0.0062 (0.0026)**	-0.0156 (0.0038)***	-0.0088 (0.0037)**
constant	0.0674 (0.0465)	-0.0779 (0.0350)**	-0.0463 (0.0289)	0.0329 (0.0215)	0.1018 (0.0323)***	0.0523 (0.0284)*
Obs.	30	24	27	41	40	55
Adjusted R^2	0.6044	0.6876	0.7286	0.6547	0.5223	0.3846

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The estimates are OLS with robust standard errors are written in the brackets. Dependent variable is average annual growth in output per worker during 1980 and 2000. High corrupt countries are the countries with the corruption index greater than the median value of the corresponding corruption index. The 'Growth of capital labor ratio' is average annual growth for 1980-2000; the 'Change in schooling years' variable is the average annual change in years of schooling, in population over 25 years of age, between the reference time period.

Table A2.5 Replication and Extension of Rogers Results (1990-2000)

Panel (a): Estimations without Initial Output									
		(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG84	(6) ICRG8490	(7) ICRG90	(8) ICRG8400
Low corrupt	gkpw8000	0.6205 (0.3045)*	0.5244 (0.1140)***	0.4888 (0.1349)***	0.3478 (0.1602)**	0.6866 (0.1160)***	0.2167 (0.1981)	0.1944 (0.1958)	0.3970 (0.2822)
	cschool8000	0.1214 (0.1037)	0.1715 (0.0815)**	0.2340 (0.0562)***	0.1210 (0.0663)**	0.1411 (0.1125)	0.2696 (0.0879)***	0.2543 (0.0853)***	0.1528 (0.0588)**
	constant	-0.0023 (0.0116)	-0.0088 (0.0090)	-0.0098 (0.0080)	-0.00016 (0.0087)	-0.0087 (0.0132)	-0.0164 (0.0100)	-0.0118 (0.0102)	-0.0120 (0.0098)
	Observations	32	29	26	41	37	49	48	55
	Adjusted R^2	0.2742	0.3998	0.5142	0.2662	0.4524	0.2825	0.2424	0.2214
High corrupt	gkpw8000	0.4033 (0.1361)***	0.4736 (0.1789)**	0.5850 (0.1714)***	0.5773 (0.1130)***	0.5028 (0.1648)***	0.4522 (0.1585)***	0.5349 (0.2190)**	0.5381 (0.1478)***
	cschool8000	0.2245 (0.0798)***	0.4350 (0.1479)***	0.3309 (0.1177)**	0.1762 (0.0909)*	0.0605 (0.1304)	0.1138 (0.1224)	0.0906 (0.1398)	0.0176 (0.0924)
	constant	-0.0330 (0.0110)***	-0.0529 (0.0153)***	-0.0479 (0.0132)***	-0.0256 (0.0089)***	-0.0146 (0.0131)	-0.0223 (0.0141)	-0.0231 (0.0166)	-0.0132 (0.0107)
	Observations	30	24	27	41	36	41	31	58
	Adjusted R^2	0.3251	0.4732	0.4988	0.3984	0.1749	0.1283	0.1439	0.1828

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The estimates are OLS with the robust standard errors are written in parenthesis. The dependent variable is average annual growth in output per worker during 1990-2000. The 'Growth of capital labor ratio' is the average annual growth for 1990-2000; the 'Change in schooling years' variable is the average annual change in years of schooling, in population over 25 years of age, between 1990 and 2000.

Table A2.5 (Continue...) Replication and Extension of Rogers Results (1990-2000)

Panel (b): Estimations with Initial Output									
		(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG84	(6) ICRG8490	(7) ICRG90	(8) ICRG8400
Low corrupt	gkpw8000	0.6164 (0.3132)*	0.5190 (0.2296)**	0.4050 (0.1307)***	0.3284 (0.1562)**	0.7337 (0.1511)***	0.2371 (0.1926)	0.2100 (0.1933)	0.4603 (0.2668)*
	cschool8000	0.1180 (0.1056)	0.1710 (0.0787)**	0.2232 (0.0694)***	0.1247 (0.0710)*	0.1347 (0.1206)	0.2264 (0.0923)**	0.2249 (0.0877)**	0.1165 (0.0522)**
	initial	0.0029 (0.0049)	-0.00032 (0.0097)	-0.0108 (0.0070)	-0.0023 (0.0062)	0.0052 (0.0054)	0.0039 (0.0041)	0.0027 (0.0040)	0.0107 (0.0056)*
	constant	-0.0307 (0.0475)	-0.0054 (0.1019)	0.1022 (0.0768)	0.0230 (0.0658)	-0.06007 (0.0520)	-0.0492 (0.0380)	-0.0342 (0.0379)	-0.1105 (0.0560)**
	Observations	32	29	26	41	37	49	48	55
	Adjusted R^2	0.2791	0.3998	0.5565	0.2692	0.4701	0.2966	0.2495	0.2834
High corrupt	gkpw8000	0.3993 (0.1516)**	0.4456 (0.1815)**	0.6060 (0.1841)***	0.5598 (0.1169)***	0.5504 (0.1685)***	0.4770 (0.1608)***	0.5508 (0.2222)**	0.5312 (0.1461)***
	cschool8000	0.2180 (0.0807)**	0.3266 (0.1159)**	0.2831 (0.1055)**	0.2072 (0.0957)**	0.1385 (0.1279)	0.1781 (0.1273)	0.1465 (0.1559)	0.0472 (0.1216)
	initial	0.0009 (0.0071)	0.0155 (0.0072)**	0.0060 (0.0051)	-0.0045 (0.0066)	-0.0127 (0.0087)	-0.0093 (0.0087)	-0.0072 (0.0108)	-0.0042 (0.0081)
	constant	-0.0406 (0.0604)	-0.1785 (0.0589)***	-0.0967 (0.0480)*	0.0097 (0.0531)	0.0842 (0.0707)	0.0502 (0.0702)	0.0328 (0.0858)	0.0192 (0.0611)
	Observations	30	24	27	41	36	41	31	58
	Adjusted R^2	0.3256	0.5627	0.5139	0.4046	0.2180	0.1483	0.1546	0.1876

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Estimates are OLS with the robust standard errors are written in parenthesis. The dependent variable is average annual growth in output per worker during 1990-2000. The ‘Growth of capital labor ratio’ is the average annual growth for 1990-2000; the ‘Change in schooling years’ variable is the average annual change in years of schooling, in population over 25 years of age, between 1990 and 2000.

Table A2.6 Human Capital and Economic Growth: Role of Corruption (1980-2000)

Panel (a): Estimations without initial output per worker						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG9000
Growth in capital per worker	0.6495 (0.0868)***	0.7484 (0.0800)***	0.7689 (0.076)***	0.6214 (0.0624)***	0.5763 (0.1003)***	0.5463 (0.0863)***
Change in Schooling	0.0569 (0.0486)	0.0871 (0.0522)	0.0889 (0.0487)*	0.0704 (0.0366)*	0.0138 (0.0475	0.0015 (0.0469)
Corruption	-0.0029 (0.0008)***	-0.0030 (0.0005)***	-0.0037 (0.0005)***	-0.0032 (0.0005)***	-0.0050 (0.0010)***	-0.0076 (0.0013)***
Constant	-0.0033 (0.0078)	0.0003 (0.0076)	0.0017 (0.0075)	0.0063 (0.0057)	0.0073 (0.0067)	0.0137 (0.0071)*
Obs.	65	53	53	82	111	112
Adjusted R^2	0.4574	0.6671	0.7168	0.6470	0.4134	0.4485
Panel (b): Estimations with initial output per worker						
	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG9000
Growth in capital per worker	0.6539 (0.0937)***	0.7336 (0.0912)***	0.7329 (0.0801)***	0.6061 (0.0640)***	0.5668 (0.1029)***	0.5249 (0.0902)***
Change in Schooling	0.0801 0.0490)	0.0977 (0.0616)	0.1222 (0.0553)**	0.1074 (0.0364)***	0.0366 (0.0539)	0.0309 (0.0537
Corruption	-0.0039 (0.0013)***	-0.0038 (0.0010)***	-0.0053 (0.0009)***	-0.0052 (0.0008)***	-0.0060 (0.0015)***	-0.0093 (0.0018)***
Initial Output	-0.0047 (0.0041)	-0.0022 (0.0035)	-0.0067 (0.0031)**	-0.0066 (0.0024)***	-0.0030 (0.0029)	-0.0042 (0.0030)
Constant	0.04085 (0.0394)	0.0232 (0.0338)	0.0692 (0.0289)**	0.0719 (0.0238)***	0.0343 (0.0270)	0.0529 (0.0281)*
Obs.	65	53	53	82	111	112
Adjusted R^2	0.4772	0.6700	0.7398	0.6828	0.4221	0.4647

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The standard errors are written under the brackets. ‘Growth of capital labor ratio’ is the average annual growth for 1980-2000; the ‘Change in schooling years’ variable is the average annual change in years of schooling, in population over 25 years of age, between 1980 and 2000.

Table A2.7 Human Capital, Corruption and Economic Growth: First-stage Regressions for Instrumental Variable Estimation (1980-2000)

	(1) BI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG8490	(6) ICRG8400
Growth in capital per worker	6.8724 (15.4575)	19.2619 (20.1510)	26.35149 (19.3601)	2.5923 (10.5057)	-3.8214 (5.9817)	-3.2956 (4.1611)
Change in Schooling	8.7704 (14.8383)	33.5360 (15.1980)**	29.5733 (14.5266)**	4.9637 (11.5771)	-5.0271 (6.7179)	-5.6110 (5.4319)
Ethfract	0.0485 (0.0413)	0.1320 (0.0414)***	0.1179 (0.0403)***	0.0625 (0.0260)**	0.0108 (0.0143)	0.0091 (0.0113)
Interaction	-0.1681 (0.3141)	-0.7569 (0.3644)**	-0.6157 (0.3459)*	-0.2390 (0.2270)	0.0220 (0.1218)	0.0336 (0.0978)
Constant	0.7906 (2.2021)	-1.7661 (2.1449)	-1.4354 (2.1309)	3.0168 (1.6104)*	2.7130 (0.9163)***	2.7895 (0.7255)***
Obs.	63	47	47	72	97	98
R^2	0.1030	0.2681	0.2711	0.2215	0.1213	0.1506
Adj. R^2	0.0411	0.1983	0.2017	0.1750	0.0831	0.1141

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The standard errors are written in parenthesis. Estimates are First-stage regressions of the instrumental variable estimation in table 2.4, Ethfrac is ethnolinguistic fractionalisation. The 'Growth of capital labor ratio' is the average annual growth for 1980-2000; the 'Change in schooling years' variable is the average annual change in years of schooling, in population over 25 years of age, between 1980 and 2000.

Table A2.8 Human Capital, Corruption and Economic Growth: First-stage Regressions for Instrumental Variable Estimation (1990-2000)

	(1) TI8083	(2) TI8085	(3) TI8892	(4) TI9500	(5) ICRG84	(6) ICRG8490	(7) ICRG90	(8) ICRG9000
Growth in capital per worker	16.7571 (9.2883)*	33.3888 (13.8854)**	29.7569 (14.7317)**	1.7053 (4.5102)	1.5079 (3.8426)	-0.1107 (2.9187)	-0.9378 (3.2418)	0.3325 (2.0012)
Change in Schooling	0.2708 (0.6754)	17.5896 (9.9506)*	11.7394 (12.0695)	-4.6433 (8.5636)	0.2824 (7.1817)	-0.8423 (4.0389)	-1.2858 (4.2925)	0.4368 (0.1512)***
Ethfrac	-4.8977 (3.2651)	0.0701 (0.0314)**	0.0914 (0.0212)***	-10.3324 (1.7920)***	-4.0654 (1.7291)**	0.0227 (0.0080)***	0.0166 (0.0084)**	-0.5203 (1.5911)
Interaction	-0.8655 (0.8886)	-0.1770 (0.2284)	-0.4590 (0.1869)**	5.1349 (16.4555)	-13.2127 (14.4887)	-0.0903 (0.0794)	-0.0434 (0.0830)	-0.8916 (0.3174)***
Constant	6.6016 (2.3608)***	-0.3472 (1.6080)	1.2328 (1.4198)	11.1638 (0.8849)***	5.5165 (0.8325)***	2.0829 (0.4911)***	2.1796 (0.5093)***	3.0282 (0.7201)***
Obs.	52	43	47	82	95	97	97	95
R^2	0.5630	0.2214	0.3138	0.5779	0.4704	0.1410	0.0955	0.6021
Adj. R^2	0.5258	0.1395	0.2484	0.5559	0.4469	0.1036	0.0562	0.5844

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The standard errors are written in parenthesis. Estimates are first-stage regressions for results in table 2.7. Ethnolinguistic fractionalization (i.e., Ethfrac) is used as instrument for model (2), (3), (6) and (7) and voice and accountability (i.e., va) is used as instrument for model (1), (4), (5) and (8). The 'Growth of capital labor ratio' is the average annual growth for 1990-2000; 'Change in schooling years' variable is average annual change in years of schooling in population over 25 years of age during 1990-2000.

CHAPTER THREE

HUMAN CAPITAL, INSTITUTIONS AND ECONOMIC GROWTH

3.1. Introduction

Several theoretical literatures based on both neoclassical and endogenous growth theories recognize the importance of human capital in the growth process. The emergence of the neoclassical growth model is considered as the pioneer work in assessing the impact of human capital on economic growth. The augmented neoclassical model explicitly introduces human capital as an additional input in the production function. The endogenous growth models assign the crucial role to human capital accumulation in growth performance. Some scholars, like Romer (1990), stress the role of human capital in the research sector and may lead to technological progress by creating new ideas or products. Nelson and Phelps (1966) postulate that human capital affects growth by determining the country's ability to innovate in new technologies and by facilitating the country to adopt new technologies. Lucas (1988) argues that human capital generates positive externalities to the production process from learning by doing.

Although human capital plays a crucial role in theoretical literature based on both neoclassical and endogenous growth models, the empirical evidence reports only a weak relationship in both cross sectional (Benhabib and Spiegel, 1994 and Pritchett, 2001) as well as in panel data studies (Kumar 2006; Bond, Hoeffler and Temple, 2001; Caselli, Esquivel and Lefort, 1996; Islam, 1995). Numerous studies have attempted to explain the insignificant effect of human capital on growth, including measurement errors (Krueger and Lindahl, 2001), data quality (de la Fuente and Domenech, 2000 and 2002, Cohen and Soto, 2007, Bassanini and Scarpetta, 2001) while others have worked with alternative estimation methodologies (Bassanini and Scarpetta, 2001, 2002; Freire-Serean, 2002).

There is another view that the conventional factors of production such as physical capital, human capital and technology may not be the main driving force behind the growth performance and they may only partially explain cross country differences in growth. Easterly and Levine (2001) suggest that these factors are only the proximate causes of growth and do not explain why countries differ in the efficiency with which they use physical and human capital. It therefore appears that what matters for growth is not only the factor of production which a country has accumulated but also the way in which it combines those factors, the so-called "fundamental causes" of economic growth. Countries differ in the efficiency of the factor accumulation and this may account for the large cross country income differences (see Acemoglu, 2009, Ch 1).

Therefore, studies that recognize the roles of proximate causes of growth, for example the impact of human capital on economic growth, should also consider the importance of factors which may affect the efficiency of this factor accumulation. Another strand of literature recognizes the importance of institutions in economic growth and suggests that institutions are one of the major causes of long run growth (see Hall and Jones, 1999; Acemoglu et al., 2001; Rodrik et al. 2004; Easterly and Levine, 2003; and many others). Acemoglu et al. (2004) argue that institutions are important because they influence the structure of incentives in the economy. For example, poor property rights not only discourage investment in physical and human capital but also make it difficult to innovate to more efficient technologies.

Some researchers have attempted to distinguish between the sources of growth and causes of institutional improvements. The empirical analysis of Glaeser et al. (2004) suggests that initial human capital and institutions are strong predictors of subsequent economic growth. These findings were challenged by Acemoglu and Johnson (2005). They argue that variations in schooling are the major causal factor in explaining differences in growth. The focus of these studies is on the distinction between relative importance's of the determinants of growth.

The analysis in this chapter builds on chapter two and considers host of exhaustive institutional measures along with corruption as an additional measure of institution. We focus on the literature of human capital on growth where human capital often enters insignificantly particularly in the case of developing countries and explain the effects of human capital on growth by introducing the important role of institutions and its indirect effect on growth through human capital. In addition to the direct effects of human capital and institutions, we also consider their joint effect on growth to see whether they appear as substitutes or compliments on their impacts on growth. The literature suggests that although economic growth is largely determined by the accumulation of physical capital and human capital, the role of institutions cannot be ignored. The brief review of the literature on institutions and growth suggest that an improvement in institutional quality leads to higher growth.

On the one hand, the institutional environment can be seen as well established for the sample of developed countries and any further improvement in institutional quality may not enhance the impact of human capital on growth. In this case, a growth maximising strategy would be to focus on only one determinant of growth either institutions or human capital alone but not on both simultaneously. On the other hand, the institutional environment may not be well developed for the sample of developing countries and any improvement in the institutional quality may enhance the impact of human capital on growth. Institutions in this context act as compliment to the human capital and balanced improvements in both human capital and institution may lead to higher growth.

The remaining of the study is organized as follows: The literature review is discussed in Section 3.2. Section 3.3 presents data and econometric methodology. Section 3.4 explains the results and concluding remarks are discussed in Section 3.5.

3.2. Literature Review

The role of human capital is well recognized in both neoclassical and endogenous growth literature. The exogenous growth models like Mankiw, Romer and Weil (1992) highlighted the role of human capital in the growth regressions by explicitly introducing it as an additional factor of production. In the exogenous growth models, the growth rate was determined outside the model and driven by exogenous technological progress.

New growth theory attempted to endogenize the sources of growth and the growth rate was determined within the model. There are two distinct approaches in the endogenous growth literature for incorporating human capital. The first endogenous growth model which regards the accumulation of human capital as an engine of growth is by Lucas (1988). Human capital enters in the production function in labor augmenting form as in the Solow model. The model departs from the constant return to scale assumption by modelling the individual educational investment decisions and by allowing the external effect of human capital. The second approach is due to Romer (1990) and Nelson and Phelps (1966). In Romer (1990) human capital directly affects productivity and determines the nation's ability to innovate to new technologies that are more suited to domestic production, hence leading to endogenous growth. Secondly, the Nelson and Phelps (1966) model assigns to human capital levels a role in influencing the speed of technological catch up and diffusion. An additional channel through which human capital can affect growth is explored by Benhabib and Spiegel (1994). In their opinion human capital has second order effects on the growth process by attracting physical capital investment.

The empirical evidence on the contribution of human capital on growth is surprisingly mixed. Early papers, which rely on cross sectional analysis (Barro 1991; Mankiw Romer and Weil, 1992) choose school enrolment rates as the proxy for human capital, report large and significant effects. However, other cross country studies (Kyriacou, 1991; Benhabib and Spiegel, 1994; Nonneman and Vanhoudt, 1996, Pritchett, 2001) not only report an insignificant relationship but also show a negative impact of human capital on income. Similar patterns of results can also be observed in panel data studies (Kumar, 2006, Bond, Hoeffler and Temple, 2001, Caselli, Esquivel and Lefort, 1996; Islam, 1995; Sacerdoti, Brunschwig and Tang, 1998; Knight, Loayza and Villanueva, 1993).

We explain the insignificant or negative effect of human capital by considering the important role of institutions. We consider both the direct effects of institutions and human capital as well as their joint impact on growth. The joint role of human capital and institutions highlights whether human capital and institutions enforce each other on their impact on growth or they act as substitutes. For the sample of countries with better institutional environment, the impact of human capital on growth may not increase with further improvement in institutional quality. For such group of countries, the more focussed attention is needed on institutions or human capital but not both jointly and hence human capital and institutions appear as substitutes. We first briefly review the literature on institutions and growth and then use various measures of institutions to assess the important role of human capital on economic growth.

Recently, the emphasis in the growth literature has shifted from factor accumulation as the determinant of growth to attempt to identify the fundamental causes of growth, such as the role of institutions in the growth process. Following the work of Douglas North (e.g., North and Thomas 1973, North 1990), the role of institutions in economic performance gained much attention in the growth theory. The argument that institutions, especially in the form of property rights protection and non-distortionary policies, affect incentives to invest to achieve desirable economic outcomes (North, 1990), is supported by econometric results presented in many empirical papers, including Hall and Jones (1999), Acemoglu *et al.* (2001), and Rodrik *et al.* (2004).

Earlier empirical research employs imperfect proxies for institutions to capture the effects of property rights on growth. Some researchers employ measures of revolutions or coups and political assassinations (Barro, 1991; De Long and Summers, 1991; and Benhabib and Spiegel, 1994; Barro and Sala-i-Martin, 1995; Alesina and Perotti, 1996 and Barro, 1996) while others rely on the Gastil (1987) indices of political rights and civil liberties (Kormendi and Meguire, 1985; Scully, 1988; Grier and Tullock, 1989; McMillan, Rausser and Johnson, 1993 and Levine and Renelt, 1992). For example Barro (1996) uses revolutions or coups to investigate the impact of institutions on growth and finds a negative association between revolutions or coups with growth, which disappears when property rights are used as a control variable. Alesina and Perotti (1996) conclude that aggregate indexes of riots, demonstrations, and assassinations do not appear to affect growth but they may reduce investment and saving.

In an early study, Kormendi and Meguire (1985) suggest an indirect effect of institutions on growth through investment, but no causal relation is established due to endogeneity problems, as civil rights is measured contemporaneously with growth and other variables. Scully (1988) examines whether civil, political, and economic rights have a direct efficiency-enhancing effect on growth, and again, the evidence is mixed and is compromised by endogeneity problems. However, these variables capture only incompletely the relevant threats to property and contractual rights. According to Aron (2000), these measures may proxy ineffective property rights.

The study by Knack and Keefer (1995) criticized previous attempts to investigate the impact of institutions on economic performance for using very crude proxies of property rights, such as Gastil's indices of political freedoms and civil liberties, and frequencies of acts of political violence. They highlight that these proxies do not consider the relevant information and therefore do not provide incentives for innovation and investment, and these measures are also highly endogenous. The authors explore the link between institutions, investment and growth using preferred measures based on ICRG (International Country Risk Guide) and BERI (Business Environment Risk Intelligence) data for institutions. The results indicate that property rights have a greater impact on investment and growth when using their measure of institutions as compared to the other measures such as Gastil's index and frequencies of revolutions, coups, and political assassinations which are imperfect proxies for the quality of institutions that protect property rights.

The different aspects of institutions are discussed in Rodrik (2005) (see table A10). He divides institutions into four categories (market creating, market legitimising, market regulating and market stabilising institutions). Following the four-way classification of Rodrik (2005), Bhattacharyya (2009) estimates the relative importance and contribution of market creating, market regulating, market stabilising and market legitimising institutions. He proxies market creating institutions by the ICRG law and order index, market regulating institutions by the Gwartney and Lawson (2005) composite index of regulation (MR) in the credit market, labor market and business in general, market stabilising institutions by the Gwartney and Lawson (2005) sound money (SM) index and market legitimising institutions by Polity IV democracy index. The study concludes with the findings that strong market creating institutions are growth enhancing, market stabilising institutions boost investor confidence and are also good for growth, there exists a growth maximising level of market regulation beyond which it increases red tape and destroys the incentives for investment, while market legitimising institutions are statistically insignificant.

The study by Hall and Jones (1999) defined an overall measure of institutions, which they call social infrastructure[1]. They combined the ICRG data on law and order, bureaucratic quality, risk of expropriation and government repudiation of contracts and Sachs and Warner (1995) index of openness. They suggest that bad institutions reduce aggregate productivity. The EFW index is alternative measure of institution as two of five areas of EFW index (i.e. legal structure and security of property rights and freedom to trade internationally) provide evidence on the issues discussed in Hall and Jones (1999). Dawson (1998) was one of several early empirical studies of cross-country growth incorporating a measure of economic freedom to be published after the appearance of the EFW index. Farr, Lord, and Wolfenbarger (1998) use the EFW index in a causality study of institutions and income levels, and Heckelman (2000) uses the Heritage Foundation's measure of economic freedom to study causality between institutions and growth.

An alternative approach has been proposed by Acemoglu et al. (2001), who measure institutions by the risk of expropriation. The study shows that there is a high correlation between mortality rates faced by soldiers, bishops, and sailors in the colonies and European settlements; between European settlements and early measures of institutions; and between early institutions and institutions today. According to them, Europeans resorted to different styles of colonisation in different parts of the world due to the feasibility of settlement. The mortality rate among Europeans was extremely high in the tropical climate which created health hazards and prevented them from settling there and they concentrated on extracting resources and left behind poor institutions. However, the mortality rate was low in the areas where colonizers encountered less health hazards, which made them ideal for settlement and they established strong institutions in these settlements. The study also documents large effects of institutions on income per capita and emphasizes colonial experience as one of the many factors affecting institutions.

The relative importance of potential "deep determinants" of growth such as institutions, geography and trade is investigated by Rodrik et al. (2004). Their measure of institutions is the composite indicator of property rights and rule of law from Kaufmann et al. (2002).

[1] Hall and Jones (1999) define social infrastructure as "the institutions and government policies that determine the economic environment within which individuals accumulate skills and firms accumulate capital and produce output".

They use settler mortality of Acemoglu et al. (2001) and linguistic origins from Hall and Jones (1999). The results show in the presence of good institutions both geography and openness do not matter for development. However, Glaser et al. (2004) observe that the settler mortality instrument used by Acemoglu et al. (2001) and Rodrik et al. (2004) has strong explanatory power for both institutions and schooling. They argue that European migrants also brought with them their stock of ideas and human capital and not just institutions.

Acemoglu and Johnson (2005) use executive constraints as a proxy for property rights institutions and legal formalism index as a proxy for contracting institutions to separately estimate their contributions on long run growth using a cross sectional framework. They show that ‘property rights institutions’ rather than ‘contracting institutions’ matter for long run growth.

Others have analysed whether institutions cause growth or growth and human capital accumulation lead to institutional improvement, for example Glaeser et al. (2004). The empirical analysis based on OLS results show that initial human capital and institutions (constraints on executive, risk of expropriation, government effectiveness, and autocracy) are strong predictors of subsequent economic growth and also shows that the more basic cause of growth is human capital rather than constraints on executives. Acemoglu and Johnson (2005) challenge the Glaeser et al. (2004) argument that variations in schooling are a major causal factor in explaining differences in political institutions. They show that the effect of schooling on democracy disappears when country fixed effects are included in the regression, indicating omitted factors influence both schooling and democracy in the long run.

Another aspect of institutions highlighted in Rodrik (2005) is market legitimising institutions. The index of democracy can be used to measure market legitimising institutions (Bhattacharyya, 2009). Many researchers made repeated attempts over the years to prove a demonstrable link between economic growth and democracy (see Sirowy and Inkeles 1990 for a review). Studies that use objective measures of democracy tend to find inconclusive results in growth regressions because democracy may have both positive and negative implications for growth through various channels (Alesina and Rodrik 1994; Helliwell 1994; Alesina and Perotti 1996 and others). On the positive side, transparency and accountability may enhance economic and other rights, including respect for contracts.

Adelman and Morris (1967), Weede (1983) and Sloan and Tedin (1987) purported to show that the relationship is a positive one. On the negative side, the consensus required by democratic institutions, or interest group lobbies, may delay responses to shocks and implementation of legislation. Huntington and Dominguez (1975), Marsh (1979) and Landau (1986), for example, found a negative relationship between democracy and growth. Finally, some studies, such as Dick (1974) and Marsh (1988) hypothesize that there is no relationship at all. Gurr's POLITY database is the first attempt to go beyond this democracy/non-democracy dichotomy. Bhattacharyya (2009) also uses the Polity IV democracy index to measure market legitimizing institutions.

The above literature emphasizes the role of institution in growth but often neglects the joint importance of both institutions and human capital in growth regressions. We consider that both institutions and human capital are important determinant of growth and also consider their interaction effect to analyze whether they appear as substitutes or complements on their impact on growth. The interaction term has important implication for growth; it shows the conditional effect of human capital on growth depends on institutional quality. The positive coefficient on interaction term suggests that good institutions and human capital are compliments (i.e. human capital will affect growth only if the institutional quality is better). Conversely, the negative coefficient on interaction term indicates that good institutions and human capital are substitute rather than compliments on their impact on growth. For some sample of developed countries, the institutional environment may be very high and further improvements in institutional quality do not contribute to growth. In that case any improvement in the institutional quality may not enhance the impact of human capital on growth and institutions may act as substitute for human capital. On the other hand, for the sample of countries for which institutional quality is low, an improvement in the institutional environment may enhance the impact of human capital on growth and act as compliment for its role on growth. The interaction effect has important policy implication as it shows whether there is need to consider improvements in both variables simultaneously or individually. Substitutability leads to more focused attention on human capital or institutional quality separately while complementarity requires balanced improvements in both variables simultaneously.

3.3. Data and Methodology

3.3.1. Data

The data on output per worker and capital per worker is available for 140 countries while the schooling data is available for 121 countries. Hence we use a panel of 121 countries (13 high income Non-OECD, 25 High income OECD, 29 low income, 31 lower middle income, 20 upper middle income or 10 East Asia and pacific, 22 Latin American and Caribbean, 8 Middle East and North African, 7 South Asian, 32 Sub-Saharan African and 2 Europe and Central Asian countries or 81 developing and 40 developed countries) (a list of which is given in the Appendix Table A3.1) for the period 1980-2008[2]. The choice of period and countries is due to the availability of data on schooling, growth in output per worker and growth in capital per worker. We follow the standard approach of constructing 5-year period averages (1980-84 to 2005-08) to minimize business cycle effects.

We use growth in output per worker (grgdpwok) as the dependent variable and log of output per worker at the beginning of each five year interval (lnrgdpwork0) to control for convergence. We use eight measures of institutions; quality of governance (QoG), rule of law/ law and order (Rule), economic freedom of the world (EFW), Polity, International Country Risk Guide Measure (ICRG) of corruption and Transparency International (TI) measure of corruption, composite index of regulation (MR) in the credit market, labor market, and business in general and sound money index (SM). The purpose of using various measures of institutions is to capture different aspects of institutions as emphasized in Rodrik (2005) and also to check whether the results are robust to alternative measures of institutions. The details of the institutional measures are given in the following sub-section. The definitions and sources of all variables are provided in Appendix, Table A3.2.

[2] Five year growth rates of the period 1980-2008 are calculated as: 1980-1985, 1985-1990, 1990-1995, 1995-2000, 2000-2005 and 2005-2008.

3.3.2. Measures of Institutions

The term "institution" is multifaceted and difficult to define. The alternative measures of institutions are presented in appendix Table A3.9. Most previous empirical analyses rely on the imperfect measure of property rights institutions and use measures such as Gastil measure of political freedom and civil liberties and coups, revolutions and political assassinations. Recognizing the weaknesses of the early measures of institutions, Knack and Keefer (1995) use data from International Country Risk Guide (ICRG) and Business Environment Risk Intelligence (BERI) which perform better than the earlier measures of institutions. Knack and Keefer (1995) use 'repudiation of government contracts' as a measure of contracting institutions which is criticised by Bhattacharrya (2009) for primarily focusing on institutions which define the relationship between the state and its subjects and by not focusing on institutions which provide the legal framework that enable private contracts to facilitate economic transactions and it is available for only a small sample of countries.

Hall and Jones (1999) build on the Knack and Keefer (1995) indices and define an overall measure of institutions, which they call social infrastructure[3]. It is the average of the government anti-diversion index (i.e., law and order, bureaucratic quality, risk of expropriation, and government repudiation of contracts from ICRG) and the Sachs-Warner index of trade openness, each of which in turn includes five different categories. The resulting index is measured on a scale of 0 to 1 and assigns a higher value to more desirable outcomes. As noticed by Bhattacharyya (2009), this measure is available for only small number of countries and is not suitable for panel data analysis. Also the Sachs-Warner index of trade openness is not measure of institutions. We follow Rodrik (2005) four-way classification to capture different aspects of institutions (see Appendix Table A3.9 for details). We use ICRG data on quality of governance, law and order and corruption to measure market creating institutions. The underlying assumption is that strong law and order reflects that a country enjoys better property rights and contract enforcement. The index is based on a six point scale with a higher value implying better law and order. Better law and order may imply less risk of expropriation and ensures better contract enforcement. Bhattacharyya (2009) and Alesina and Dollar (2000) also use the

[3] Hall and Jones (1999) define social infrastructure as "the institutions and government policies that determine the economic environment within which individuals accumulate skills and firms accumulate capital and produce output".

ICRG law and order measure of institution. There are several advantages of using this index. First, it has sufficiently long time dimension for panel data estimation. Earlier measures of institutions such as 'rule of law index' of Rodrik et al. (2004) and 'legal formalism index' of Acemoglu and Johnson (2005) are available in cross sections and 'expropriation risk' of Acemoglu et al. (2001) is available for the period 1982 to 1997 which is not suitable for dynamic panel data estimation. Second, it can be used to measure both property rights and contracting institutions as suggested by Bhattacharyya (2009).

We use Economic Freedom of the World (EFW) as another measure to capture the market creating institutions. The EFW is considered as the broadest measure due to its availability for a large number of countries and time. The EFW index is based on the classical conception of individual liberty, which emphasizes personal choice, private property, and freedom of exchange. The index covers five areas of freedom which are aggregated into a single summary index of economic freedom. The five major areas of the index are (1) size of government; (2) legal structure and security of property rights; (3) access to sound money; (4) freedom to trade internationally; and (5) regulation of credit, labor, and business. All underlying component data are converted to a scale from 1 (representing the least free) to 10 (most free). The index is available for a large number of countries in five-year intervals from 1975-1995, and annually since 1995. In addition to the EFW index, we also employ two component measures of EFW, the composite index of regulation (MR) in credit market, labor market and business in general and sound money (SM) index to proxy market legitimising and market stabilising institutions respectively. We follow Bhattacharyya (2009) in using these component measures of EFW.

Another measure of institution is the democracy index from Polity IV database (see Table A3.9) that can be used as a proxy for marker legitimising institutions as suggested by Rodrik (2005) and used by Bhattacharyya (2009) for this purpose. Market legitimising institutions can be defined as those that deal with redistribution, manage social conflict, and provide social protection and insurance in the event of a shock (see Bhattacharyya, 2009). The Polity IV democracy index measures the effectiveness of democratic institutions by capturing different shades of democracy and aims to measure the limits of executive powers (Glaeser et al., 2004). The index ranges from 0 to 10 with a high score implying a more democratic system. Several previous studies (see Barro, 1996; Rodrik, 1999; Tavares and Wacziarg, 2001; Glaeser et al., 2004; Acemoglu and Johnson, 2005, Bhattacharyya, 2009; and many others) use this as a measure of democracy. We also employ democracy index as an additional measure of institution.

There is also a strong a view in the literature that corruption should be treated as an institution. Hall and Jones (1999) and Knack and Keefer (1995) include corruption in their overall measure of institutions. The most widely used institutional measure in the literature is provided by ICRG, which dates back to 1984, and covers 140 countries (Political Risk Services 2003). Many researchers have either taken the whole index or sometimes have taken components of the ICRG data. The first widely cited paper to use the ICRG data is Knack and Keefer (1995). Numerous researchers have either taken Knack and Keefer's definition (such as Hall and Jones 1999; Rodrik 1997; Sala-i-Martin 1997 and others), or have used individual components of this index, such as Rodriguez and Rodrik (1999), who used the Bureaucratic Quality measure, Sachs and Warner (1995), who used the Rule of Law measure, Wei (2000), who used the corruption index, and Acemoglu et al. (2001), who used 'Risk of Expropriation'. The other measure is BERI index of political risk that dates back to 1972, which gives better coverage over time compared to the ICRG index, however, it covers a much smaller range of countries. We use ICRG overall measure of corruption as another measure of institution in our empirical analysis.

Given the degree of potential measurement error in one particular survey or index, the use of multiple sources for each country should in theory be more accurate. The two most commonly used datasets that are derived in this fashion are from Transparency International (TI), and the World Bank's Governance Indicators produced by Kaufmann et al. (1999). TI has produced a 'corruption perceptions index' with relatively wide country coverage since 1995. The original number of countries covered was only 41, however, that has now been expanded to 133 countries. The TI corruption index is now a relatively common institutional measure in the literature (for example, see Wei 2000; Gyimah-Brempong 2002; Ng and Yeats 1999; Torrez 2002, among others).

The governance indicators were developed by Kaufmann, Kraay and Zoido- Lobatón (KKZ) in 1999, with the first year of data being 1996–1997. They have taken a similar approach to the TI corruption perceptions index; however, they have attempted to cover a broad range of governance indicators, not just corruption. These indicators are divided into six categories (Voice and accountability, Political instability and violence, Government effectiveness, Regulatory burden, Rule of law, Graft (corruption)). These indicators become widespread in the literature in a very short space of time. For example, Dollar and Kraay (2003) and Rodrik et al. (2004) use the rule of law index, while Easterly and Levine (2003) use all six categories combined into one. However, the KKZ governance indicators are available in cross section only, hence we utilise TI index as another measure of institution.

3.3.3. Econometric Methodology

This section explains the econometric and statistical technique used to estimate the conditional effects of human capital on economic growth using various measures of institutions. In the following subsection, we explain dynamic panel GMM estimation and the post-estimation diagnostics.

3.3.3.1 Dynamic Panel GMM Estimation

We estimate the conditional effect of human capital on growth using the following model.

$$grgdpwok_{i,t} = \alpha_t + \beta_1(lnrgdpwok)_{i,t-1} + \beta_2(gkapw)_{i,t} + \beta_3(School)_{i,t}$$
$$+\beta_4(Institution)_{i,t} + \beta_5(School * Institution)_{i,t} + u_{i,t} \qquad (3.1)$$

where $grgdpwok_{i,t}$ growth in output per worker is constructed by dividing the log difference of output per worker by the number of years to which t relates; the subscripts i and t represent country and time period respectively and are defined as, $i = 1, 2, 3, \ldots., 121,\ \ t = 1, 2, \ldots, 6$; α_t is a period specific intercept; $lnrgdpwok_{i,t-1}$ is log of initial output per worker; $School_{i,t}$ is average years of schooling for the population 25 years and above; $\text{Institution}_{i,t}$ is a measure of institutions; $(\text{School} * \text{Institution})_{i,t}$ is the interaction of human capital and institution; and $u_{i,t}$ is the error term, which is assumed equal to $(\eta_i + \varepsilon_{i,t})$, where η_i is the country specific component that may not have mean zero while $\varepsilon_{i,t}$ is a white noise component that has mean zero.

Equation (3.1) may suffer from the problem of endogeneity because of two reasons; firstly, because the variable $lnrgdpwok_{i,t-1}$ is a component of the dependent variable; secondly, because we treat all right hand side variables as potentially endogenous as they may have feedback effects. The dynamic panel regression accounts for possible endogeneity by using internal instruments, considering the model as a set of equations in first differences and in levels. The endogenous variables in the first-difference equations are instrumented with lags of their levels and the endogenous variables in the level equations are instrumented with lags of their first differences.

We estimate our dynamic panel model by using the GMM estimator of Arellano and Bond (1991). This method eliminates the country specific effects and correlation between country specific effects with explanatory variables by taking the first difference of equation (3.1).

$$\Delta grgdpwok_{i,t} = \alpha_t + \beta_1 \Delta(lnrgdpwok0)_{i,t-1} + \beta_2 \Delta(gkapw)_{i,t} + \beta_3 \Delta(School)_{i,t} + \beta_4 \Delta(Institution)_{i,t} + \beta_5 \Delta(School * Institution)_{i,t} + \Delta\varepsilon_{i,t} \quad (3.2)$$

Although the first difference of equation (3.1) eliminates the country specific effects (η_i), the lagged dependent variable is still endogenous as the term $lnrgdpwok_{i,t-1}$ in $\Delta(\ln rgdpwok)_{i,t-1}$ correlates with $\varepsilon_{i,t-1}$ in $\Delta\varepsilon_{i,t}$. Also the explanatory variables may be endogenous because they may also be related to $\varepsilon_{i,t-1}$. This problem can be overcome by using the lagged values of the explanatory variables as instruments for the differences in endogenous variables as suggested by Arellano and Bond (1991). In our context the following moments should be fulfilled:

$$E\left[lnrgdpwok_{i,t-j}, \Delta\varepsilon_{i,t}\right] = 0 \qquad such\ that\ j \geq 2; t = 3,4,5,6$$
$$E\left[School_{i,t-j}, \Delta\varepsilon_{i,t}\right] = 0 \qquad such\ that\ j \geq 2; t = 3,4,5,6 \qquad (3.3)$$
$$E\left[Institution_{i,t-j}, \Delta\varepsilon_{i,t}\right] = 0 \qquad such\ that\ j \geq 2; t = 3,4,5,6$$
$$\mathrm{E}\left[(School * Institution)_{i,t-1}, \Delta\varepsilon_{i,t}\right] = 0 \qquad such\ that\ j \geq 2; t = 3,4,5,6$$

The system GMM estimator of Arellano and Bover (1995) has added advantages of controlling for the country specific effects by using relevant instruments instead of removing them by first differencing and also for its suitability when “T” is small and “N” is large, as in our case of 6 periods and 121 countries. Given that the correlations between country-specific fixed effects and RHS level variables in equation (3.1) are constant over time, the procedure in one-step system GMM estimation combines the set of equations in first difference and level with suitable lagged level and lagged first differences as instruments respectively.

The additional moment conditions for the system GMM estimator in levels are given as follows:

$$
\begin{aligned}
&E\left[\Delta lnrgdpwok_{i,t-1}.\left(\eta_i + \varepsilon_{i,t}\right)\right] = 0 && \text{for t = 3, 4, 5, 6} \\
&E\left[\Delta School_{i,t-1}.\left(\eta_i + \varepsilon_{i,t}\right)\right] = 0 && \text{for t = 3, 4, 5, 6} \qquad (3.4) \\
&E\left[\Delta Institution_{i,t-1}.\left(\eta_i + \varepsilon_{i,t}\right)\right] = 0 && \text{for t = 3, 4, 5, 6} \\
&E\left[\Delta (School * Institution)_{i,t-1}.\left(\eta_i + \varepsilon_{i,t}\right)\right] = 0 && \text{for t = 3, 4, 5, 6}
\end{aligned}
$$

We use one-step system GMM estimator to estimate the equation (3.1) and use time dummies as strictly exogenous regressors in all regressions. We also treat all RHS variables as endogenous.

3.3.3.2 Post-Estimation Diagnostics

To confirm the consistency of the GMM results, we apply two specification tests to check the validity of the instruments and the assumption of no serial correlation in the error term($\varepsilon_{i,t}$). The first test is the Hansen (1982) *J*-test of over-identifying restrictions to examine the exogeneity of the instruments under the null hypothesis that instrumented variables are uncorrelated with the residuals. It follows χ^2 distribution with $(J - K)$ degree of freedom, where J is the numbers of instruments and K is the number of endogenous variables. The instruments are judged to be valid if the null hypothesis is not rejected.

The second test is the Arellano and Bond (1991) test for serial correlation. This test assumes that there is first order serial correlation but not the second order serial correlation in the first differenced error term ($\Delta\varepsilon_{i,t}$). If the test fails to reject the null hypothesis of no second order serial correlation, we may conclude that the original error term is serially uncorrelated.

3.4. Results

In this section, we present dynamic panel GMM estimation results to explore the link between human capital and economic growth by introducing different institutional measures (i.e., quality of governance, rule of law, EFW, Polity, ICRG, TI, MR and SR) and also the interaction of these institutional variables with human capital.

3.4.1 Human Capital, Institutions and Economic Growth: Evidence from Full Sample of countries

In this sub-section, we use the data on the full sample of countries and begin our investigations by first estimating the baseline model by regressing economic growth on initial output per worker, growth in capital per worker and schooling. The baseline model (1) in Table 3.1 excludes institution and the interaction of institution with schooling from the specification of equation (3.1) above. Models (2) through (9) add institutional measures and their interactions with human capital. Our findings of the one-step system GMM estimation for the full sample of countries are presented in Table 3.1. We test both growth accounting specification and the endogenous growth specification. The former specification relates the growth of human capital to the change in years of schooling and considers change in schooling as proxy for human capital in the growth equation (i.e., Pritchett, 2001 and Bils and Klenow, 2000). The later specification links growth of human capital with the level of years of schooling and uses this in the growth equation (Lucas, 1988 and Romer, 1990). For all tables, Panel (a) reports the results of regressions using the level of schooling as the measure of human capital, while Panel (b) reports the results using the change in schooling.

The baseline model (1) shows a negative sign on the initial output per worker which is consistent with the technological catch-up hypothesis (Dowrick and Nguyen, 1989). The coefficient on the growth in capital worker is positive and highly significant at 1% level, while schooling is positive and insignificant. The insignificant coefficient is also observed in earlier empirical literature (i.e., Kumar, 2006; Nonneman and Vanhoudt, 1996; De Gregorio, 1992 and others). We consider both the direct effects of institutions and human capital as well as their interaction term in models (2) through (9). The measures of institutions are quality of governance (QOG), rule of law (Rule), economic freedom of the world (EFW), democracy (Polity), two measures of corruption; International Country Risk Guide (ICRG) and Transparency International (TI), composite index of regulation (MR) in the credit market, labor market, and business in general and sound money index (SM).

In all these models the coefficient on the growth in capital per worker is positive and highly significant at 1 % level and ranges from 0.9069 to 1.0857. The coefficient on schooling in models (2) through (9) becomes significant at 10% or higher and substantially increases in magnitude as compared to the baseline model (1). Models (2), (3), (4), (5), (8) and (9) report positive coefficients on QOG, Rule, EFW, Polity, MR and SM. The coefficient on Rule and Polity is significant at the 1% level; the coefficient on QOG is significant at 5% level; the coefficient on SM is significant at 10% level while the coefficient on EFW and MR is insignificant. We also performed a joint significance test on schooling, institutions and the interaction of schooling and institutions. The joint test show significance at 1% level on model (3), (5), (6) and (8); 5% level on model (4), (7) and (9); 10% level on model (2).

The positive coefficients on the institutional variables in models (2) through (5) suggest that an improvement in the institutional quality enhances economic growth which is consistent with the empirical literature on institutions and growth (See for example, Hall and Jones, 1999; Knack and Keefer, 1995; Acemoglu et al. 2001; Glaeser et al., 2004, Bhattacharyya 2009; and others). Models (6) and (7) use ICRG and TI measures of corruption for institutions and report expected negative coefficient on both ICRG and TI. The coefficient on TI is significant at 5% level while ICRG is insignificant.

The negative coefficient on ICRG and TI is consistent with the empirical literature of corruption and growth. The interaction term of the institutional variables and human capital is negative in many cases except for model (7) for which the interaction term is positive. The coefficient on the interaction term in model (2) is significant at 10%; the coefficient on interaction in models (3), (8) and (9) is significant at 5% level while the coefficient on interaction in models (4) through (7) is insignificant. The negative interaction on models (2) through (5) shows that direct effect of human capital on growth decreases with the increase in institutional quality. It suggests that human capital and institutional variables are substitutes for their impact on economic growth. One implication of this result is that more focused attention should be given to either human capital or institutions individually and not on the balanced improvements on both variables jointly. Although the interaction term in model (6) is negative and insignificant, it suggests that the impact of human capital may be conditional on the level of corruption and human capital may lose its impact on economic growth as the level of corruption increases. All the regressions estimates are satisfactory as they do not reject the Hansen (1982) J-test as well as the Arellano and Bond AR (2) test. Overall, the results in panel (a) of Table (3.1) suggest that the results in model (3) best explain growth where law and order (Rule) is used as the measure of institution and highlights the importance of market creating institutions.

Panel (b) of Table 3.1 uses the alternative growth accounting specification where the change in schooling is used as proxy for human capital instead of the level of schooling. Again, the coefficient on schooling is insignificant for the baseline estimation in model (1). All the models report results broadly similar to panel (a). Although the signs of the coefficients on each model are same to the models in panel (a) but the coefficients of $\Delta School$ for the models in panel (b) lose its significance for majority of the cases. The coefficient on institution and interaction term appears with the expected sign. The post-estimation diagnostics again confirms that estimates are adequate. Overall the results in panel (b) provide some support to the results in panel (a) and also suggest that the specification in panel (a) is better than the specification in panel (b). Again, model (3) in panel (b) highlights the importance of market creating institutions.

Table 3.1 Human Capital, Institutions and Economic Growth: Evidence from full Sample of countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0053 (0.0040)	-0.0117** (0.0055)	-0.0227*** (0.0054)	-0.0077* (0.0043)	-0.0129*** (0.0045)	-0.0450*** (0.0095)	-0.0772*** (0.0282)	-0.0225*** (0.0039)	-0.0081* (0.0041)
gkapw	0.7320*** (0.1677)	0.9786*** (0.1067)	1.0857*** (0.0083)	0.9457*** (0.1286)	0.9069*** (0.1466)	1.0829*** (0.0149)	1.0843*** (0.0138)	1.0788*** (0.0171)	0.9389*** (0.1346)
School	0.0051 (0.0031)	0.0219** (0.0097)	0.0270*** (0.0095)	0.0240** (0.0118)	0.0099* (0.0051)	0.0300*** (0.0102)	0.0248* (0.0129)	0.0372*** (0.0100)	0.0282*** (0.0097)
Institution		0.0633** (0.0312)	0.0101*** (0.0036)	0.0009 (0.0059)	0.0017*** (0.0006)	-0.0017 (0.0033)	-0.0164** (0.0068)	0.0055 (0.0040)	0.0039* (0.0023)
Interaction		-0.0228* (0.0118)	-0.0035** (0.0016)	-0.0022 (0.0018)	-0.0005 (0.0004)	-0.0009 (0.0017)	0.0008 (0.0020)	-0.0032** (0.0015)	-0.0024** (0.0010)
Constant	0.0404 (0.0322)	0.0602 (0.0427)	0.1537*** (0.0402)	0.0479 (0.0500)	0.1004*** (0.0362)	0.3817*** (0.0837)	0.7645*** (0.2815)	0.1459*** (0.0400)	0.0295 (0.0369)
Observations	1,131	502	496	629	1,026	505	358	616	716
Countries	121	103	103	103	112	104	106	105	105
Instruments	101	68	52	78	102	27	22	74	122
Arellano Bond AR(1) (P-Value)	-3.5930 (0.0003)	-2.1460 (0.0318)	-2.1030 (0.0355)	-5.4570 (0.0000)	-3.15800 (0.0016)	-2.2070 (0.0273)	-2.9280 (0.0034)	-5.2250 (0.0000)	-5.4820 (0.0000)
Arellano Bond AR(2) (P-Value)	-0.6240 (0.5330)	-0.3560 (0.7220)	-0.1240 (0.9010)	-0.2940 (0.7680)	-0.8380 (0.4020)	-0.1410 (0.8880)	-0.7280 (0.4670)	0.3130 (0.7540)	-1.0700 (0.2840)
Hansen J-test (P-Value)	109.9000 (0.1740)	72.6500 (0.1670)	58.5500 (0.1010)	81.7900 (0.2010)	103.2000 (0.2900)	25.1700 (0.2400)	23.3300 (0.1050)	71.0400 (0.3770)	100.5000 (0.8470)

Table 3.1 (Continue...) Human Capital, Institutions and Economic Growth: Evidence from full Sample of countries

Panel (b): Change in Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	0.0018 (0.0035)	-0.0349*** (0.0122)	-0.0183** (0.0074)	-0.0002 (0.0075)	-0.0095 (0.0105)	-0.0120 (0.0109)	-0.0011 (0.0050)	-0.0017 (0.0043)	0.0029 (0.0040)
gkapw	0.7758*** (0.1595)	0.8985*** (0.1883)	1.0845*** (0.0087)	0.7975*** (0.2435)	0.8245*** (0.1633)	0.9651*** (0.1566)	0.9186*** (0.1593)	0.9780*** (0.1034)	0.7652*** (0.2049)
∆School	0.0082 (0.0094)	0.0265 (0.1195)	0.0789* (0.0447)	0.1291 (0.1360)	0.0728* (0.0393)	0.0518 (0.0638)	0.0032 (0.0192)	0.0304 (0.1140)	0.0062 (0.0450)
Institution		0.1965*** (0.0693)	0.0113*** (0.0037)	0.0046 (0.0068)	0.0031* (0.0017)	-0.0009 (0.0046)	-0.0013 (0.0022)	0.0050 (0.0061)	0.0012 (0.0021)
Interaction		-0.0070 (0.1488)	-0.0141* (0.0078)	-0.0254 (0.0209)	-0.0083** (0.0042)	-0.0161 (0.0207)	-0.0042 (0.0057)	-0.0038 (0.0189)	-0.0001 (0.0050)
Constant	-0.0208 (0.0324)	0.2110** (0.0940)	0.1228** (0.0594)	-0.0212 (0.0591)	0.0685 (0.0923)	0.1182 (0.1074)	0.0191 (0.0561)	-0.0187 (0.0352)	-0.0396 (0.0349)
Observations	1,131	502	496	629	1,026	505	358	616	716
Countries	121	103	103	103	112	104	106	105	105
Instruments	119	31	52	30	12	20	63	84	93
Arellano Bond AR(1) (P-Value)	-3.5650 (0.0004)	-2.1670 (0.0303)	-2.1580 (0.0310)	-4.5860 (0.0000)	-3.0840 (0.0020)	-2.2020 (0.0276)	-3.8030 (0.0001)	-5.4670 (0.0000)	-5.0990 (0.0000)
Arellano Bond AR(2) (P-Value)	-0.6570 (0.5110)	-0.8920 (0.3730)	-0.2650 (0.7910)	-1.1770 (0.2390)	-0.8460 (0.3980)	-0.3150 (0.7530)	-1.1710 (0.2410)	0.0359 (0.9710)	-1.4780 (0.1390)
Hansen J-test (P-Value)	119.0000 (0.3800)	30.3000 (0.2130)	52.2100 (0.2450)	32.9300 (0.1050)	6.4440 (0.3750)	18.7100 (0.1760)	61.5800 (0.3160)	87.5400 (0.2160)	90.1100 (0.3880)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

3.4.2 Human Capital, Institutions and Economic Growth: Evidence from Disaggregated Sample

In this subsection, we provide the evidence by disaggregating the full sample of countries into the subsamples of developing/developed, income groups and regional groups to analyze the link between human capital, institutions and economic growth. This disaggregation is helps to analyze the experience of the sample of countries which are at the same stage of development. It is therefore useful to compare the impact of human capital and institution across different group of countries. Results in Table 3.2 to 3.8 are organized in the same way as in Table 3.1.

3.4.2.1 Results from the sample of Developing and Developed Countries

Dividing the countries into sub-sample of developing and developed countries may be useful to investigate the relative importance of human capital and institutions in the growth regressions. For example, Pritchett (2001) argues that poor institutional framework and low quality of schooling in the developing countries may be responsible for the lack of empirical link between human capital and growth.

Table 3.2 reports the results for the sample of developing countries. The coefficient on initial output per worker (lnrgdpwok0) is negative suggesting the catch-up hypothesis, and the coefficient on growth in capital per worker (gkapw) is 0.7564 which is also highly significant at 1% with very similar values to the model for all countries in Table 3.1. The coefficient on schooling enters with a negative sign. The negative coefficient on schooling is often reported in the empirical literature on human capital and economic growth (i.e., Bond, Hoeffler and Temple, 2001; Islam 1995) and it is even negative and significant (i.e., Knight, Loayza and Villanueva, 1993; Caselli, Esquivel and Lefort, 1996). We explain the negative coefficient by considering the conditional effects of human capital on economic growth by using various measures of institutions (i.e., QOG, Rule, EFW, Polity, ICRG, TI, MR, and SM). As compared to the baseline model (1) in Table 3.2 where schooling enters with a negative coefficient, the coefficient on schooling becomes positive for all the models (2) through (9) and significant at 5% level for models (2) and (4) while it is significant at 10% for models (5) and (6).

The coefficient on institution in Table 3.2 is similar in Table 1 for models (2) through (6) except for model (7). Institutional variable enters with positive sign and significant at 1% level for model (2), significant at 5% level for model (5), significant at 10% level for model (3) and approaching to 10% level for model (4). Models (2) through model (5) suggest positive impact of institution on growth as found in the literature on institutions and growth (See for example, Hall and Jones, 1999; Knack and Keefer, 1995; Acemoglu et al. 2001; Glaeser et al., 2004, Bhattacharyya 2009; and others). Model (6) report negative coefficient on ICRG which suggest that corruption has an adverse impact on growth and is consistent with the literature on corruption and growth. The coefficient on interaction term is higher in magnitude in Table 3.2 as compared to the corresponding results in Table 3.1. Interaction term in models (2), (4) and (5) is negative and significant at 5% level while it is approaching towards 10% level for model (3). The coefficient on the interaction term for models (6) and (8) is nearly significant at 10% level while it is negative and insignificant for models (7) and (9). The negative coefficient on models (2) through model (5) and in models (8) and (9) indicate the human capital and institutions are substitutes while the negative coefficient on models (6) and (7) show that impact of schooling on growth reduces with the increase in corruption. The results in the baseline model report a negative sign on schooling that may be the result of the omitted variable bias of not including the institutions and the interaction term of institution and schooling. The results in model (2) with QoG measure of institution are better than other specifications and suggest the importance of market creating institutions as in Table 3.1.

Panel (b) of Table 3.2 repeats the analysis by using the change in schooling instead of level of schooling. The baseline model shows positive but insignificant coefficient on the change in schooling which can also be found in the previous empirical literature of human capital and growth (see Kumar, 2006 and Nonneman and Vanhoudt, 1996). The coefficient on change in schooling becomes significant in the majority of the cases when we include the institutional measures and their interaction with change in schooling. We also find the correct sign on institutions and interaction term while in some cases the coefficients are insignificant. Overall results provide some support for the specification in panel (a). Again, model (3) highlights the importance of market creating institutions. One feature of the results in Table 3.2 is that there is substantial variation on the coefficient of the schooling variable, depending on the institutional measure used.

Table 3.2 Human Capital, Institutions and Economic Growth: Evidence from Developing countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
Initial	0.0144 (0.0156)	-0.0182** (0.0083)	-0.0050 (0.0045)	-0.0141 (0.0099)	-0.0067 (0.0043)	-0.0447*** (0.0109)	-0.0077 (0.0075)	-0.0036 (0.0058)	-0.0184** (0.0088)
gkapw	0.7564*** (0.2252)	1.0835*** (0.0086)	1.0706*** (0.0648)	0.9462*** (0.1460)	0.9823*** (0.1120)	1.0782*** (0.0130)	0.8694*** (0.1948)	0.8230*** (0.1738)	0.9142*** (0.1682)
School	-0.0064 (0.0094)	0.0395** (0.017)	0.0224 (0.0203)	0.0831** (0.0352)	0.0066* (0.0039)	0.0500* (0.0255)	0.0088 (0.0346)	0.0434 (0.0312)	0.0483 (0.0332)
Institution		0.1089*** (0.0396)	0.0189* (0.0101)	0.0104 (0.0087)	0.0022** (0.0009)	-0.0008 (0.0050)	0.0047 (0.0098)	0.0036 (0.0066)	0.0005 (0.0100)
Interaction		-0.0675** (0.0316)	-0.0072 (0.0060)	-0.0117** (0.0054)	-0.0012** (0.0005)	-0.0049 (0.0040)	-0.0007 (0.0054)	-0.0064 (0.0051)	-0.0049 (0.0050)
Constant	-0.1237 (0.1281)	0.1006 (0.0647)	-0.0131 (0.0426)	0.0467 (0.0840)	0.0482 (0.0353)	0.3682*** (0.0906)	0.0281 (0.1104)	0.0005 (0.0412)	0.1370 (0.0888)
Obs.	748	320	316	393	706	325	208	379	466
Countries	81	66	66	67	79	67	68	69	69
Instruments	11	60	43	32	102	27	29	67	12
Arellano BondAR(1) (p-value)	-2.8260 (0.0047)	-1.9980 (0.0457)	-1.7610 (0.0783)	-4.2730 (0.0000)	-2.8140 (0.0049)	-2.0920 (0.0365)	-2.2920 (0.0219)	-4.2270 (0.0000)	-4.1850 (0.0000)
Arellano BondAR(2) (p-value)	-0.4970 (0.6190)	-0.3620 (0.7170)	-0.3360 (0.7370)	-1.2050 (0.2280)	-0.5790 (0.5620)	-0.3750 (0.7080)	-1.4620 (0.1440)	-1.1950 (0.2320)	-1.3320 (0.1830)
Hansen J-test (P-Val)	8.3840 (0.3000)	59.0700 (0.2950)	39.0700 (0.3770)	32.3700 (0.1810)	75.5200 (0.9390)	28.8200 (0.1180)	26.2200 (0.2910)	62.1100 (0.4360)	3.7470 (0.7110)

Table 3.2 (Continue...) **Human Capital, Institutions and Economic Growth: Evidence from Developing countries**

Panel (b): Change in Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
Initial	-0.0184 (0.0138)	-0.0068 (0.0068)	-0.0077 (0.0096)	-0.0021 (0.0067)	-0.0216** (0.0104)	-0.0208** (0.0090)	0.0051 (0.0169)	0.0081 (0.0066)	-0.0072 (0.0093)
gkapw	0.7728*** (0.1701)	1.0397*** (0.0965)	1.0326*** (0.1149)	0.9500*** (0.1351)	0.9318*** (0.1236)	1.0497*** (0.0844)	0.9585*** (0.2085)	1.0010*** (0.0826)	0.8925*** (0.1528)
ΔSchool	0.0594 (0.0470)	0.2184 (0.1587)	0.2292* (0.1383)	0.0108 (0.2158)	0.0581* (0.0351)	0.0543 (0.1433)	0.0178 (0.1707)	0.0891 (0.2001)	0.0913 (0.1322)
Institution		0.2114** (0.0847)	0.0206* (0.0121)	0.0009 (0.0078)	0.0017* (0.0010)	-0.0066 (0.0092)	0.0155 (0.0164)	0.0024 (0.0102)	0.0003 (0.0045)
Interaction		-0.5057* (0.2937)	-0.0778* (0.0430)	0.0095 (0.0402)	-0.0021 (0.0034)	-0.0077 (0.0323)	-0.0047 (0.0310)	-0.0184 (0.0337)	-0.0084 (0.0201)
Constant	0.1453 (0.1127)	-0.0324 (0.0503)	0.0052 (0.1058)	-0.0040 (0.0594)	0.1716** (0.0855)	0.2148** (0.0943)	-0.1505 (0.2131)	-0.0866 (0.0768)	0.0488 (0.0756)
Obs.	748	320	316	393	706	325	208	379	466
Countries	81	66	66	67	79	67	68	69	69
Instruments	14	39	22	36	52	28	28	53	44
Arellano BondAR(1) (p-value)	-3.0880 (0.0020)	-1.8560 (0.0635)	-1.8140 (0.0696)	-4.1170 (0.0000)	-2.9110 (0.0036)	-1.9570 (0.0503)	-2.1540 (0.0313)	-4.1610 (0.0000)	-4.0520 (0.0000)
Arellano BondAR(2) (p-value)	-0.4570 (0.6480)	-0.790 (0.4290)	-0.4600 (0.6450)	-1.3960 (0.1630	-0.5620 (0.5740)	-0.4520 (0.6520)	-1.2960 (0.1950)	-1.2490 (0.2120)	-1.7470 (0.0806)
Hansen J-test (P-Val)	11.9100 (0.2910)	0.3810 (35.2000)	0.0040 (21.4300)	0.0266 (29.8100)	2.33e-08 (48.2500)	0.0001 (29.8900)	0.0121 (27.1500)	51.0800 (0.3170)	47.0500 (0.1490)

Note: Dependent variable is growth in output per worker, the robust standard errors reported in parenthesis,* indicates significant at 10% level, ** Indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table 3.3 reports one-step system GMM estimates for the sample of developed countries. Panel (a) shows that the coefficient on schooling is positive and marginally significant in the baseline model (1) as contrast to the negative and insignificant coefficient on schooling in model (1) of Table 3.2 for the case of developing countries. The significance of the schooling increases by including institution and interaction for majority of the models except model (4), (7) and (9). The coefficient on institutional variable appears with anticipated sign, positive for models (2) through (5) and also in models (8) and (9) while it is negative for models (6) and (7). It is highly significant at 1% level for model (3), significant at 5% level for model (8) while marginally significant at 10% level for model (7).

The interaction term is negative and significant at 1% level for models (2) and (3), significant at 10% level for model (8) suggesting that institutional variables and human capital are substitutes. The interaction term for model (6) is negative and insignificant suggesting that corruption reduces the impact of human capital on growth. The results are better in model (3) with the institutional measure of law and order (Rule) as compared to other measures of institutions suggesting the importance of market creating institutions. The results in panel (b) show the correct signs on all the models but the estimates become insignificant. Again in panel (b) the results in model (3) with institutional measure of law and order (Rule) are better as compared to the other institutional measures. It again recognises the importance of market creating institutions.

The coefficient on schooling is often larger in Table 3.3 than Table 3.2 and it is also more often significant. There is also less evidence of interaction effects for developed countries, it may be that there is not much variation in the institutional variables across these countries because they typically have strong institutions. The comparison of the results in Tables 3.2 and 3.3 suggest that it is group of developing countries that lacks in quality of human capital and good institutional framework which are not supporting their productive impact on growth as compared to the developed countries.

Table 3.3 Human Capital, Institutions and Economic Growth: Evidence from sample of Developed countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
Initial	-0.0235 (0.0219)	-0.0672*** (0.0237)	-0.0452** (0.0176)	-0.0861*** (0.0109)	-0.0536*** (0.0194)	-0.0499** (0.0237)	-0.0237 (0.0185)	-0.0623*** (0.0187)	-0.0276 (0.0412)
gkapw	0.7594** (0.3041)	0.0768 (0.4197)	0.0362 (0.2880)	0.0446 (0.1801)	0.5835*** (0.1355)	0.1809 (0.2841)	0.7204*** (0.1631)	0.2791* (0.1534)	0.3798* (0.2092)
School	0.0107* (0.0065)	0.0779*** (0.0240)	0.0601*** (0.0220)	0.0067 (0.0151)	0.0239** (0.0119)	0.0273*** (0.0076)	0.0027 (0.0069)	0.0399*** (0.0146)	0.0376 (0.0338)
Institution		0.1501 (0.1005)	0.0272*** (0.0096)	0.0042 (0.0072)	0.0002 (0.0013)	-0.0022 (0.0047)	-0.0069* (0.0038)	0.0222** (0.0098)	0.0070 (0.0081)
Interaction		-0.0763** (0.0304)	-0.0098** (0.0039)	0.0013 (0.0022)	-0.0006 (0.0007)	-0.0011 (0.0018)	0.0014 (0.0012)	-0.0047* (0.0025)	-0.0032 (0.0043)
Constant	0.2192 (0.2162)	0.5623** (0.2715)	0.3282 (0.2095)	0.8489*** (0.1320)	0.5128*** (0.1862)	0.4724* (0.2556)	0.2537 (0.1862)	0.5022** (0.2106)	0.2115 (0.4739)
Obs.	383	182	180	236	320	180	150	237	250
Countries	40	37	37	36	33	37	38	36	36
Instruments	20	31	47	32	27	12	45	17	12
Arellano BondAR(1) (P-Val.)	-2.4870 (0.0129)	-1.7970 (0.0723)	-1.7300 (0.0837)	-1.8940 (0.0582)	-2.1650 (0.0304)	-1.4810 (0.1390)	-2.9510 (0.0031)	-2.0270 (0.0426)	-1.9540 (0.0507)
Arellano BondAR(2) (P-Val.)	-0.5740 (0.5660)	1.4960 (0.1350)	1.5780 (0.1150)	2.7260 (0.0064)	-0.6140 (0.5390)	1.8990 (0.0575)	1.1840 (0.2370)	1.2780 (0.2010)	1.4890 (0.1370)
Hansen J-test (P-Value)	20.5800 (0.1950)	28.7500 (0.2750)	34.5000 (0.7530)	27.7800 (0.3690)	27.8000 (0.1460)	8.6350 (0.1950)	30.7800 (0.8230)	11.0300 (0.4410)	7.4060 (0.2850)

Table 3.3 (Continue...) Human Capital, Institutions and Economic Growth: Evidence from sample of Developed countries

Panel (b): Change in Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
Initial	-0.0058 (0.0096)	0.0069 (0.0145)	-0.0614*** (0.0151)	-0.0235* (0.0129)	-0.0112 (0.0090)	-0.0140 (0.0168)	-0.0044 (0.0089)	-0.0264 (0.0331)	-0.0381*** (0.0097)
gkapw	0.7301*** (0.1569)	0.2938 (0.2673)	0.0743 (0.2434)	0.1911 (0.2048)	0.7483*** (0.1905)	0.1193 (0.8829)	0.6819** (0.2807)	0.0434 (0.3928)	0.0175 (0.1272)
ΔSchool	0.0008 (0.0073)	0.0353 (0.1203)	0.0650 (0.1102)	0.1147 (0.1383)	0.0489 (0.0468)	0.0053 (0.0416)	0.0022 (0.0213)	0.1128 (0.0817)	0.0783 (0.1021)
Institution		0.0469 (0.0544)	0.0189** (0.0076)	0.0102 (0.0089)	0.0015 (0.0015)	0.0053 (0.0062)	-0.0014 (0.0038)	0.0142** (0.0071)	0.0097** (0.0046)
Interaction		-0.0580 (0.1451)	-0.0117 (0.0191)	-0.0143 (0.0186)	-0.0039 (0.0047)	-0.0134 (0.0143)	-0.0005 (0.0067)	-0.0166 (0.0130)	-0.0077 (0.0111)
Constant	0.0605 (0.1039)	-0.0993 (0.1678)	0.5646*** (0.1648)	0.1857* (0.0973)	0.0997 (0.0941)	0.1559 (0.1682)	0.0545 (0.0962)	0.2022 (0.3187)	0.3329*** (0.0884)
Obs.	383	182	180	236	320	180	150	237	250
Countries	40	37	37	36	33	37	38	36	36
Instruments	14	30	31	55	17	12	25	34	34
Arellano BondAR(1) (P-Val.)	-3.4240 (0.0006)	-1.5320 (0.1260)	-1.5520 (0.1210)	-2.3060 (0.0211)	-2.8420 (0.0044)	-1.7760 (0.0758)	-3.0890 (0.0020)	-1.6080 (0.1080)	-2.0720 (0.0383)
Arellano BondAR(2) (P-Val.)	-0.5610 (0.5750)	1.7400 (0.0818)	1.2030 (0.2290)	2.5630 (0.0104)	-0.9370 (0.3490)	1.4450 (0.1490)	1.3290 (0.1840)	0.6960 (0.4860)	2.3090 (0.0209)
Hansen J-test (P-Value)	8.1290 (0.6160)	31.3400 (0.1440)	33.6400 (0.1160)	34.4900 (0.9420)	12.9400 (0.2970)	6.3290 (0.3870)	26.7500 (0.1110)	32.7300 (0.2460)	33.8300 (0.2060)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

3.4.2.2 Results from Different income Groups

In this sub-section, we estimate the models of Table 3.1 using one-step system GMM method by disaggregating the full sample of countries into different income groups. We disaggregate the whole sample according to the income groups to see whether the impact of human capital will vary in different income groups and also to analyse whether conditional effect of human capital and institutions matter more in low income groups as human capital is often an issue for this group of countries.

Table 3.4 shows the results for low income countries. Similar to the results in Table 3.2 for the case of developing countries, the baseline model (1) in Table 3.4 also report a negative and insignificant coefficient on schooling suggesting that schooling does not matter for the group of low income countries. The empirical literature on human capital and economic growth often reports a negative and insignificant coefficient on schooling (i.e., Bond, Hoeffler and Temple, 2001; Islam, 1995). We explain negative coefficient by considering the joint role of institutions and human capital in addition to their direct effects on growth by using various measures of institutions (i.e., QoG, Rule, EFW, ICRG, TI, MR and SM).

Models (2) through model (9) include institutional variable as well as the interaction of institution and schooling and report positive and significant coefficient on schooling for majority of the cases. These models report the expected sign on institutions, positive for models (2), (3), (4), (5), (8) and (9) while negative on models (6) and (7). As in Table 3.2, the interaction term in Table 3.4 is also negative for models (2), (3), (4), (5), (8) and (9) suggesting that schooling and institutions are substitutes while the negative coefficient on models (6) and (7) suggest the impact of schooling on growth is diminished by the increase in the level of corruption. Together, the evidence suggests that impact of schooling on growth is positive and often significant once we include institutions and their interaction with schooling. The results in model (5) and (2) suggest the importance of market legitimising institutions and market creating institutions for the group of low income countries. Although the results in Table 3.4 show a similar pattern of results in Table 3.2, for developing countries but there are some minor differences. The coefficient on schooling increases in magnitude in Table 3.4 compared to Table 3.2 and there is also less interaction effect in Table 3.4 as compared to Table 3.2. It may be due to smaller number of low income countries.

Panel (b) of Table 3.4 reports the results of the corresponding models in panel (a) by using change in schooling as the proxy for human capital. The baseline model (1) again reports a negative coefficient on change in schooling as in panel (a). Models (2) through (9) report positive and often significant coefficient on change in schooling. The coefficient on institution and interaction has the same sign as in panel (a). Model (3) observes better results and highlights the importance of market creating institution. Both results in panel (a) and in panel (b) suggest that the impact of schooling on growth is conditional and is enhanced by including institutions and the interaction of institutions with schooling.

Table 3.4 Human Capital, Institutions and Economic Growth: Evidence from Low Income countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
Initial	0.0085 (0.0502)	-0.0688*** (0.0229)	-0.0981* (0.0536)	-0.0533 (0.0436)	-0.0470*** (0.0168)	-0.0788*** (0.0222)	-0.0634 (0.0843)	-0.0590 (0.0772)	-0.0970*** (0.0289)
gkapw	0.8201*** (0.2141)	1.0624*** (0.0362)	1.4216*** (0.5510)	0.9890*** (0.0856)	1.0707*** (0.0147)	1.0614*** (0.0120)	1.0783*** (0.0911)	0.9472*** (0.1273)	1.1094*** (0.0591)
School	-0.0018 (0.0248)	0.0535* (0.0305)	0.1934* (0.1172)	0.2863* (0.1719)	0.0288*** (0.0083)	0.0497* (0.0284)	0.0476 (0.1098)	0.3260 (0.2764)	0.0645 (0.0399)
Institution		0.1694*** (0.0578)	0.0752 (0.0518)	0.0465* (0.0277)	0.0022* (0.0013)	-0.0051* (0.0030)	-0.0005 (0.0162)	0.0283 (0.0403)	0.0021 (0.0070)
Interaction		-0.0876 (0.0715)	-0.0499 (0.0324)	-0.0530 (0.0351)	-0.0023* (0.0013)	-0.0034 (0.0037)	-0.0046 (0.0189)	-0.0587 (0.0529)	-0.0026 (0.0080)
Constant	-0.0782 (0.3778)	0.4540*** (0.1749)	0.5270 (0.3281)	0.1624 (0.4012)	0.3396*** (0.1236)	0.6175*** (0.1584)	0.4851 (0.6834)	0.2895 (0.5424)	0.7017*** (0.2108)
Obs.	219	81	78	109	203	86	41	109	133
Countries	26	17	17	19	26	18	17	20	20
Instruments	11	23	12	17	27	30	12	12	17
Arellano BondAR(1) (P-Val.)	-1.7170 (0.0860)	-1.3270 (0.1840)	-1.3520 (0.1760)	-1.2790 (0.2010)	-2.0110 (0.0444)	-1.4730 (0.1410)	-1.0440 (0.2960)	-1.2920 (0.1960)	-1.7300 (0.0836)
Arellano BondAR(2) (P-Val.)	-1.1630 (0.2450)	-1.1550 (0.2480)	-0.4800 (0.6310)	-0.2450 (0.8060)	-1.4420 (0.1490)	-1.2060 (0.2280)	-0.6860 (0.4930)	0.2450 (0.8060)	-0.3130 (0.7540)
Hansen J-test (P-Value)	6.9300 (0.4360)	11.4500 (0.8320)	4.7660 (0.5740)	13.9400 (0.2360)	23.1200 (0.3380)	10.8500 (0.9900)	9.4560 (0.1500)	8.4320 (0.2080)	13.4400 (0.2660)

Table 3.4 (Continue...) Human Capital, Institutions and Economic Growth: Evidence from Low Income countries

Panel (b): Change in Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
Initial	-0.0376 (0.0381)	-0.0459 (0.0291)	-0.0546** (0.0260)	-0.0429 (0.0270)	-0.0663** (0.0318)	-0.0906*** (0.0207)	-0.0023 (0.0267)	-0.1232 (0.1069)	-0.0823** (0.0376)
gkapw	0.8977*** (0.1550)	0.9569*** (0.1411)	1.0766*** (0.0108)	1.0761*** (0.0265)	0.9976*** (0.1043)	1.0514*** (0.0151)	1.0467*** (0.0575)	0.9599*** (0.1489)	1.0710*** (0.0300)
ΔSchool	-0.0201 (0.1399)	0.4288* (0.2212)	0.4882*** (0.1614)	0.6430* (0.3607)	0.0441 (0.1275)	0.3102* (0.1684)	0.0643 (0.7228)	0.9082 (1.4048)	0.1710 (0.2183)
Institution		0.3057*** (0.0950)	0.0413*** (0.0085)	0.0351*** (0.0120)	0.0065*** (0.0016)	-0.0010 (0.0061)	-0.0045 (0.0206)	0.0244 (0.0312)	0.0028 (0.0069)
Interaction		-0.8502** (0.4309)	-0.1268*** (0.0307)	-0.0971 (0.0829)	-0.0402** (0.0194)	-0.0441 (0.0321)	-0.0255 (0.0849)	-0.1112 (0.2855)	0.0229 (0.0380)
Constant	0.2759 (0.2807)	0.2225 (0.2017)	0.2862 (0.2008)	0.1286 (0.2262)	0.4976** (0.2380)	0.6971*** (0.1318)	0.0674 (0.2715)	0.7729 (0.8462)	0.5737** (0.2802)
Obs.	219	81	78	109	203	86	41	109	133
Countries	26	17	17	19	26	18	17	20	20
Instruments	14	17	12	36	27	45	12	12	22
Arellano BondAR(1) (P-Val.)	-1.7130 (0.0868)	-1.0640 (0.2880)	-1.3310 (0.1830)	-1.8330 (0.0668)	-1.7000) (0.0892)	-1.5680 (0.1170)	-1.2280 (0.2190)	-0.9030 (0.3660)	-1.5620 (0.1180)
Arellano BondAR(2) (P-Val.)	-1.3230 (0.1860)	-1.2590 (0.2080)	-0.9560 (0.3390)	-0.4420 (0.6590)	-1.5190 (0.1290)	-1.0830 (0.2790)	-0.7880 (0.4310)	-0.1160 (0.9080)	0.0918 (0.9270)
Hansen J-test (P-Value)	14.2900 (0.1600)	11.4700 (0.4050)	6.6320 (0.3560)	12.0700 (0.9990)	22.6300 (0.3640)	12.5400 (1.0000)	6.8660 (0.3330)	6.0140 (0.4220)	14.8000 (0.5390)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table 3.5 estimates the models for the group of lower middle income countries. The baseline model in panel (a) reports the negative coefficient on schooling as in Table 3.2 for the case of developing countries and also in Table 3.4 for the case of low income countries, it becomes positive in models (2) through (9) but the results loses significance as compared to the corresponding models in Table 3.2 and Table 3.4. The coefficient on institution is positive for all models through (2) and (5) and only significant at 1% level for model (2) while models (6) and (7) report the unexpected positive and insignificant coefficient on corruption. The interaction term appears with the expected negative sign on models (2) through (9) except for model (7).

The results in Table 3.5 follow the similar pattern of results in Table 3.4, for the low income countries. The coefficient on schooling in Table 3.4 is significant in majority of the cases as compared to Table 3.5, for lower middle income countries while some more interaction effect in Table 3.5. Similarly, the coefficient on schooling is often significant in Table 3.2, for developing countries and it is also having more interaction effect than in Table 3.5. The quality of governance variable used as the measure of institution report better results in model (2), suggesting the importance of market creating institutions for this group of countries.

In panel (b) we re-estimate all the models in panel (a) by using the change in schooling by following the growth accounting specification. It is quite interesting to notice that in panel (b) we again found negative coefficient on change in schooling in model (1) as in panel (a) but it has also become significant as well. There are examples of papers which also observe negative and significant coefficient (i.e., Knight, Loayza and Villanueva, 1993 and Caseli, Esquivel and Lefort, 1996).

Models (2) through (9) in panel (b) report the similar results as in panel (a). The coefficient on institution is positive for models (2), (3), (4), (5), (8) and (9) and only significant at 10% level for model (2) suggesting positive effect on growth, while negative for models (6) and (7) implying that corruption reduces growth. The interaction term is negative for models (2) through (9) except for model (6); it is significant at 10% level for model (2) suggesting that institutions and human capital are substitutes. Again, model (2) presents better results and indicates the importance of market creating institutions. The results are similar to Table 3.4, for low income countries but the coefficient of schooling is often significant in Table 3.4 than in Table 3.5 and there is also more interaction effect in

Table 3.4.Overall, the results in Table 3.4 and 3.5 suggest that effect of human capital on economic growth is conditional on institutions and it become positive and often significant by considering both the role of institutions and their interaction with human capital.

We also estimate the corresponding models of Table 3.4 and 3.5 for two more income groups of countries for high income OECD and upper middle income countries in appendix Table A3.3 and A3.4 respectively. The results in these tables show positive and insignificant coefficient on schooling in the baseline model (1) which gains significance by including institutions and the interaction of institutions with schooling. Overall the results in Tables A3.3 and A3.4 provide some weak support for the results in Tables 3.4 and 3.5.

Table 3.5 Human Capital, Institutions and Economic Growth: Evidence from Lower Middle Income countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
Initial	0.0441 (0.0400)	-0.0203 (0.0129)	-0.0857** (0.0419)	-0.0184*** (0.0063)	-0.0182 (0.0150)	0.0354 (0.1584)	-0.0165 (0.0321)	-0.0124 (0.0266)	-0.0418** (0.0210)
gkapw	0.8238** (0.3516)	0.9404*** (0.1434)	0.3533* (0.1821)	0.5352*** (0.1255)	0.7258** (0.3268)	0.6668 (1.8414)	1.4036** (0.6633)	1.0916** (0.5227)	0.3697* (0.1914)
School	-0.0098 (0.0132)	0.0389* (0.0201)	0.0096 (0.0235)	0.0287* (0.0172)	0.0039 (0.0081)	0.1989 (0.5476)	0.0021 (0.0921)	0.0469 (0.0561)	0.0014 (0.0374)
Institution		0.1820*** (0.0688)	0.0175 (0.0129)	0.0078 (0.0050)	0.0001 (0.0017)	0.0970 (0.2506)	0.0135 (0.0293)	0.0012 (0.0121)	0.0010 (0.0059)
Interaction		-0.0861** (0.0364)	-0.0058 (0.0062)	-0.0049* (0.0028)	-0.0003 (0.0010)	-0.0342 (0.0963)	0.0018 (0.0129)	-0.0055 (0.0098)	-0.00003 (0.0051)
Constant	-0.3768 (0.3461)	0.1012 (0.1046)	0.7224** (0.3519)	0.1248** (0.0519)	0.1550 (0.1299)	-0.8814 (2.7114)	0.0242 (0.3475)	0.0842 (0.2010)	0.3712* (0.2146)
Obs.	292	133	132	146	273	133	92	140	176
Countries	31	27	27	25	29	27	28	26	26
Instruments	11	39	25	93	17	8	18	22	17
Arellano Bond AR(1) (P-Val.)	-1.4160 (0.1570)	-1.3690 (0.1710)	-1.2870 (0.1980)	-3.1850 (0.0014)	-1.5770 (0.1150)	-1.0940 (0.2740)	-1.1920 (0.2330)	-2.2810 (0.0226)	-2.4400 (0.0147)
Arellano Bond AR(2) (P-Val.)	0.4980 (0.6190)	0.7310 (0.4650)	0.9400 (0.3470)	-1.4590 (0.1450)	0.6330 (0.5270)	0.2370 (0.8130)	-0.6110 (0.5410)	-1.3480 (0.1780)	-1.1710 (0.2420)
Hansen J-test (P-Value)	11.0100 (0.1380)	22.9500 (0.9040)	20.5400 (0.3630)	21.5100 (1.0000)	7.9810 (0.7150)	0.3370 (0.8450)	11.2400 (0.5080)	12.8500 (0.6840)	11.1900 (0.4280)

Table 3.5 (Cont...) Human Capital, Institutions and Economic Growth: Evidence from Lower Middle Income countries

Panel (b): Change in Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0114 (0.0102)	-0.0779** (0.0369)	-0.0531 (0.0462)	-0.0422* (0.0231)	-0.0339 (0.0291)	-0.0788** (0.0324)	-0.0255* (0.0152)	-0.0090 (0.0068)	-0.0258*** (0.0094)
gkapw	0.5166*** (0.1835)	0.3437** (0.1478)	0.8730*** (0.3285)	0.2230 (0.2194)	0.4219*** (0.1434)	0.4000*** (0.1475)	0.3914* (0.2087)	0.5781*** (0.1104)	0.4423*** (0.1320)
ΔSchool	-0.1002* (0.0587)	0.3313* (0.1879)	0.1784 (0.1844)	0.0620 (0.4386)	0.0272 (0.0329)	0.0364 (0.1020)	0.0249 (0.2286)	0.0538 (0.2424)	0.0690 (0.1925)
Institution		0.1744* (0.0946)	0.0197 (0.0174)	0.0039 (0.0141)	0.0011 (0.0021)	-0.0018 (0.0053)	-0.0016 (0.0108)	0.0083 (0.0080)	0.0035 (0.0076)
Interaction		-0.5525* (0.3137)	-0.0397 (0.0566)	-0.0146 (0.0713)	-0.0040 (0.0078)	0.0069 (0.0216)	-0.0013 (0.0312)	-0.0122 (0.0433)	-0.0120 (0.0282)
Constant	0.1189 (0.0929)	0.6007** (0.2933)	0.4024 (0.3691)	0.3672* (0.2043)	0.2972 (0.2515)	0.6961** (0.2972)	0.2377 (0.1762)	0.0430 (0.0584)	0.2145** (0.1005)
Obs.	292	133	132	146	273	133	92	140	176
Countries	31	27	27	25	29	27	28	26	26
Instruments	32	28	15	24	27	45	36	53	36
Arellano Bond AR(1) (P-Val.)	-1.7350 (0.0827)	-1.4550 (0.1460)	-1.3300 (0.1840)	-3.1020 (0.0019)	-1.8140 (0.0696)	-1.3910 (0.1640)	-1.8890 (0.0589)	-3.5190 (0.00043)	-2.4130 (0.0158)
Arellano Bond AR(2) (P-Val.)	0.6740 (0.5010)	0.8670 (0.3860)	0.8740 (0.3820)	-1.0930 (0.2740)	0.6570 (0.5110)	0.9410 (0.3460)	-1.0920 (0.2750)	-1.5330 (0.1250)	-1.2800 (0.2010)
Hansen J-test (P-Val.)	23.2700 (0.7190)	18.5600 (0.6720)	9.9020 (0.3590)	21.2900 (0.2650)	19.8100 (0.5330)	17.9100 (0.9980)	18.9900 (0.9400)	23.3700 (0.9980)	21.8500 (0.8590)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates Significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

3.4.2.3 Results from Different Regional Groups

In this sub-section we again estimate all the corresponding models by using one-step system GMM estimator and disaggregate the full sample of countries into different regional groups of East Asia and Pacific, Latin American and Caribbean, Sub-Saharan Africa and Middle East and African countries. Table 3.6 uses the sample of East Asia and Pacific countries. There is small number of countries in this group. In all these models the coefficient on initial output per worker (lnrgdpwok0) is negative except for the baseline model suggesting catch-up interpretation and the coefficient on growth in capital per worker is highly significant for majority of the cases. The coefficient on schooling is negative in the baseline model as in Table 3.2, 3.4 and 3.5, it become positive in all models through (2) to (7) and also gains some significance in some of the cases. The coefficient on institution is also positive and significant at 1% level for model (2), significant at 5% for model (7) and significant at 10% level for model (4) suggesting the importance of institutions for growth. The coefficient on the interaction term is negative, it is significant at 1% level for model (2), significant at 5% for model (4) and approaching towards 10% significance level for models (3) and (7) suggesting that institutions and human capital are substitutes. Results in model (2) suggest the importance of market creating institutions. These results are similar to the results in Table 3.2, 3.4 and 3.5.

The results in panel (b) again report a negative and insignificant coefficient on schooling in baseline model and become positive and insignificant in all the models through (2) to (7) by including institutions and the interaction of institutions and human capital. All coefficients enter insignificantly except the coefficient on growth in capital per worker. The results in panel (b) provide some weak support to the results in panel (a).

Overall the results in Table 3.6 find support for the results in Table 3.2, 3.4 and 3.5 and indicate that human capital matter for growth once we take into account both direct effects of institutions and human capital as well as the conditional effect of human capital on economic growth due to institution.

Table 3.6 Human Capital, Institutions and Economic Growth: Evidence from East Asia and Pacific countries

Panel (a): Level of Schooling							
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) MR
lnrgdpwok0	0.0010 (0.0070)	-0.0231*** (0.0070)	-0.0150 (0.0126)	-0.0161 (0.0380)	-0.0084 (0.0114)	-0.0004 (0.0244)	-0.0229*** (0.0076)
gkapw	0.6433*** (0.1388)	0.3094*** (0.0923)	0.3178** (0.1415)	0.6063*** (0.2085)	0.3414* (0.1967)	0.8449* (0.4566)	0.4396*** (0.0752)
School	-0.0051 (0.0056)	0.0439** (0.0204)	0.0171 (0.0276)	0.1861** (0.0781)	0.0057 (0.0131)	0.0091 (0.0324)	0.0576 (0.0492)
Institution		0.1576*** (0.0468)	0.0154 (0.0146)	0.0341* (0.0188)	0.0028 (0.0035)	0.0184 (0.0180)	0.0147** (0.0060)
Interaction		-0.0872*** (0.0332)	-0.0065 (0.0063)	-0.0289** (0.0131)	-0.0020 (0.0022)	-0.0023 (0.0047)	-0.0095 (0.0077)
Constant	0.0045 (0.0511)	0.1440** (0.0601)	0.1060 (0.0962)	-0.0604 (0.2646)	0.0816 (0.0842)	-0.0862 (0.2712)	0.1344*** (0.0426)
Observations	86	34	34	43	84	34	46
Countries	10	7	7	7	10	7	8
Instruments	8	17	12	12	17	11	70
Arellano Bond AR(1) (P-Val.)	-2.5030 (0.0123)	-2.213 (0.0269)	-2.2670 (0.0234)	-2.1520 (0.0314)	-1.8290 (0.0673)	-1.6890 (0.0912)	-2.3170 (0.0205)
Arellano Bond AR(2) (P-Val.)	-1.9000 (0.0575)	-0.0587 (0.9530)	-0.4920 (0.6230)	0.0977 (0.9220)	-2.1090 (0.0350)	0.2450 (0.8070)	0.2220 (0.8240)
Hansen J-test (P-Value)	3.4640 (0.4830)	4.2170 (0.9630)	0.0078 (1.0000)	0.0601 (1.0000)	3.7860 (0.9760)	0.5330 (0.9910)	3.326 (1.0000)

Table 3.6 (Continue...) Human Capital, Institutions and Economic Growth: East Asia and Pacific countries

Panel (b): Change in Schooling							
	(1) Baseline	(2) QOG	(3) Rule	(4) Polity	(5) ICRG	(6) TI	(7) MR
lnrgdpwok0	-0.0012 (0.0046)	-0.0004 (0.0157)	0.0133 (0.0163)	-0.0055 (0.0082)	-0.0071 (0.0208)	-0.0101 (0.0107)	-0.0009 (0.0082)
gkapw	0.6771*** (0.1279)	0.5518** (0.2459)	0.8472** (0.4030)	0.4192** (0.1827)	0.9065** (0.4328)	0.6205** (0.2465)	0.5893*** (0.1404)
Δ School	-0.0040 (0.0256)	0.0125 (0.1574)	0.0267 (0.0943)	0.0152 (0.0332)	0.0274 (0.2359)	0.0028 (0.1795)	0.1650 (0.4296)
Institution		0.0807 (0.1095)	0.0058 (0.0126)	0.0011 (0.0016)	0.0169 (0.0235)	-0.0008 (0.0089)	0.0085 (0.0151)
Interaction		0.0895 (0.3091)	-0.0096 (0.0274)	-0.0009 (0.0070)	-0.0156 (0.0390)	-0.0029 (0.0281)	-0.0293 (0.0716)
Constant	0.0186 (0.0354)	-0.0397 (0.1185)	-0.1287 (0.1377)	0.0555 (0.0630)	-0.0122 (0.2913)	0.1062 (0.1314)	-0.0283 (0.0605)
Observations	86	34	34	84	34	29	46
Countries	10	7	7	10	7	7	8
Instruments	8	12	17	12	11	25	17
Arellano Bond AR(1) (P-Val.)	-2.6250 (0.0087)	-1.9330 (0.0532)	-1.8060 (0.0709)	-2.3000 (0.0215)	-2.1710 (0.0299)	-1.9670 (0.0492)	-2.3210 (0.0203)
Arellano Bond AR(2) (P-Val.)	-1.8630 (0.0625)	-1.3140 (0.1890)	-0.7630 (0.4450)	-1.8270 (0.0678)	0.2200 (0.8260)	-0.8420 (0.4000)	-0.3410 (0.7330)
Hansen J-test (P-Value)	2.9240 (0.5710)	3.6260 (0.7270)	2.4240 (0.9960)	5.1020 (0.5310)	1.6050 (0.9010)	4.9660 (0.9990)	3.2230 (0.9870)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table 3.7 provides the evidence for the sample of Latin American and Caribbean countries. The coefficient on initial output per worker (lnrgdpwok0) generally appears with a negative sign indicating catch-up. The coefficient on growth in capital per worker (gkapw) is positive and highly significant at 1% level. The baseline model (1) shows positive but insignificant coefficient on schooling. Models (2) through model (9) explain the insignificant coefficient on schooling by adding both the institutional variable and their interaction with schooling. The coefficient on schooling is significant in many cases except for models (6), (7) and (8). The results in models (2), (4), and (5) report the expected positive coefficient on institutions and it is also significant suggesting importance of institutions in explaining growth. The interaction term in each model appears with negative sign and significant for models (2) through (5) suggesting that institution and schooling are substitutes while the interaction term is negative for models (6) and (7) but it is insignificant. The results in models (4) and (5) suggest the importance of market creating and market legitimising institutions.

Again the coefficient on initial output per worker generally appears with negative sign suggesting catch-up in panel (b). The coefficient on growth in capital per worker is positive and highly significant at 1% level for all the models. The coefficient on change in schooling is positive but insignificant for baseline model but it becomes significant for models (2) through model (4). The coefficient on institution enters with the expected sign except for model (6). The interaction term appears with the negative sign and is significant for models (2) through (4). The results in panel (b) are similar to the results in panel (a). Overall, the results in Table 3.7 find some support for the hypothesis that schooling matters for growth once we take into account institutions and their interaction with the schooling measure. The results in models (2) and (3) suggest the importance of market creating institutions.

Table 3.7 Human Capital, Institutions and Economic Growth: Evidence from Latin American and Caribbean countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	0.0019 (0.0141)	-0.0273 (0.0241)	-0.0265* (0.0139)	-0.0150 (0.0101)	-0.0090 (0.0133)	0.0489 (0.1967)	-0.0897 (0.0892)	-0.0223 (0.0230)	-0.0041 (0.0079)
gkapw	1.1076*** (0.0406)	1.0913*** (0.0168)	1.0957*** (0.0140)	1.0993*** (0.0117)	1.1288*** (0.0443)	1.0081*** (0.2307)	1.1959*** (0.1034)	1.1537*** (0.0750)	1.0849*** (0.0046)
Schooling	0.0048 (0.0037)	0.0540** (0.0218)	0.0337** (0.0158)	0.1117*** (0.0399)	0.0077** (0.0031)	0.1192 (0.5801)	0.0172 (0.0564)	0.1935 (0.1949)	0.0356** (0.0167)
Institution		0.1112** (0.0559)	0.0122 (0.0103)	0.0173** (0.0080)	0.0027*** (0.0008)	0.0212 (0.1154)	0.0065 (0.0203)	0.0222 (0.0401)	0.0023 (0.0032)
Interaction		-0.0885** (0.0377)	-0.0080* (0.0047)	-0.0159*** (0.0058)	-0.0013*** (0.0004)	-0.0209 (0.1059)	-0.0019 (0.0093)	-0.0290 (0.0311)	-0.0034 (0.0022)
Constant	-0.0316 (0.1295)	0.1840 (0.2116)	0.1954 (0.1269)	0.0131 (0.0988)	0.0665 (0.1222)	-0.5994 (2.5029)	0.8055 (0.8620)	0.0453 (0.3987)	-0.0026 (0.0745)
Observations	225	104	104	125	218	104	72	110	147
Countries	22	21	21	21	21	21	22	21	21
Instruments	11	20	30	36	22	8	18	12	93
Arellano Bond AR(1) (p-val.)	-2.9230 (0.0035)	-1.8410 (0.0656)	-1.8400 (0.0658)	-1.7530 (0.0796)	-2.7800 (0.0054)	-1.4210 (0.1550	-1.3610 (0.1740)	-1.8520 (0.0640)	-2.2840 (0.0224)
Arellano Bond AR(2) (p-val.)	-0.1970 (0.8440)	-1.7540 (0.0794)	-1.4980 (0.1340)	-0.6370 (0.5240)	-0.0944 (0.9250)	-0.5820 (0.5610)	-0.4950 (0.6210)	-1.6130 (0.1070)	-0.2430 (0.8080)
Hansen J-test (P-Value)	5.4250 (0.6080)	15.1200 (0.3700)	17.5400 (0.8250)	20.4300 (0.9050)	19.4200 (0.2480)	0.3220 (0.8510)	10.9800 (0.5310)	4.5420 (0.6040)	15.9900 (1.0000)

Table 3.7 (Continue...) **Human Capital, Institutions and Economic Growth: Evidence from Latin American and Caribbean countries**

Panel (b): Change in Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.00004 (0.0102)	-0.0374** (0.0162)	-0.0552*** (0.0205)	-0.0527 (0.0331)	-0.0117 (0.0122)	0.0053 (0.0449)	-0.0262 (0.0307)	-0.0377 (0.0258)	0.0173 (0.0776)
gkapw	1.0834*** (0.0036)	1.1003*** (0.0058)	1.1474*** (0.0575)	1.1116*** (0.0289)	1.0877*** (0.0043)	1.0016*** (0.1220)	1.0881*** (0.0230)	1.1352*** (0.0625)	0.9520*** (0.1358)
Δ Schooling	0.0168 (0.0147)	0.1715* (0.0989)	0.3331* (0.1731)	0.7896* (0.4640)	0.0195 (0.0242)	0.8140 (1.8144)	0.0107 (0.1554)	0.5801 (0.4937)	0.7370 (1.2728)
Institution		0.1433** (0.0656)	0.0324** (0.0141)	0.0298 (0.0183)	0.0018** (0.0008)	0.0380 (0.0930)	-0.0015 (0.0092)	0.0137 (0.0218)	0.0235 (0.0433)
Interaction		-0.4248** (0.2133)	-0.1071** (0.0422)	-0.1263* (0.0719)	-0.0016 (0.0024)	-0.1751 (0.3920)	-0.0026 (0.0248)	-0.1142 (0.0859)	-0.1372 (0.2033)
Constant	-0.0114 (0.0952)	0.2895** (0.1418)	0.4199** (0.2003)	0.3089 (0.3382)	0.0940 (0.1142)	-0.2359 (0.7386)	0.2576 (0.3004)	0.2920 (0.2377)	-0.3021 (0.9724)
Observations	225	104	104	125	218	104	72	110	147
Countries	22	21	21	21	21	21	22	21	21
Instruments	20	17	22	22	17	8	23	12	12
Arellano Bond AR(1) (p-val.)	-2.9430 (0.0032)	-2.7190 (0.0066)	-3.2320 (0.0012)	-2.074 (0.0380)	-2.7870 (0.0053)	-0.8280 (0.4080)	-1.0320 (0.3020)	-2.3600 (0.0183)	-1.0240 (0.3060)
Arellano Bond AR(2) (p-val.)	-0.4060 (0.6850)	-1.2100 (0.2260)	-0.2690 (0.7880)	-0.4620 (0.6440)	-0.2660 (0.7900)	-0.7020 (0.4820)	-1.3850 (0.1660)	-1.4090 (0.1590)	-0.4590 (0.6460)
Hansen J-test (P-Value)	19.6600 (0.2360)	13.6500 (0.2530)	18.1000 (0.3180)	14.7400 (0.5440)	16.2100 (0.1340)	0.1270 (0.9380)	16.4800 (0.4900)	5.1290 (0.5270)	1.1150 (0.9810)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table 3.8 reports the results for the sample of Sub-Saharan African countries. The initial output per worker enters with negative sign showing convergence while growth in capital per worker is positive and significant for all models except the baseline model. The coefficient on schooling enters with negative sign in the base line model and turns into positive in all models through (2) to (8), it is also significant at 5% level for model (4) and significant at 10% level for model (8). The coefficient on institution reports the expected positive sign on models (2) through (5) and (8) while negative for model (6) and (7). The coefficient on interaction term is negative and significant at 10% level for model (4) suggesting that schooling and institutions are substitutes. The results in model (4) suggest the importance of market creating institutions.

Panel (b) uses change in schooling as proxy for human capital and finds the similar results as in panel (a) but the coefficient estimates are less significant in this case. The results in model (3) highlight the importance of market creating institutions. The results in Table 3.8 for the sample of Sub-Saharan African countries is similar to the results discussed earlier for the group of low income, lower middle income and for the sample of East Asia and Pacific countries in Tables 3.4, 3.5 and 3.6 respectively. These group of countries to some extent have similar institutional characteristics and share similar results.

In appendix we also report the results for the sample of Middle East and North African nations in Table A3.5 and find support for the results in Tables 3.7, A3.3 and A3.4.

Table 3.8 Human Capital, Institutions and Economic Growth: Evidence from Sub-Saharan African countries

Panel (a): Level of Schooling								
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) SM
lnrgdpwok0	-0.0133 (0.0160)	-0.0125 (0.0133)	-0.0117 (0.0085)	-0.0064 (0.0107)	-0.0341* (0.0176)	-0.0230 (0.0173)	-0.0184** (0.0077)	-0.0114 (0.0173)
gkapw	0.0343 (0.2400)	0.6784*** (0.2299)	0.5893*** (0.1724)	0.5894** (0.2588)	0.4046* (0.2183)	0.9404** (0.4628)	0.8902*** (0.2282)	0.3364*** (0.0778)
Schooling	-0.0023 (0.0138)	0.0005 (0.0302)	0.0051 (0.0264)	0.0716** (0.0342)	0.0125 (0.0110)	0.0452 (0.0325)	0.0088 (0.0333)	0.0461* (0.0268)
Institution		0.0776 (0.0890)	0.0143** (0.0065)	0.0184* (0.0107)	0.0017 (0.0015)	-0.0019 (0.0085)	-0.0052 (0.0062)	0.0019 (0.0051)
Interaction		0.0184 (0.0687)	-0.0022 (0.0084)	-0.0128* (0.0066)	0.0006 (0.0026)	-0.0052 (0.0057)	-0.0004 (0.0056)	-0.0058 (0.0049)
Constant	0.1165 (0.1234)	0.0627 (0.1050)	0.0556 (0.0619)	-0.0429 (0.1133)	0.2762** (0.1373)	0.1847 (0.1545)	0.1869** (0.0905)	0.0768 (0.1540)
Observations	282	112	108	139	260	117	62	173
Countries	32	24	24	25	32	25	24	26
Instruments	8	20	39	22	42	30	34	17
Arellano Bond AR(1) (p-val.)	-2.5090 (0.0121)	-1.3730 (0.1700)	-1.3730 (0.1700)	-3.0730 (0.0021)	-2.6620 (0.0078)	-1.7220 (0.0850)	-1.7320 (0.0833)	-2.9590 (0.0031)
Arellano Bond AR(2) (p-val.)	-0.5930 (0.5530)	-1.1220 (0.2620)	-0.9600 (0.3370)	-0.1410 (0.8880)	-0.9970 (0.3190)	-1.1850 (0.2360)	-0.9620 (0.3360)	-0.9530 (0.3400)
Hansen J-test (P-Value)	2.3510 (0.6710)	15.970 (0.3150)	19.2900 (0.9720)	17.5300 (0.3520)	27.4500 (0.8460)	22.080 (0.5750)	17.7300 (0.9330)	9.5440 (0.5720)

Table 3.8 (Cont...) Human Capital, Institutions and Economic Growth: Evidence from Sub-Saharan African countries

Panel (b): Change in Schooling								
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) SM
lnrgdpwok0	-0.0052 (0.0121)	-0.0224 (0.0151)	-0.0097 (0.0078)	-0.0230* (0.0130)	-0.0130 (0.0153)	-0.0113 (0.0077)	-0.0221* (0.0120)	-0.0051 (0.0069)
gkapw	0.3643** (0.1728)	0.6138*** (0.2031)	0.4915** (0.2185)	0.4535*** (0.1326)	0.4472*** (0.1442)	0.3573* (0.2094)	0.5661* (0.3265)	0.3033* (0.1790)
Δ Schooling	-0.0005 (0.0386)	0.1107 (0.1256)	0.1385* (0.0812)	0.0035 (0.2156)	0.0422 (0.0452)	0.0758 (0.0654)	0.0500 (0.2090)	0.1129 (0.1234)
Institution		0.1150 (0.0850)	0.0174* (0.0091)	0.0132* (0.0076)	0.0024** (0.0012)	-0.0014 (0.0046)	-0.0008 (0.0116)	0.0031 (0.0039)
Interaction		-0.2499 (0.2431)	-0.0281 (0.0172)	0.0063 (0.0352)	0.0023 (0.0069)	-0.0153 (0.0140)	-0.0057 (0.0424)	-0.0097 (0.0196)
Constant	0.0442 (0.0952)	0.1341 (0.0943)	0.0197 (0.0558)	0.1152 (0.0990)	0.1087 (0.1210)	0.0994 (0.0770)	0.1948 (0.1453)	0.0186 (0.0640)
Observations	282	112	108	139	260	117	62	173
Countries	32	24	24	25	32	25	24	26
Instruments	29	44	39	12	27	51	22	22
Arellano Bond AR(1) (p-val.)	-2.3780 (0.0174)	-1.5320 (0.1250)	-1.3870 (0.1660)	-3.3400 (0.00084)	-2.2100 (0.0271)	-1.6200 (0.1050)	-1.6320 (0.1030)	-3.3110 (0.0009)
Arellano Bond AR(2) (p-val.)	-0.7060 (0.4800)	-1.1920 (0.2330)	-0.9730 (0.3300)	-0.1930 (0.8470)	-0.8540 (0.3930)	-1.2230 (0.2210)	-1.0330 (0.3020)	-0.6150 (0.5390)
Hansen J-test (P-Value)	25.5000 (0.4350)	20.3800 (0.9910)	17.5600 (0.9870)	6.7500 (0.3450)	19.1500 (0.5750)	16.9900 (1.0000)	15.5600 (0.4840)	14.5500 (0.5580)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include time dummies.

3.4.2.4 Results using dummy variables

The results presented earlier in subsection 3.4.2 are based on the disaggregated sample of whole sample into three different types of sub-samples of developing/developed, income groups and regional groups. Dividing the sample into these subgroups results into lower number of observation and one may think about the loss of important information. In order to overcome this problem we re-estimate all models by using dummy variable for developing countries, dummy for income groups and dummy for regional groups in appendix in Tables A3.6 through A3.8.

In Table A3.6, we use a dummy for developing countries and estimate the corresponding models in subsection 3.4.1. The results are similar to Table 3.1; the coefficient on schooling is insignificant in baseline model and becomes significant for the models that include institution and the interaction of institution with schooling. The coefficient on institution and interaction term reports the expected sign and is significant in many cases. The coefficient on schooling become significant when including institutional variable, interaction of institution with schooling and the dummy variable for developing countries. The positive and significant coefficient on institution for models (2), (3) and (5) suggest direct positive role of institution in growth while negative and significant coefficient on models (6) and (7) suggests that corruption reduces growth. The interaction term is negative and significant for models (2) through (4) suggesting that schooling and institutions are substitutes. Panel (b) uses the change in schooling and reports the similar results as in panel (a).

Table A3.7 reports the results of the corresponding models by using dummy variables for high income, lower middle income, upper middle income and low income countries. The baseline model show positive but insignificant coefficient on schooling which gains significance level in some models that also includes institutions and interaction term. Panel (b) show the similar results but the coefficient estimates lose their significance.

The results in Table A3.8 includes the dummy variable for different regional groups such as, East Asia and the Pacific (EAP), Latin American and the Caribbean (LAC), Middle East and North Africa (MENA), South Asia (SA), Sub-Saharan Africa (SSA) and Europe and central Asia (ECA). The results are similar to the Table A3.7 and A3.8, the coefficient on schooling is positive and insignificant in baseline model but become significant in some models including institution and interaction term. Overall, the results in Table A3.6 through A3.8 show that we do not lose information by disaggregating the full sample of countries into sample of developing, developed, low income, lower middle income, High income OECD, Upper middle income, East Asia and pacific, Latin America and Caribbean, Sub-Saharan Africa and Middle east and North African countries in Table 3.2, 3.3, 3.4, 3.5, A3.3, A3.4, 3.6, 3.7, 3.8 and A3.5.

3.5. Conclusion

In this study we attempt to explain the lack of significant relationship between human capital and economic growth. We investigate the empirical analysis by dynamic panel data estimation technique and use one-step system GMM estimator. The empirical analysis begins with estimating the baseline model where initial output per worker, growth in capital per worker and schooling is regressed on growth in output per worker. The schooling variable in the baseline model enters with positive but insignificant coefficient and sometime it appears with a negative sign (for example in the sample of developing, low income, middle income, East Asia and Pacific and Sub-Saharan African countries). We explain the insignificant or negative effect of human capital on growth by also considering the role of institutions and also its interaction with the human capital by using several measures of institutions (ICRG data on quality of governance, law and order and corruption; Gwartney et al. (2009) data on EFW, Sound Money index and Market regulation; Polity IV data on democracy and TI data on corruption).

In our preferred specification, the coefficient on schooling become positive and significant in all the models with institution and interaction term suggesting that baseline model suffers from omitted variable bias of not considering institutional variable and their interaction with schooling. Moreover, the institutional variable generally enters with the positive and significant coefficient. The interaction term appears with a negative sign and is significant in many cases suggesting that institutions and human capital are substitutes on their impact on growth. The negative interaction term suggests that a more focussed attention should be given to institutions or human capital individually. For the sample of developed countries, the institutional quality is sufficiently high so that further improvements in institutional quality do not promote the impact of human capital on growth. On the other hand, in the case of developing countries or low income countries, the institutional quality is at very low levels and requires a long time and more focussed investments in institutions to generate any positive impact on human capital and hence on growth. We also found the importance of market creating institutions.

As a robustness analysis we also disaggregate the full sample of countries into group of developing/developed countries as well as in different income and regional groups. Similar results are observed in the abovementioned sample of countries as well.

Appendix

Table A3.1 List of Countries

	Country	Classification		Country	Classification
1	Afghanistan	South Asia, Low income, Developing	21	Chile	Latin America and Caribbean, Upper Middle Income, Developing
2	Algeria	Middle East and North Africa, Lower Middle Income, Developing	22	China	East Asia and Pacific, High income Non OECD, Developing
3	Argentina	Latin America and Caribbean, Upper Middle Income, Developing	23	Colombia	Latin America and Caribbean, Lower Middle Income, Developing
4	Australia	High Income OECD, Developed	24	Congo, Dem. Rep.	Sub-Saharan Africa, Low income, Developing
5	Austria	High Income OECD, Developed	25	Congo, Rep. of	Sub-Saharan Africa, Lower Middle Income, Developing
6	Bahrain	High income Non OECD, Developed	26	Costa Rica	Latin America and Caribbean, Upper Middle Income, Developing
7	Bangladesh	South Asia, Low income, Developing	27	Cote d`Ivoire	Sub-Saharan Africa, Low income, Developing
8	Barbados	High income Non OECD, Developed	28	Cuba	Latin America and Caribbean, Upper Middle Income, Developing
9	Belgium	High Income OECD, Developed	29	Cyprus	High income Non OECD, Developed
10	Belize	Latin America and Caribbean, Upper Middle Income, Developing	30	Denmark	High Income OECD, Developed
11	Benin	Sub-Saharan Africa, Low income, Developing	31	Dominican Rep	Latin America and Caribbean, Lower Middle Income, Developing
12	Bolivia	Latin America and Caribbean, Lower Middle Income, Developing	32	Ecuador	Latin America and Caribbean, Lower Middle Income, Developing
13	Botswana	Sub-Saharan Africa, Upper Middle Income, Developing	33	Egypt	Middle East and North Africa, Lower Middle Income, Developing
14	Brazil	Latin America and Caribbean, Upper Middle Income, Developing	34	El Salvador	Latin America and Caribbean, Lower Middle Income, Developing
15	Brunei	High income Non OECD, Developed	35	Fiji	East Asia and Pacific, Upper Middle Income, Developing
16	Burundi	Sub-Saharan Africa, Low income, Developing	36	Finland	High Income OECD, Developed
17	Cambodia	East Asia and Pacific, Low income, Developing	37	France	High Income OECD, Developed
18	Cameroon	Sub-Saharan Africa, Lower Middle Income, Developing	38	Gabon	Sub-Saharan Africa, Upper Middle Income, Developing
19	Canada	High Income OECD, Developed	39	Gambia, The	Sub-Saharan Africa, Low income, Developing
20	Central African	Sub-Saharan Africa, Low income, Developing	40	Germany	High Income OECD, Developed

Table A3.1 (Continue...) List of Countries

	Country	Classification		Country	Classification
41	Ghana	Sub-Saharan Africa, Low income, Developing	62	Laos	East Asia and Pacific, Developing
42	Greece	High Income OECD, Developed	63	Lesotho	Sub-Saharan Africa, Lower Middle Income, Developing
43	Guatemala	Latin America and Caribbean, Lower Middle Income, Developing	64	Liberia	Sub-Saharan Africa, Low income, Developing
44	Haiti	Latin America and Caribbean, Low income, Developing	65	Luxembourg	High Income OECD, Developed
45	Honduras	Latin America and Caribbean, Lower Middle Income, Developing	66	Macao	Developed
46	Hong Kong	Developed	67	Malawi	Sub-Saharan Africa, Low income, Developing
47	Hungary	High Income OECD, Developed	68	Malaysia	East Asia and Pacific, Upper Middle Income, Developing
48	Iceland	High Income OECD, Developed	69	Maldives	South Asia, Lower Middle Income, Developing
49	India	South Asia, Lower Middle Income, Developing	70	Mali	Sub-Saharan Africa, Low income, Developing
50	Indonesia	East Asia and Pacific, Lower Middle Income, Developing	71	Malta	High Income Non OECD, Developed
51	Iran	Middle East and North Africa, Lower Middle Income, Developing	72	Mauritania	Sub-Saharan Africa, Low income, Developing
52	Iraq	Middle East and North Africa, Lower Middle Income, Developing	73	Mauritius	Sub-Saharan Africa, Upper Middle Income, Developing
53	Ireland	High Income OECD, Developed	74	Mexico	Latin America and Caribbean, Upper Middle Income, Developing
54	Israel	High Income Non-OECD, Developed	75	Mongolia	East Asia and Pacific, Lower Middle Income, Developing
55	Italy	High Income OECD, Developed	76	Morocco	Middle East and North Africa, Lower Middle Income, Developing
56	Jamaica	Latin America and Caribbean, Upper Middle Income, Developing	77	Mozambique	Sub-Saharan Africa, Low income, Developing
57	Japan	High Income OECD, Developed	78	Namibia	Sub-Saharan Africa, Lower Middle Income, Developing
58	Jordan	Middle East and North Africa, Lower Middle Income, Developing	79	Nepal	South Asia, Low income, Developing
59	Kenya	Sub-Saharan Africa, Low income, Developing	80	Netherlands	High Income OECD, Developed
60	Korea, Rep. of	High Income OECD, Developed	81	New Zealand	High Income OECD, Developed
61	Kuwait	High Income Non-OECD, Developed	82	Nicaragua	Latin America and Caribbean, Lower Middle Income, Developing

Table A3.1 (Continue...)   List of Countries

	Country	Classification		Country	Classification
83	Niger	Sub-Saharan Africa, Low income, Developing	103	Sudan	Sub-Saharan Africa, Lower Middle Income, Developing
84	Norway	High Income OECD, Developed	104	Swaziland	Sub-Saharan Africa, Lower Middle Income, Developing
85	Pakistan	South Asia, Low income, Developing	105	Sweden	High Income OECD, Developed
86	Panama	Latin America and Caribbean, Upper Middle Income, Developing	106	Switzerland	High Income OECD, Developed
87	Papua New Guinea	East Asia and Pacific, Low income, Developing	107	Syria	Middle East and North Africa, Lower Middle Income, Developing
88	Paraguay	Latin America and Caribbean, Lower Middle Income, Developing	108	Tanzania	Sub-Saharan Africa, Low income, Developing
89	Peru	Latin America and Caribbean, Lower Middle Income, Developing	109	Thailand	East Asia and Pacific, Lower Middle Income, Developing
90	Philippines	East Asia and Pacific, Lower Middle Income, Developing	110	Togo	Sub-Saharan Africa, Low income, Developing
91	Poland	Upper Middle Income, Developed	111	Trinidad and Tobago	High Income Non-OECD, Developed
92	Portugal	High Income OECD, Developed	112	Tunisia	Middle East and North Africa, Lower Middle Income, Developing
93	Qatar	High Income Non-OECD, Developed	113	Turkey	Europe and Central Asia, Upper Middle Income, Developing
94	Romania	Europe and Central Asia, Upper Middle Income, Developing	114	Uganda	Sub-Saharan Africa, Low income, Developing
95	Rwanda	Sub-Saharan Africa, Low income, Developing	115	UAE	High Income Non-OECD, Developed
96	Saudi Arabia	High Income Non-OECD, Developed	116	United Kingdom	High Income OECD, Developed
97	Senegal	Sub-Saharan Africa, Low income, Developing	117	United States	High Income OECD, Developed
98	Sierra Leone	Sub-Saharan Africa, Low income, Developing	118	Uruguay	Latin America and Caribbean, Upper Middle Income, Developing
99	Singapore	High Income Non-OECD, Developed	119	Venezuela	Latin America and Caribbean, Upper Middle Income, Developing
100	South Africa	Sub-Saharan Africa, Upper Middle Income, Developing	120	Zambia	Sub-Saharan Africa, Low income, Developing
101	Spain	High Income OECD, Developed	121	Zimbabwe	Sub-Saharan Africa, Low income, Developing
102	Sri Lanka	South Asia, Lower Middle Income, Developing			

Table A3.2 Definition and Sources of Data

Variable	Definition	Source
rgdpwok	Output per worker	PWT 6.2
grgdpwok	Log difference of output per worker divided by 5.	Author's construction using data from PWT 6.2
lnrgdpwok0	Log of initial output per worker	PWT 6.2
kapw	Capital per worker	PWT 6.2
gkapw	Growth in capital per worker	Author's construction using data from PWT 6.2
Schooling	Average years of total secondary years of schooling (aytsecs25).	Barro and Lee (2010)
Change in Schooling	Difference of level of schooling at 5 year interval.	Author's calculation using Barro and Lee (2010) data.
QoG	ICRG indicator of Quality of Governance, it is the mean value of the ICRG variables "Corruption", "Law and Order" and "Bureaucracy Quality", scaled 0-1. Higher values indicate higher quality of government.	International Country Risk Guide, The PRS Group
Rule	ICRG measure of Law and order, scaled 0-6. Higher values show better law and order.	International Country Risk Guide, The PRS Group
EFW	The index of the economic freedom of the world. The index ranges from 0-10 where 0 corresponds to 'less economic freedom' and 10 to 'more economic freedom'.	Fraser Institute (Gwartney et al. 2009)
Polity	Freedom house measure of democracy, Scale ranges from 0-10 where 0 is least democratic and 10 most democratic.	Freedom House
ICRG	International Country Risk Guide measure of corruption. Scaled 0-10 where 0 is no corruption and 10 is more corruption.	International Country Risk Guide, The PRS Group
TI	Transparency International measure of Corruption. Scaled 0-10 where 0 is no corruption and 10 is more corruption.	Transparency International
MR	Gwartney et al. (2009) composite index of regulation (MR) in credit market, labor market, and business in general. Scaled from 0 to 10, where high score imply fewer regulations.	Fraser Institute (Gwartney et al., 2009)
SM	Gwartney et al. (2009) sound money index (SM). Scaled from 0 to 10, where high score imply better market stabilising institutions.	Fraser Institute (Gwartney et al., 2009)

Table A3.3 Human Capital, Institutions and Economic Growth: Evidence from High Income OECD Countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0143* (0.0081)	-0.0108* (0.0059)	-0.0144** (0.0062)	-0.0077 (0.0204)	-0.0177** (0.0083)	-0.0110 (0.0152)	-0.0350** (0.0177)	-0.0133 (0.0101)	0.0032 (0.0261)
gkapw	0.5807*** (0.0994)	0.4128*** (0.1044)	0.5870*** (0.1373)	0.5023*** (0.1761)	0.5671*** (0.0796)	0.6357*** (0.1482)	0.6919* (0.3854)	0.3289*** (0.0994)	0.5165*** (0.1815)
Schooling	0.0029 (0.0027)	0.0251* (0.0179)	0.0267** (0.0132)	0.0195** (0.0085)	0.0040 (0.0053)	0.0145* (0.0081)	0.0013 (0.0090)	0.0248*** (0.0081)	0.0247** (0.0123)
Institution		0.0716* (0.0415)	0.0158** (0.0064)	0.0074* (0.0045)	0.0006 (0.0005)	-0.0006 (0.0044)	-0.0112** (0.0056)	0.0155** (0.0068)	0.0042 (0.0034)
Interaction		-0.0250 (0.0157)	-0.0045* (0.0024)	-0.0024* (0.0014)	-0.00003 (0.0004)	-0.0010 (0.0013)	0.0028* (0.0017)	-0.0035** (0.0014)	-0.0025** (0.0012)
Constant	0.1466* (0.0793)	0.0524 (0.0644)	0.0662 (0.0788)	0.0290 (0.2178)	0.1744** (0.0774)	0.0819 (0.1486)	0.3781** (0.1721)	0.0492 (0.0985)	-0.0720 (0.2503)
Observations	271	130	128	177	249	128	126	176	181
Countries	26	26	26	26	24	26	26	26	26
Instruments	8	46	46	22	32	12	17	12	22
Arellano Bond AR(1) (p-val.)	-3.4400 (0.0006)	-3.4560 (0.0005)	-3.3340 (0.0009)	-3.2830 (0.0010)	-3.3620 (0.0008)	-3.4720 (0.0005)	-2.9850 (0.0028)	-3.7050 (0.0002)	-2.7140 (0.0067)
Arellano Bond AR(2) (p-val.)	2.6990 (0.0070)	2.6840 (0.0073)	2.9310 (0.0034)	2.5070 (0.0122)	2.3750 (0.0175)	2.2190 (0.0265)	1.8910 (0.0586)	2.8910 (0.0038)	2.2590 (0.0239)
Hansen J-test (P-Value)	3.7320 (0.4440)	24.1200 (0.9780)	24.2900 (0.9760)	17.5200 (0.3530)	22.6900 (0.6500)	7.4720 (0.2790)	14.9000 (0.1870)	8.4030 (0.2100)	19.4600 (0.2460)

Table A3.3 (Cont...) Human Capital, Institutions and Economic Growth: Evidence from High Income OECD Countries

Panel (b): Change in Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0105** (0.0052)	-0.0006 (0.0052)	0.0113 (0.0173)	0.0046 (0.0111)	-0.0031 (0.0097)	0.0051 (0.0062)	0.0007 (0.0069)	0.0070 (0.0114)	-0.0095 (0.0107)
gkapw	0.5328*** (0.0906)	0.7945*** (0.1169)	0.8608*** (0.3036)	0.5569*** (0.1410)	0.7457*** (0.2577)	0.9854*** (0.3819)	0.7185*** (0.1203)	0.5330*** (0.1463)	0.2920** (0.1220)
Δ Schooling	0.0046 (0.0149)	0.0063 (0.0878)	0.2529** (0.1214)	0.1153 (0.0804)	0.0062 (0.0293)	0.0299 (0.0706)	0.0041 (0.0142)	0.0948* (0.0503)	0.0012 (0.0851)
Institution		0.0321 (0.0316)	0.0215** (0.0085)	0.0055** (0.0027)	0.0006 (0.0009)	-0.0007 (0.0066)	-0.0004 (0.0036)	0.0044 (0.0039)	0.0037 (0.0037)
Interaction		-0.0094 (0.0938)	-0.0509** (0.0246)	-0.0179 (0.0116)	0.00003 (0.0035)	-0.0094 (0.0244)	-0.0034 (0.0069)	-0.0156* (0.0082)	-0.0008 (0.0086)
Constant	0.1145** (0.0530)	-0.0198 (0.0511)	-0.2301 (0.1926)	-0.0790 (0.1141)	0.0254 (0.1005)	-0.0584 (0.0678)	-0.0022 (0.0776)	-0.0959 (0.1065)	0.0822 (0.0928)
Observations	271	130	128	177	249	128	126	176	181
Countries	26	26	26	26	24	26	26	26	26
Instruments	11	27	25	22	12	12	22	17	34
Arellano Bond AR(1) (p-val.)	-3.5540 (0.00038)	-3.4720 (0.0005)	-3.5390 (0.0004)	-3.4640 (0.0005)	-3.0620 (0.0022)	-2.8170 (0.0049)	-3.6460 (0.0003)	-3.2750 (0.0011)	-3.6460 (0.0003)
Arellano Bond AR(2) (p-val.)	2.8320 (0.0046)	2.5700 (0.0102)	2.5330 (0.0113)	2.4640 (0.0137)	2.0590 (0.0395)	2.1440 (0.0321)	2.2860 (0.0222)	2.4750 (0.0133)	2.9050 (0.0037)
Hansen J-test (P-Value)	8.5430 (0.2870)	23.0500 (0.3410)	23.1700 (0.2300)	18.4600 (0.2970)	5.3440 (0.5010)	9.4600 (0.1490)	20.7800 (0.1870)	10.9800 (0.4450)	23.8700 (0.6880)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table A3.4 Human Capital, Institutions and Economic Growth: Evidence from Upper Middle Income Countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0291 (0.0295)	-0.0333 (0.0321)	-0.0178 (0.0221)	-0.0205 (0.0268)	-0.0548*** (0.0202)	-0.0567** (0.0247)	-0.0493* (0.0256)	-0.0400 (0.0255)	-0.0389** (0.0156)
gkapw	0.6834*** (0.1685)	0.7563*** (0.2417)	0.5524*** (0.1461)	0.5368*** (0.1591)	0.5391*** (0.1752)	0.3446* (0.1838)	0.4787* (0.2466)	0.5320*** (0.1907)	0.1967* (0.1175)
Schooling	0.0043 (0.0054)	0.0443 (0.0441)	0.0026 (0.0272)	0.0234 (0.0489)	0.0066 (0.0078)	0.0640* (0.0388)	0.0044 (0.0406)	0.1223 (0.1250)	0.0137 (0.0201)
Institution		0.2486* (0.1455)	0.0120 (0.0178)	0.0112 (0.0137)	-0.0016 (0.0030)	0.0070 (0.0105)	-0.0012 (0.0182)	0.0454 (0.0425)	0.0073 (0.0054)
Interaction		-0.0748 (0.0820)	0.0001 (0.0080)	-0.0038 (0.0083)	0.0007 (0.0015)	-0.0097 (0.0068)	0.0009 (0.0072)	-0.0207 (0.0216)	-0.0022 (0.0031)
Constant	0.2725 (0.2778)	0.1818 (0.3394)	0.1279 (0.2586)	0.1336 (0.3188)	0.5183*** (0.1874)	0.4880** (0.2060)	0.4692 (0.2959)	0.1289 (0.3266)	0.3385** (0.1622)
Observations	237	106	106	138	230	106	75	130	157
Countries	24	22	22	23	24	22	23	23	23
Instruments	20	23	20	17	32	20	17	12	22
Arellano Bond AR(1) (p-val.)	-2.7700 (0.0056)	-1.2550 (0.2100)	-1.6180 (0.1060)	-2.2080 (0.0273)	-2.4840 (0.0130)	-1.3110 (0.1900)	-0.0712 (0.9430)	-1.2590 (0.2080)	-2.7050 (0.0068)
Arellano Bond AR(2) (p-val.)	0.0535 (0.9570)	-0.5050 (0.6130)	-1.8910 (0.0586)	0.0382 (0.9700)	-0.5440 (0.5870)	-1.7690 (0.0769)	-1.2240 (0.2210)	-0.5840 (0.5590)	-1.6260 (0.1040)
Hansen J-test (P-Value)	19.3100 (0.2530)	20.1500 (0.2670)	18.6200 (0.1800)	13.3000 0.2740)	17.5600 (0.8910)	15.0100 (0.3770)	11.8200 (0.3780)	5.3550 (0.4990)	13.8500 (0.6100)

Table A3.4 (Cont...) Human Capital, Institutions and Economic Growth: Evidence from Upper Middle Income Countries

Panel (b): Change in Schooling									
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0289 (0.0194)	-0.0488* (0.0251)	-0.0406* (0.0233)	-0.0261** (0.0111)	-0.0486** (0.0240)	-0.0236 (0.0221)	-0.0011 (0.0196)	-0.0178 (0.0129)	-0.0389** (0.0156)
gkapw	0.5718** (0.2658)	0.4801*** (0.1110)	0.4970*** (0.1300)	0.4616*** (0.1667)	0.5296** (0.2377)	0.4290*** (0.1433)	0.5639*** (0.1875)	0.6748*** (0.0861)	0.1967* (0.1175)
Δ Schooling	0.0344 (0.0235)	0.1874** (0.0948)	0.1844** (0.0872)	0.2637 (0.4546)	0.0975* (0.0581)	0.0697 (0.0882)	0.0158 (0.0747)	0.2079** (0.0867)	0.0137 (0.0201)
Institution		0.1091* (0.0602)	0.0214** (0.0096)	0.0140 (0.0199)	0.0010 (0.0026)	-0.0002 (0.0065)	0.0093 (0.0076)	0.0118** (0.0046)	0.0073 (0.0054)
Interaction		-0.3245* (0.1676)	-0.0566** (0.0254)	-0.0427 (0.0786)	-0.0053 (0.0084)	-0.0142 (0.0199)	-0.0029 (0.0152)	-0.0329** (0.0138)	-0.0022 (0.0031)
Constant	0.2706 (0.1864)	0.4098 (0.2507)	0.3220 (0.2358)	0.1675 (0.1567)	0.4450** (0.2237)	0.2287 (0.2331)	-0.0421 (0.2122)	0.0984 (0.1144)	0.3385** (0.1622)
Observations	237	106	106	138	230	106	75	130	157
Countries	24	22	22	23	24	22	23	23	23
Instruments	14	22	22	12	12	29	28	66	22
Arellano Bond AR(1) (p-val.)	-2.9600 (0.0031)	-1.4060 (0.1600)	-1.9360 (0.0529)	-2.1800 (0.0293)	-2.9660 (0.0030)	-1.4000) (0.1620)	-0.1380 (0.8900)	-2.4960 (0.0126)	-2.7050 (0.0068)
Arellano Bond AR(2) (p-val.)	-0.0315 (0.9750)	-1.6800 (0.0929)	-1.8910 (0.0586)	-0.4240 (0.6720)	-0.5040 (0.6140)	-2.1600 (0.0308)	-1.5060 (0.1320)	-1.6320 (0.1030)	-1.6260 (0.1040)
Hansen J-test (P-Value)	6.2870 (0.7910)	15.0400 (0.5220)	17.0800 (0.3810)	8.2430 (0.2210)	2.8610 (0.8260)	17.9100 (0.7620)	18.1500 (0.6970)	14.1400 (1.0000)	13.8500 (0.6100)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table A3.5 Human Capital, Institutions and Economic Growth: Evidence from Middle East and North African (MENA) Countries

Panel (a): Level of Schooling								
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) MR	(8) SM
lnrgdpwok0	0.0263 (0.0407)	-0.0420 (0.0430)	-0.0410 (0.0330)	-0.0417 (0.0465)	-0.0255*** (0.0086)	-0.0865 (0.0669)	-0.0793* (0.0442)	-0.0435 (0.0301)
gkapw	1.0348* (0.5553)	0.9360*** (0.2070)	0.6431*** (0.1962)	0.9644*** (0.0969)	0.4719*** (0.1186)	0.4220 (0.3213)	0.5545* (0.3343)	0.4368** (0.1829)
Schooling	0.0083 (0.0213)	0.0433*** (0.0161)	0.0235 (0.0149)	0.0905** (0.0410)	0.0022 (0.0135)	0.0162 (0.0763)	0.1304** (0.0627)	0.0752 (0.0645)
Institution		0.2962** (0.1362)	0.0175* (0.0091)	0.0135 (0.0095)	0.0024 (0.003)	-0.0072 (0.0170)	0.0260* (0.0155)	0.0080 (0.0127)
Interaction		-0.0900** (0.0360)	-0.0064 (0.0050)	-0.0110* (0.0059)	0.0029 (0.0027)	0.0006 (0.0124)	-0.0213** (0.0101)	-0.0090 (0.0078)
Constant	-0.2550 (0.3800)	0.2586 (0.3586)	0.3259 (0.3043)	0.2867 (0.4241)	0.2658*** (0.0758)	0.8222 (0.6475)	0.5924 (0.4068)	0.3434* (0.2066)
Observations	75	40	40	45	74	40	39	49
Countries	8	8	8	7	8	8	7	7
Instruments	8	15	30	12	52	18	12	12
Arellano Bond AR(1) (p-val.)	-1.0590 (0.2900)	-1.1790 (0.2390)	-1.1040 (0.2700)	-1.8060 (0.0709)	-1.1840 (0.2370)	-1.2100 (0.2260)	-1.6530 (0.0984)	-1.7870 (0.0739)
Arellano Bond AR(2) (p-val.)	0.8340 (0.4040)	1.1030 (0.2700)	1.0240 (0.3060)	0.8110 (0.4170)	0.8400 (0.4010)	1.1030 (0.2700)	-1.3150 (0.1890)	0.3690 (0.7120)
Hansen J-test (P-Value)	1.5940 (0.8100)	1.7350 (0.9950)	1.9550 (1.000)	2.5070 (0.8680)	1.7620 (1.0000)	1.1860 (1.0000)	2.1950 (0.9010)	0.1390 (1.0000)

Table A3.5 (Continue...) **Human Capital, Institutions and Economic Growth: Evidence from Middle East and North African (MENA) Countries**

Panel (b): Change in Schooling								
	(1) Baseline	(2) QOG	(3) Rule	(4) EFW	(5) Polity	(6) ICRG	(7) MR	(8) SM
lnrgdpwok0	0.0074 (0.0262)	-0.0588 (0.0477)	-0.2118* (0.1274)	-0.0409 (0.0250)	-0.0305 (0.0287)	-0.1427 (0.1019)	-0.0432*** (0.0095)	-0.0562 (0.0529)
gkapw	0.4233 (0.5280)	0.5934*** (0.1626)	1.8966*** (0.7248)	0.2517 (0.3192)	0.5345*** (0.1445)	0.8417*** (0.2680)	0.3407*** (0.1303)	0.4645*** (0.1704)
Δ Schooling	-0.0684 (0.1498)	0.5922* (0.3154)	0.8297* (0.43549	0.6821** (0.2800)	0.0584 (0.1157)	0.1194 (0.3991)	0.1227 (0.1455)	0.5580* (0.2915)
Institution		0.4280** (0.1731)	0.0429* (0.0243)	0.0535** (0.0209)	0.0012 (0.0019)	-0.0387** (0.0191)	0.0073 (0.0098)	0.0203 (0.0162)
Interaction		-0.9841** (0.4555)	-0.0818 (0.0604)	-0.1425** (0.0588)	0.0053 (0.0055)	0.0329 (0.0565)	-0.0209 (0.0354)	-0.0688* (0.0406)
Constant	-0.0498 (0.2123)	0.3135 (0.3425)	1.6876 (1.0608)	0.1301 (0.2425)	0.2852 (0.2326)	1.4611 (0.9691)	0.3677*** (0.0757)	0.3660 (0.4673)
Observations	75	40	40	45	74	40	39	49
Countries	8	8	8	7	8	8	7	7
Instruments	8	50	17	12	32	17	22	12
Arellano Bond AR(1) (p-val.)	-1.2530 (0.2100)	-1.3280 (0.1840)	-1.1680 (0.2430)	-1.7530 (0.0796)	-1.3200 (0.1870)	-1.6900 (0.0910)	-1.7430 (0.0814)	-1.3730 (0.1700)
Arellano Bond AR(2) (p-val.)	0.9150 (0.3600)	1.2190 (0.2230)	-0.5040 (0.6140)	-0.0258 (0.9790)	0.9730 (0.3310)	1.3310 (0.1830)	-1.4000 (0.1620)	-0.6380 (0.5240)
Hansen J-test (P-Value)	3.9180 (0.4170)	0.5220 (1.0000)	3.1060 (0.9890)	3.9560 (0.6830)	0.1230 (1.0000)	2.9130 (0.9920)	1.3960 (1.0000)	0.8370 (0.9910)

Note: Dependent variable is growth in output per worker, robust standard errors reported in parenthesis,* indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table A3.6 Human Capital, Institutions and Economic Growth: Using Dummy variable for Developing Countries

Panel (a): Level of Schooling									
	(1) Baseline	(2) Rule	(3) QoG	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0116* (0.0062)	-0.0198*** (0.0062)	-0.0140* (0.0074)	-0.0046 (0.0064)	-0.0120** (0.0053)	-0.0264*** (0.0087)	-0.0329* (0.0200)	-0.0185 (0.0071)***	-0.0006 (0.0055)
gkapw	0.7115*** (0.1870)	1.0790*** (0.0131)	0.9777*** (0.1076)	0.8124*** (0.2032)	0.9091*** (0.1480)	1.0837*** (0.0100)	1.0826*** (0.0103)	1.0797 (0.0163)***	0.8900 (0.1699)***
Schooling	0.0048 (0.0032)	0.0242** (0.0095)	0.0240** (0.0114)	0.0234** (0.0097)	0.0097* (0.0051)	0.0104** (0.0052)	0.0165* (0.0098)	0.0356 (0.0102)***	0.0287 (0.0104)***
Institution		0.0100*** (0.0037)	0.0648** (0.0314)	0.0041 (0.0046)	0.0017*** (0.0006)	-0.0070*** (0.0026)	-0.0163** (0.0073)	0.0051 (0.0040)	0.0037 (0.0025)
Interaction		-0.0039** (0.0018)	-0.0261* (0.0140)	-0.0025** (0.0012)	-0.0005 (0.0004)	0.0016 (0.0013)	0.0004 (0.0017)	-0.0030 (0.0015)*	-0.0025 (0.0011)**
dum_developing	-0.0206 (0.0147)	-0.0148 (0.0125)	-0.0085 (0.0136)	0.0054 (0.0135)	0.0030 (0.0092)	0.0189 (0.0187)	0.0751 (0.0498)	0.0105 (0.0150)	0.0204 (0.0148)
Constant	0.1126* (0.0656)	0.1447** (0.0589)	0.0865 (0.0667)	0.0008 (0.0607)	0.0900* (0.0489)	0.2363** (0.0952)	0.3133 (0.2023)	0.1040 (0.0753)	-0.0526 (0.0626)
Observations	1,131	496	502	629	1,026	505	358	616	716
Countries	121	103	103	103	112	104	106	105	105
Instruments	101	72	68	96	102	60	45	74	92
Arellano-Bond AR(1) (p-val.)	-3.4850 (0.0005)	-2.1010 (0.0357)	-2.1270 (0.0334)	-4.8770 (1.08e-06)	-3.1140 (0.0019)	-2.3190 (0.0204)	-3.5980 (0.0003)	-5.3370 (0.0000)	-5.2600 (0.0000)
Arellano-Bond AR(2) (p-val.)	-0.6060 (0.5450)	-0.1240 (0.9010)	-0.3480 (0.7280)	-0.7480 (0.4540)	-0.8430 (0.3990)	-0.2210 (0.8250)	-1.2260 (0.2200)	0.2800 (0.7790)	-1.2380 (0.2160)
Hansen J-test (p-val.)	108.1000 (0.1870)	74.6200 (0.1940)	71.4700 (0.1690)	93.7600 (0.3440)	103.2000 (0.2660)	56.3100 (0.3520)	46.2300 (0.1690)	71.9200 (0.3180)	93.7900 (0.2410)

Table A3.6 (Continue...) Human Capital, Institutions and Economic Growth: Using Dummy variable for Developing Countries

Panel (b): Change in Schooling									
	(1) Baseline	(2) Rule	(3) QoG	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0092 (0.0065)	-0.0226** (0.0103)	-0.0124 (0.0142)	-0.0007 (0.0183)	-0.0097 (0.0089)	-0.0128 (0.0216)	-0.0010 (0.0239)	-0.0086 (0.0212)	0.0065 (0.0086)
gkapw	0.6508*** (0.1872)	1.0844*** (0.0088)	0.6846** (0.3204)	0.8038*** (0.2696)	0.8454*** (0.1504)	0.9651*** (0.1562)	0.8573*** (0.2945)	0.7885 (0.2580)***	0.8158 (0.2003)***
∆Schooling	0.0081 (0.0129)	0.0832* (0.0467)	0.1176 (0.1669)	0.0783 (0.2626)	0.0207 (0.0284)	0.0519 (0.0632)	0.0310 (0.0974)	0.0571 (0.1471)	0.0404 (0.0610)
Institution		0.0103*** (0.0034)	0.1798*** (0.0530)	0.0032 (0.0121)	0.0019** (0.0009)	-0.0008 (0.0057)	-0.0328 (0.0202)	0.0056 (0.0083)	0.0022 (0.0028)
Interaction		-0.0149* (0.0082)	-0.1783 (0.2197)	-0.0208 (0.0398)	-0.0013 (0.0039)	-0.0160 (0.0209)	-0.0007 (0.0345)	-0.0087 (0.0243)	-0.0043 (0.0069)
dum_developing	-0.0422** (0.0186)	-0.0187 (0.0189)	0.0406 (0.0439)	-0.0192 (0.0576)	0.0257 (0.0373)	-0.0049 (0.1444)	0.1240 (0.0799)	-0.0423 (0.0640)	0.0157 (0.0167)
Constant	0.1108 (0.0720)	0.1792* (0.1005)	-0.0155 (0.1416)	0.0097 (0.1950)	0.0604 (0.0922)	0.1282 (0.2725)	0.0928 (0.2674)	0.0720 (0.2218)	-0.0918 (0.0851)
Observations	1,131	496	502	629	1,026	505	358	616	716
Countries	121	103	103	103	112	104	106	105	105
Instruments	80	52	12	17	47	20	12	34	84
Arellano-Bond AR(1) (p-val.)	-3.5250 (0.0004)	-2.1820 (0.0291)	-2.0220 (0.0431)	-3.6720 (0.0002)	-3.1510 (0.0016)	-2.1540 (0.0313)	-2.1240 (0.0337)	-4.5060 (0.0000)	-5.1270 (0.0000)
Arellano-Bond AR(2) (p-val.)	-0.5970 (0.5500)	-0.2350 (0.8140)	-0.9250 (0.3550)	-1.1670 (0.2430)	-0.8540 (0.3930)	-0.3160 (0.7520)	-1.2670 (0.2050)	-0.1630 (0.8710)	-1.3810 (0.1670
Hansen J-test (p-val.)	89.9500 (0.1150)	52.0500 (0.2190)	6.3760 (0.2710)	9.9790 (0.4420)	48.5300 (0.1670)	17.2700 (0.1870)	6.8080 (0.2350)	35.6000 (0.1240)	83.17 (0.2950)

Note: Dependent variable is growth in output per worker, Robust standard errors reported in parenthesis, * indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. The dum_developing is the dummy variable for developing countries. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table A3.7 Human Capital, Institutions and Economic Growth: Using Dummies for Different Income Groups

Panel (a): Level of Schooling									
	(1) Baseline	(2) Rule	(3) QoG	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0161* (0.0092)	-0.1223 (0.0773)	-0.0196 (0.0138)	-0.0016 (0.0106)	-0.0071 (0.0082)	-0.0342* (0.0182)	-0.0154 (0.0116)	0.0450 (0.0260)*	0.0118 (0.0110)
gkapw	0.7799*** (0.1863)	0.9816*** (0.1446)	1.0548*** (0.0921)	1.0821*** (0.0139)	0.9771*** (0.1239)	0.9825*** (0.0940)	0.9759*** (0.1100)	1.1221 (0.0136)***	0.9576 (0.1298)***
Schooling	0.0060 (0.0036)	0.0058 (0.0316)	0.0202* (0.0122)	0.0230* (0.0131)	0.0070* (0.0041)	0.0132* (0.0078)	0.0045 (0.0079)	0.0367 (0.0159)**	0.0352 (0.0141)**
Institution		0.0010 (0.0151)	0.1205** (0.0541)	0.00003 (0.0042)	0.0016** (0.0008)	-0.0012 (0.0033)	-0.0014 (0.0046)	0.0062 (0.0080)	0.0036 (0.0029)
Interaction		0.0029 (0.0091)	-0.0283 (0.0177)	-0.0016 (0.0019)	-0.0005 (0.0004)	-0.0008 (0.0013)	-0.0006 (0.0017)	-0.0051* (0.0028)	-0.0035 (0.0016)**
dum_hi	0.0405 (0.0276)	0.3079 (0.2118)	0.0210 (0.0425)	-0.0393 (0.0322)	-0.0019 (0.0253)	0.0535 (0.0521)	0.0433 (0.0354)	-0.1846*** (0.0645)	-0.0471 (0.0316)
dum_lmi	0.0265 (0.0187)	0.2135 (0.1963)	0.0273 (0.0256)	-0.0206 (0.0237)	0.0045 (0.0162)	0.0312 (0.0272)	0.0397* (0.0216)	-0.1222** (0.0486)	-0.0064 (0.0149)
dum_umi	0.0433* (0.0237)	0.2433 (0.2375)	0.0129 (0.0376)	-0.0046 (0.0291)	0.0071 (0.0213)	0.0745 (0.0467)	0.0553 (0.0382)	-0.1625** (0.0744)	-0.0303 (0.0263)
Constant	0.1075 (0.070)	0.8949 (0.5604)	0.0935 (0.1050)	0.0063 (0.0856)	0.0467 (0.0619)	0.2613** (0.1267)	0.1074 (0.0867)	-0.3440 (0.2160)	-0.1298 (0.0944)
Observations	1,019	444	450	570	955	453	334	555	647
Countries	107	92	92	93	103	93	94	95	95
Instruments	101	14	54	75	102	69	84	32	75
Arellano-Bond AR(1) (p-val.)	-3.3930 (0.0007)	-1.7110 (0.0871)	-2.0430 (0.0411)	-4.8570 0.0000	-2.9220 (0.0035)	-2.2550 (0.0241)	-4.1030 (4.08e-05)	-4.1750 (0.0000)	-4.8670 (0.0000)
Arellano-Bond AR(2) (p-val.)	-0.2480 (0.8040)	0.1270 (0.8990)	-0.3910 (0.6960)	-0.1100 0.9130	-0.4330 (0.6650)	-0.3440 (0.7310)	-0.6170 (0.5370)	-0.2590 (0.7960)	-0.9170 (0.3590)
Hansen J-test (p-val.)	100.6000 (0.3010)	8.7830 (0.1180)	50.2700 (0.2730)	73.81 0.2380	98.7500 (0.3220)	73.1200 (0.1190)	69.8500 (0.6470)	31.7500 (0.1050)	78.19 (0.1450)

Table A3.7 (Continue...) Human Capital, Institutions and Economic Growth: Using Dummies for Different Income Groups

Panel (b): Change in Schooling									
	(1) Baseline	(2) Rule	(3) QoG	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0066 (0.0089)	0.0510 (0.0332)	0.0098 (0.0333)	0.0035 (0.0178)	0.0316** (0.0129)	0.0253 (0.0302)	0.0037 (0.0109)	0.0136 (0.0140)	0.0493 (0.0239)**
gkapw	0.7726*** (0.1862)	1.1399*** (0.0391)	0.8661*** (0.2191)	0.7018*** (0.2202)	1.1406*** (0.0238)	1.1045*** (0.0234)	0.8476*** (0.1615)	0.9507 (0.1267)***	0.8975 (0.1680)***
ΔSchooling	0.0037 (0.0113)	0.1143* (0.0593)	0.1023 (0.2584)	0.1522 (0.0985)	0.0016 (0.0204)	0.0009 (0.0231)	0.0177 (0.0241)	0.2435 (0.1338)*	0.1829 (0.1093)*
Institution		0.0212*** (0.0080)	0.1422 (0.0991)	0.0046 (0.0037)	-0.0001 (0.0010)	-0.0082* (0.0045)	-0.0001 (0.0035)	0.0088 (0.0068)	0.0030 (0.0039)
Interaction		-0.0189 (0.0116)	-0.1007 (0.2935)	-0.0215 (0.0140)	0.0004 (0.0023)	-0.0003 (0.0088)	-0.0062 (0.0068)	-0.0428 (0.0222)*	-0.0230 (0.0129)*
dum_hi	0.0302 (0.0288)	-0.3314* (0.1828)	-0.0980 (0.1802)	-0.0096 (0.0524)	-0.1890*** (0.0551)	-0.2034 (0.1476)	0.0089 (0.0212)	-0.0399 (0.0353)	-0.1530 (0.0747)**
dum_lmi	0.0176 (0.0194)	-0.2344 (0.1565)	-0.0153 (0.1216)	-0.0001 (0.0301)	-0.1777* (0.0938)	-0.1166 (0.1211)	0.0161 (0.0156)	-0.0062 (0.0171)	-0.0815 (0.0825)
dum_umi	0.0275 (0.0240)	-0.1589 (0.1522)	-0.0623 (0.1436)	-0.0081 (0.0437)	-0.1716 (0.1725)	-0.0234 (0.1200)	0.0070 (0.0243)	-0.0100 (0.0268)	-0.1680 (0.0887)*
Constant	0.0362 (0.0687)	-0.3647 (0.2378)	-0.1371 (0.2616)	-0.0623 (0.1343)	-0.1565* (0.0879)	-0.1045 (0.2275)	-0.0438 (0.1018)	-0.1652 (0.1074)	-0.3821 (0.1764)**
Observations	1,019	444	450	570	955	453	334	555	647
Countries	107	92	92	93	103	93	94	95	95
Instruments	101	27	17	69	12	45	69	60	44
Arellano-Bond AR(1) (p-val.)	-3.3400 (0.0008)	-1.7860 (0.0741)	-1.8650 (0.0621)	-4.0020 0.0000	-2.8930 (0.0038)	-1.9680 (0.0491)	-3.7240 (0.0002)	-5.0510 (0.0000)	-4.0410 (0.0000)
Arellano-Bond AR(2) (p-val.)	-0.2670 (0.7900)	-0.4060 (0.6850)	-0.7550 (0.4500)	-1.2910 0.1970	-0.4050 (0.6860)	-0.3910 (0.6960)	-0.7830 (0.4340)	-0.5470 (0.5840)	-1.3680 (0.1710)
Hansen J-test (p-val.)	101.4000 (0.2820)	20.8200 (0.2880)	11.9100 (0.1550)	58.69 0.5240	13.9600 (0.0030)	44.3900 (0.1590)	69.2000 (0.1950)	46.2300 (0.6630)	43.86 (0.1450)

Note: Dependent variable is growth in output per worker, Robust standard errors reported in parenthesis, * indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. Where dum_hi is dummy for high income countries, dum_lmi is dummy for lower middle income countries and dum_umi is dummy for upper middle income countries. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table A3.8 Human Capital, Institutions and Economic Growth: Using Dummies for Different Regional Groups

	Panel (a): Level of Schooling								
	(1) Baseline	(2) Rule	(3) QoG	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0049 (0.0076)	0.1548 (0.1063)	0.0488 (0.0510)	0.0667* (0.0398)	-0.0300*** (0.0109)	0.0796 (0.0518)	-0.0064 (0.0084)	0.0488 (0.0298)	0.0042 (0.0091)
gkapw	0.7732*** (0.1917)	0.8880*** (0.1918)	1.0125*** (0.1032)	1.0519*** (0.0570)	1.0942*** (0.0929)	1.0136*** (0.0641)	0.9566*** (0.1375)	1.1112*** (0.2066)	0.9385*** (0.1323)
Schooling	0.0032 (0.0037)	0.1365 (0.1848)	0.0292 (0.0455)	0.0660** (0.0271)	0.0145** (0.0064)	0.0483* (0.0256)	0.0018 (0.0037)	0.0704** (0.0285)	0.0423*** (0.0137)
Institution		0.0496* (0.0292)	0.1488* (0.0807)	0.0224** (0.0109)	0.0026** (0.0011)	-0.0131* (0.0077)	-0.0001 (0.0027)	0.0164* (0.0095)	0.0056** (0.0028)
Interaction		-0.0432 (0.0499)	-0.0530 (0.0852)	-0.0113*** (0.0040)	-0.0010* (0.0005)	-0.0058 (0.0040)	-0.0003 (0.0009)	-0.0107*** (0.0036)	-0.0045*** (0.0015)
dum_eap	0.0056 (0.0351)	-2.7736 (3.8313)	-0.6661 (1.0399)	-0.2383 (0.4674)	-0.0423 (0.0402)	0.2914 (0.5054)	-0.0179 (0.0208)	-0.6860 (1.4725)	0.0235 (0.0277)
dum_lac	0.0149 (0.0404)	-0.8819 (0.9563)	-0.1787 (0.4832)	-0.0325 (0.1660)	-0.0291* (0.0161)	0.2342 (0.3455)	-0.0032 (0.0174)	0.0012 (0.3842)	0.0091 (0.0123)
dum_mena	-0.0171 (0.0446)	-0.5482 (1.2908)	0.2563 (0.5885)	-0.1388 (0.5498)	-0.0087 (0.0262)	0.7483 (0.5212)	0.0123 (0.0276)	0.6258 (1.2366)	0.0198 (0.0159)
dum_sa	-0.0261 (0.0526)	1.8376 (3.5438)	0.5525 (0.7889)	0.2820 (0.5595)	-0.0463 (0.0376)	0.4280 (0.3912)	-0.0229 (0.0356)	1.2555 (2.7968)	0.0047 (0.0313)
dum_ssa	0.0152 (0.0496)	-0.1945 (0.9007)	0.1150 (0.1634)	0.2104 (0.1839)	-0.0566* (0.0296)	0.5680** (0.2789)	-0.0171 (0.0178)	0.0116 (0.4646)	0.0251 (0.0236)
Constant	0.0280 (0.0881)	-1.0568 (1.2484)	-0.5069 (0.4969)	-0.7771* (0.4413)	0.2788*** (0.1082)	-1.0571 (0.6449)	0.0644 (0.0884)	-0.6228* (0.3429)	-0.1072 (0.1001)
Observations	930	401	405	512	858	408	289	497	585
Countries	98	83	83	84	96	84	85	86	86
Instruments	80	12	22	12	62	27	95	12	75
Arellano-Bond AR(1) (p-val.)	-3.3160 (0.0009)	-1.3830 (0.1670)	-1.6780 (0.0934	-3.6680 (0.0002)	-2.9520 (0.0032)	-1.8400 (0.0658)	-3.6090 (0.0003)	-3.7280 (0.0002)	-4.7420 (0.0000)
Arellano-Bond AR(2) (p-val.)	-0.3300 (0.7420)	-0.2550 (0.7980)	-0.5230 (0.6010	-0.3700 (0.7120)	-0.3820 (0.7030)	-0.6900 (0.4900)	-0.8920 (0.3720)	-0.2330 (0.8160)	-1.1680 (0.2430)
Hansen J-test (p-val.)	84.1800 (0.1190)	0.3470 (0.5560)	16.8700 (0.1120)	0.6050 (0.4370)	61.3800 (0.1510)	15.9800 (0.4550)	67.2300 (0.9100)	1.6410 (0.2000)	72.3400 (0.2220)

Table A3.8 (Continue...) Human Capital, Institutions and Economic Growth: Using Dummies for Different Regional Groups

	Panel (b): Change in Schooling								
	(1) Baseline	(2) Rule	(3) QoG	(4) EFW	(5) Polity	(6) ICRG	(7) TI	(8) MR	(9) SM
lnrgdpwok0	-0.0009 (0.0085)	0.0415 (0.0309)	0.0751 (0.0909)	0.0424 (0.1169)	-0.0020 (0.0128)	0.0216 (0.0836)	-0.0210* (0.0109)	0.0031 (0.0065)	0.0231 (0.0303)
gkapw	0.7567*** (0.1799)	1.0440*** (0.0392)	1.2210*** (0.2370)	0.9521* (0.5429)	0.9143*** (0.1498)	1.0059*** (0.1167)	0.8014*** (0.2431)	1.0220*** (0.0698)	0.8377*** (0.2165)
ΔSchooling	0.0060 (0.0185)	0.0953* (0.0558)	0.0666 (0.2119)	0.7564 (2.5183)	0.0330 (0.0374)	0.1434 (0.1382)	0.0109 (0.0306)	0.2159* (0.1285)	0.2040 (0.1343)
Institution		0.0220*** (0.0069)	0.3215** (0.1510)	0.0164 (0.1179)	0.0027*** (0.0010)	-0.0052 (0.0109)	-0.0038 (0.0041)	0.0103 (0.0075)	0.0060 (0.0046)
Interaction		-0.0207** (0.0099)	-0.1258 (0.2333)	-0.1058 (0.3468)	-0.0045 (0.0039)	-0.0153 (0.0329)	0.0027 (0.0067)	-0.0368* (0.0212)	-0.0195 (0.0159)
dum_eap	0.0265 (0.0478)	-0.1757 (0.2049)	0.1614 (0.9984)	-0.2929 (2.7070)	0.0293 (0.0772)	0.0148 (0.1507)	-0.0447 (0.0432)	0.0057 (0.0158)	-0.0750 (0.2403)
dum_lac	0.0346 (0.033)	0.0482 (0.0951)	0.1189 (0.2348)	0.0577 (0.3023)	0.0282 (0.0589)	0.0562 (0.1461)	-0.0229 (0.0252)	0.0172* (0.0103)	-0.0135 (0.0651)
dum_mena	-0.0013 (0.0447)	0.0379 (0.2414)	0.6721 (2.0480)	0.7291 (4.6049)	-0.0234 (0.0570)	-0.0473 (0.4473)	-0.0133 (0.0364)	0.0273 (0.0279)	-0.0694 (0.1564)
dum_sa		0.3876 (0.5885)	-0.2531 (4.3516)	1.5564 (9.0865)	-0.0099 (0.1725)	0.2715 (1.0649)	-0.0321 (0.0454)	-0.0170 (0.0296)	0.0624 (0.3120)
dum_ssa	0.0398 (0.0415)	0.2409 (0.1665)	0.3610 (0.3971)	0.2955 (0.9945)	0.0509 (0.0976)	0.1866 (0.4031)	-0.0403 (0.0256)	0.0215 (0.0164)	0.1099 (0.1570)
Constant	-0.0275 (0.091)	-0.5531 (0.3619)	-1.0643 (1.0439)	-0.7470 (1.5771)	-0.0165 (0.1676)	-0.2736 (0.9156)	0.2328* (0.1194)	-0.1046 (0.0716)	-0.2911 (0.3445)
Observations	930	401	405	512	858	408	289	497	585
Countries	98	83	83	84	96	84	85	86	86
Instruments	80	27	26	12	47	25	59	84	27
Arellano-Bond AR(1) (p-val.)	-3.2980 (0.0009)	-1.7500 (0.0802)	-1.5510 (0.1210)	-0.7170 (0.4730)	-2.8780 (0.0040)	-1.9350 (0.0529)	-3.4810 (0.0005)	-4.7080 (0.0000)	-3.5370 (0.0004)
Arellano-Bond AR(2) (p-val.)	-0.3310 (0.7400)	-0.4640 (0.6420)	-0.7860 (0.4320)	-0.9620 (0.3360)	-0.3740 (0.7090)	-0.3510 (0.7260)	-0.6070 (0.5440)	-0.5860 (0.5580)	-1.6100 (0.1070)
Hansen J-test (p-val.)	81.7000 (0.1600)	22.3500 (0.1320)	12.1700 (0.6660)	0.6610 (0.4160)	46.7700 (0.1080)	13.3700 (0.4980)	50.9700 (0.3580)	75.6800 (0.3920)	22.3200 (0.1330)

Note: Dependent variable is growth in output per worker, Robust standard errors reported in parenthesis, * indicates significant at 10% level, ** indicates significant at 5% level and *** indicates significant at 1% level. Where dum_eap is dummy for East Asia and Pacific, dum_lac is dummy for Latin American and Caribbean countries, dum_mena is dummy for Middle-East and North African countries, dum_sa is dummy for South Asia and dum_ssa is dummy for Sub-Saharan African countries. All regressions estimated by one-step System GMM estimator and also include the time dummies.

Table A3.9 Measures of Institutions utilising Rodrik (2005) classification

A. Market Creating Institutions[1]				
S #	Measure	Source	Availability	Comments
1.	Rule of law index	Rodrik et al. (2004)	Available in cross section only.	Not suitable for Dynamic panel data analysis.
2.	Protection Against Appropriation Risk	Acemoglu et al. (2001)	Only covers the period 1982 to 1997.	Too short time dimension for dynamic panel model.
3.	Executive constraint	Acemoglu and Johnson (2005)	Used by Acemoglu et al. (2002), Glaeser et (2004) etc.	Human capital rather than constraints on executive is cause of growth (Glaeser et al., 2004).
4.	Legal formalism index	Acemoglu and Johnson (2005)	Available in cross section only.	Not suitable for Dynamic panel data analysis
5.	ICRG law and order	ICRG, The PRS Group.	It has a long enough time dimension running from 1984 to 2004	Can be used for Dynamic panel data analysis.
6.	Quality of Governance	ICRG, The PRS Group.	It has a long enough time dimension running from 1984 to 2004	Can be used for Dynamic panel data analysis.
7.	Corruption	ICRG, The PRS Group.	It has a long enough time dimension running from 1984 to 2004	Can be used for Dynamic panel data analysis.
8.	Corruption	Transparency International	It has a long enough time dimension running from 1984 to 2004	Can be used for Dynamic panel data analysis.
9.	Repudiation of government contracts	ICRG, The PRS Group.	Available for small group of countries.	Not suitable for Dynamic panel data analysis. It has been criticised by Bhattacharyya (2009) due to its exclusive focus on institutions that define the relationship between the state and its subjects and not on institutions that provide the legal framework which enables private contracts to facilitate economic transactions.
10.	Economic Freedom of the World (EFW)	Gwartney et al. (2009)	scale from 1 (representing the least free) to 10 (most free).	Can be used for Dynamic panel data analysis.
11.	BERI index of Political Risk	BERI	Covers much smaller countries	Not suitable for Panel data analysis

Table A3.9 (Continue...) Measures of Institutions utilising Rodrik (2005) classification

S #	Measure	Source	Availability	Comments
A. Market Creating Institutions[1]				
B. Market legitimising institutions[2]				
12.	Democracy Index	Polity IV	Ranges from 0 to 10 with a high score implying more democratic system.	It aims directly to measure the limits of executive power (see Glaeser et al, 2004). Can be used for Dynamic Panel data analysis.
C. Market regulating institutions[3]				
13.	Composite index of regulation (*MR*) in the credit market, labour market, and business in general.	Gwartney et al. (2009)	Ranges from 0 to 10 with a high score implying fewer regulations.	Can be used for Dynamic Panel data analysis.
D. Market stabilising institutions[4]				
14.	Sound money index (*SM*)	Gwartney et al. (2009)	Ranges from 0 to 10 with a high score implying fewer regulations.	Can be used for Dynamic Panel data analysis.

[1]**Market creating institutions** ensure protection of property rights and also the contract enforcement (Bhattacharyya, 2009). [2]**Market legitimising institutions** deal with redistribution, handle social conflict, and offer social protection and insurance in the event of a shock (See Bhattacharyya, 2009). [3]**Market regulating institutions** help avoids market failure and support to sustain the log-run growth momentum (See Bhattacharyya, 2009). [4]**Market stabilising institutions** that help avoid shocks, minimises inflationary pressure, reduces macroeconomic volatility and prevents financial crises. Note: PRS (Political Risk Services), ICRG (International Country Risk Guide).

Table A3.10 Summary Statistics

	Mean	Standard Deviation		
		Overall	Between	Within
Growth in output per worker	0.0136	0.0921	0.0412	0.0848
Growth in capital per worker	0.0217	0.0858	0.0401	0.0782
schooling	1.2440	1.1303	0.8949	0.6805
Change in schooling	0.1974	0.2062	0.1241	0.1702
Rule	3.6748	1.5529	1.3893	0.7211
QoG	0.5699	0.2461	0.2306	0.0839
Polity	1.1510	7.4974	6.3679	4.0093
EFW	5.8828	1.1679	0.9308	0.6798
TI	4.9955	2.4914	2.2758	0.5138
ICRG	4.5159	2.3772	2.1543	0.9911
SM	6.7403	2.1653	1.5437	1.5256
MR	5.5549	1.0925	0.8963	0.6163

Note: Rule is law and order index; QoG is quality of governance; EFW is economic freedom of the world; TI is Transparency International measure of corruption; ICRG is International Country Risk Guide Measure of corruption; SM is sound money index and MR is index of market regulation.

Table A3.11 Correlations

	Rule	**QoG**	**ICRG**	**TI**	**EFW**	**Polity**	**SM**
Rule	1						
QoG	0.8972	1					
ICRG	-0.7198	-0.8966	1				
TI	-0.7725	-0.8958	0.8611	1			
EFW	0.6356	0.6229	-0.4475	-0.6127	1		
Polity	0.3960	0.5233	-0.5275	-0.4587	0.4377	1	
SM	0.4486	0.4363	-0.3052	-0.4417	0.8013	0.2213	1
MR	0.3934	0.4281	-0.2819	-0.4948	0.7575	0.4018	0.5032

Note: Rule is law and order index; QoG is quality of governance; EFW is economic freedom of the world; TI is Transparency International measure of corruption; ICRG is International Country Risk Guide Measure of corruption; SM is sound money index and MR is index of market regulation.

THESIS CONCLUSION

This thesis provides both theoretical and empirical evidence on the link between human capital and economic growth. The contribution is both theoretical and empirical.

In the first chapter, we provide theoretical explanation on the weak effects of human capital on growth by considering the role of bureaucratic corruption in a three period overlapping generations (OLG) model. We consider human capital technology in the spirit of the neoclassical augmented model of Lucas (1988) and the productive use of government expenditures in spirit of the Barro (1990). Corruption arises from the incentive of bureaucrats to appropriate (steal) public resources thereby reducing the provision of public services. Our dynamic general equilibrium model shows that the human capital accumulated by the corrupt bureaucrat increases the bureaucratic stealing efficiency in terms of lower concealment costs and higher appropriation of government resources. In this context, human capital has two opposing effects, positive productivity enhancing effect and negative bureaucratic stealing efficiency of corrupt bureaucrats. Consequently, there may be some development regions where countries may observe a higher stealing efficiency of corruptible bureaucrats than the productive efficiency due to the accumulation of human capital, hence potentially explaining the insignificant effect of human capital on growth.

The second chapter builds on the theoretical model of chapter one and provides the cross sectional evidence on the link between human capital and growth by explicitly introducing the role of corruption. The empirical analysis uses corruption data from three different sources (Business International, International Country Risk Guide and Transparency International) and estimates the regression at two different time periods (decadal and twenty year). We also consider the explicit role of corruption and the interaction of corruption with human capital in the growth equation and expect that the effects of human capital may be conditional on the level of corruption (i.e., the impact of human capital on growth may be diminishes due to increase in corruption). Although, we generally find the expected signs on human capital and on the interaction term but they lack in significance. We repeat the analysis with the instrumental variable estimation and found similar pattern of results and conclude that the cross sectional evidence is uninformative for the important role of human capital in economic growth.

The empirical analysis in chapter two led us to look deep into the dynamic analysis in chapter three. In the third chapter, we employ panel data technique to investigate the relationship between human capital and economic growth by using more exhaustive measures of institutions along with corruption as an additional measure. In the base line model, human capital enters with insignificant coefficient or even with negative sign. In our preferred specification, we also include the institutional variable and the interaction of institution and human capital. In addition to the direct effect of institution and human capital, the interaction term is also included to investigate the joint impact of human capital and institutions on economic growth. The results generally show positive and significant coefficient on human capital while negative coefficient on the interaction term. The coefficient on interaction term suggests that one should focus on either human capital or institutions separately but not jointly. As a policy matter it suggests that a careful attention might be devoted to decide about the level of human capital as compared to the level of institutional quality.

Overall this thesis shows that both corruption and institutions has important role on the impact of human capital and growth. The insignificant or negative impact of human capital on economic growth should not be overlooked by ignoring the role of corruption and institutions. One should also take into account the importance of corruption and institutions on the link between human capital and economic growth.

This thesis provides the starting point for the role of institutions and corruption in the human capital and growth literature and there is need for further research in this area. For example, at theoretical level one may consider the dynamic model with education and skills mismatch. Another possible extension of theoretical work is to investigate whether institutions and human capital reinforce each other and to work out the minimal level of institutional quality that is necessary to generate positive effects of human capital on growth. While at empirical level, there is need to look at the threshold level of corruptions and institutions above which human capital may have positive and significant effect on growth and below which it has negative effects on growth.

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