INSTITUTIONS, HUMAN CAPITAL, AND GROWTH: 
THE LONG-RUN INSTITUTIONAL MECHANISM

Joilson Dias  
Department of Economics  
Universidade Estadual de Maringá  
Maringá – PR - Brazil 87020-900  
jdias@uem.br

and

Edinaldo Tebaldi  
Department of Economics  
Bryant University  
Smithfield, RI - USA 02864  
etebaldi@bryant.edu

Abstract  
This paper contributes to the debate on the relationship between human capital, institutions, and economic growth. The paper first develops a theoretical model that asserts that institutions set the pace for human capital and physical accumulations thus generating a self-perpetuating accumulation mechanism. The paper uses cross-country panel data from 1965 to 2005 to test some of the model's propositions and finds that structural institutions affect long-term economic performance while political institutions are uncorrelated with productivity and long-term economic growth. The empirical estimates also show that growth of physical and human capital - instead of levels - determines long-run economic growth.

JEL Codes:O43; O11  
Keywords: growth, human capital, institutions.

Resumo  
Este artigo contribui para o debate da relação entre capital humano, instituições e crescimento e desenvolvimento econômico. O artigo desenvolve um modelo teórico que demonstra que as instituições são responsáveis pelo processo de acumulação dos insumos produtivos da economia. Os testes econômicos com dados em painel entre 1965-2005 demonstrou que as instituições estruturais afetam o desenvolvimento econômico de longo prazo, enquanto que as instituições políticas não estão correlacionados com este processo. Os resultados empíricos também confirmam que é o crescimento do capital humano e não o nível deste responsável pelo crescimento econômico de longo prazo.  
Palavras chaves: crescimento e desenvolvimento econômico, capital humano e instituições.
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1 Introduction
The literature on the relationship between human capital, institutions, and economic growth emphasizes the importance of good institutions as a key factor in determining income levels and economic growth, and in stimulating economic rewards that favor input accumulation. Institutions are also referred to as the "fundamental" determinant of economic performance. However, the links through which institutions impact factor accumulation, particularly human capital, is still the subject of an ongoing debate as discussed in the review of the literature below.
This paper develops a micro-foundation model that shows how institutions affect the process of economic development. The model has two sectors (goods and education) and both sectors use qualified (human capital) and non-qualified workers in the production function. The size of the educational sector is endogenous and depends upon the quality of the institutions. An institution’s quality directly affects the productivity of workers in the educational sector, either by rewarding them correctly or not. This is achieved by imposing conditions that allow them to fully use their knowledge or not, by making educational infra-structure available or not, etc. The advantage of this modeling strategy is that the human capital accumulation function is derived from an endogenous process. However, the human capital accumulation process does not occur automatically; it comes from a decision that weighs the intertemporal rewards from the accumulation of human capital against its costs. Institutions play a crucial role in this process as they affect the rate of return to education. Better institutions that provide a superior functioning market for human capital make the effective rate of return higher, thus stimulating human capital accumulation. Therefore, the amount of human capital available in the economy depends on the quality of institutions. Since the productivity of an economy depends on the accumulation of human capital, economic development is linked to the quality of the institutions. This evolving process creates a “historical development path.”
This paper tests the model's predictions and shows that “structural institutions” are the main cause of economic growth. Moreover, controlling for institutional quality, this paper finds evidence that the accumulation of both physical and human capital plays an important role in explaining economic growth. The empirical estimates show that growth of physical and human capital - instead of levels - determines long-run economic growth.
The rest of the paper is organized as follows: Section 2 presents the literature review, which discusses different views of the role of institutions on economic development and makes it clear what type of institution is most conducive to economic development. Section 3 develops an economic model that shows how institutions operate at a micro-level in the economy. Section 4 presents an econometric analysis that uses cross-country panel data from 1965 to 2005 to test some of the model’s propositions developed in section 3. Section 5 summarizes the paper’s findings.

2. The Literature Review
The importance of institutions in economic development can be traced as far back as Adam Smith (1776, Chapter VII). However, the role of institutions in explaining economic development has received more attention recently. Wolf, Jr. (1955) describes how the inadequacy of technology and capital formation in some countries is related to the lack of “right” institutions; meaning, the lack of institutions that allow, stimulate and
are conducive to the adoption of new techniques and the formation of productive capital. Wolf concludes that institutions are as productive as any capital and/or technological advances. Lucas (1988) asserts that economic development is related to the knowledge accumulation process, which produces an institution or social capital represented by the average knowledge in a society. As a result, the production system interacts with this average knowledge resulting in productivity increases. This average knowledge (or institution) can be interpreted as being embodied in written laws, norms, and beliefs. Romer (1990) demonstrates how knowledge created via the R&D process is made excludable as part of a process that grants monopoly power to the inventor (holder) of new ideas. Therefore, knowledge is no longer a social, but rather a private good that can be made available to the overall society as a non-rival good. The knowledge produced in the R&D sector can spread all over the economy leading to productivity increases. This process that grants monopoly power is also the engine of knowledge creation as it provides the right incentives for those engaged in R&D to make investments that will eventually lead to knowledge creation; a process that greatly depends on the quality of institutions. According to Tebaldi and Elmslie (2008), "good institutions contribute to facilitate the process of registering new patents, to disseminate ideas and promote cooperation across researchers, to speed up diffusion of scientific knowledge, to improve enforcement of property rights and to reduce the uncertainty of new projects; all factors that stimulate R&D activities" (p.36).

Dias and McDermott (2006) have developed a model that associates efficiency of public institutions and the market incentive for input accumulation. In their model, individuals choose to be educated, rent seekers, or entrepreneurs. The non-educated in order to become educated depend upon the number of entrepreneurs in the market. The entrepreneurs are the ones that generate jobs for educated and non-educated individuals. Once educated, individuals born with the inherent ability for entrepreneurship may become entrepreneurs depending upon the return of their business, which depends on government cost (tax level plus the rent seeker’s income). Thus, a tax increase improves the chances of individuals becoming rent seekers instead of working as educated labor or entrepreneurs. Therefore, government efficiency plays a key role in setting up the levels of productive inputs in the economy: educated labor and entrepreneurs. Under this theory, government efficiency is the mechanism that sets up the long run growth process of the economy, hence economies plagued by rent seekers will possess “the wrong institutions.” Nonetheless, the authors have not shown how wrong or right institutions affect the decisions of individuals in accumulating knowledge. Studies that measure returns to education following Mincer’s (1974) approach have made investigations into the presence of this mechanism in the economy. For instance, Trostel (2004) found that there are increasing returns to education in most OECD countries. Similar results were found in recent work by Schumacher et al. (2011) whose study estimates the returns to education for the Brazilian and US economies and finds increasing returns to education in Brazil, which appears to arise from knowledge present in the firms’ own sector (Lucas, 1988), from the R&D sector (Romer, 1990), and to the knowledge level of the worker (Acemoglu, 1996).
Theoretical and empirical evidence of high returns to input accumulation, particularly human capital, together with the fact that some economies with high returns to input accumulation do not necessarily experience higher rates of input growth, creates a paradigm. The quality of institutions seems to be the key to explain this paradigm. For instance, let us focus on the economic development differences of North America (excluding Mexico) and Latin America (including Mexico). These two groups of economies faced a two stage economic development process. At the beginning of 1500 up to 1700 the Latin American Economies were richer and more prosperous than the US and Canada. Engerman and Sokoloff (2002) explain that Cuba and Barbados had per capita incomes 50% to 67% higher than that in the US. Even in 1800, when the US surpassed most South American countries in per capita income, it was still behind some Caribbean countries and Haiti. However, between 1790 and 1930, the US economy grew very fast surpassing all Latin American countries.

This process of "fortune reversal" has been scrutinized by researchers. Engerman and Sokoloff (1997) suggest that this unprecedented productivity growth in North America was reached through massive immigration from Europe and Africa. White immigrants from Europe predominantly immigrated to North America1, while African slaves were predominantly shipped to Latin America. Moreover, early institutional arrangements and good geographical conditions led to the creation of a local market in North America. On the other hand, poor geographic conditions and the lack of institutions that would protect property rights in Latin America facilitated the appropriation of the returns to economic activity in Latin America by European colonizers.

Also explaining this reversal, Engerman and Sokoloff (2005) found evidence that support how the rules governing the extension of suffrage evolved over time within the United States, and across the societies of the Americas. Another view is provided by Khan and Sokoloff (2006)2 in which the patents due to its system of intellectual property protection generated industrial and technological revolutions that set a new development path that allowed the US per capita income to surpass that of Latin American economies.

Acemoglu et al. (2001) discuss how these early institutions have persisted to the present. Favorable climate conditions imposed less settler mortality, induced immigration, and, by extension, institutions favorable to property protection and market economy. However, in

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1 The first census of 1790 reported by Cubberley (1920) reveals that 91.8% of the population in the thirteen original states were British and 5.6% were German. On the other hand, in the early nineteenth century, most of the Latin America countries had less than 20% European populations. Not until the end of the century did immigrants from Europe become predominant in countries such as Argentina and Chile (Engerman and Sokoloff, 1997).

2 The authors offer a historical description of this period and how intellectual property institutions might have affected the development path, since it allowed even individuals with elementary education to innovate during this period. However, by the end of 1930 most innovations were due to individuals with high technical skills. The question is if this intellectual property institution had arisen from an inherent market demand, by knowledge of individuals who understood the importance of intellectual property rights for R&D, or by exogenous forces. We believe that such institutions arise as a combination of both: individuals who possess knowledge to perceive the market inherent opportunities, and the social economic benefit of such institutions. In other words, beginning in 1790 the US had an endogenous mechanism that rewarded knowledge accumulation that later on contributed to increase productivity, innovation, and to create new institutions that would generate a self-sustainable mechanism of economic development.
colonies with climates unfavorable to settlers’ health, the expropriation economic system was adopted. Geographic conditions affecting health also explain the economic historical development process described by Sachs (2000, 2001).

The historical development process view was further developed in Acemoglu et al. (2002a) in which they discussed how people settled in colonies with low population density. This settlement policy made by Europeans included institutions that fostered private investment in sparsely populated and poor colonies. This theory also accounts for the reversal of fortunes present in the colonies’ histories, as well as for today's macroeconomic volatility, widespread corruption, and high political instability present in the less developed economies. This theory also accounts for important aspects of modern growth. Furthermore, Acemoglu et al. (2004, 2005a) posit that the institutions brought by the settlers were fundamental to theirs and today's economic growth, investment, and financial development or simply to the economic development process. This view is corroborated by Dawson (2002).

The historical economic development process is linked to initial conditions (knowledge) or the early institutional arrangement made by colonizers. Therefore, the institutions in the colonies are the image of the institutions prevalent in the colonizer’s economy. This may reflect only the knowledge settlers brought to the new colonies that were prevalent in their homeland economy. In this case, institutions back in the homeland did reflect their overall knowledge on norms, laws, rules, and the importance of their improvement in favoring economic development. This historical educational formation of Europe is explained by Cubberley (1920) who shows how education evolved slowly under constrained institutional arrangements:

The beginnings of national educational organization in England were neither so simple nor so easy as in the other lands (Europe) we have described. So far this was in part due to the long-established idea, on the part of the small ruling class, that education was no business of the State; in part to the deeply ingrained conception as to the religious purpose of all instruction; in part to the fact that the controlling upper classes had for long been in possession of an educational system which rendered satisfactory service in preparing leaders for both Church and State; and in part--probably in large part--to the fact that national evolution in England, since the time of the Civil War (1642-49) has been a slow and peaceful growth, though accompanied by much hard thinking and vigorous parliamentary fighting. (p. 308)

This educational revolution in England quickly spread to the colonies. According to Cubberley (1920):

In 1765, and again in 1774, Declarations of Rights were drawn up and adopted by representatives from the Colonies, and were forwarded to the King. In 1774 the first Continental Congress met and formed a union of the Colonies; in 1776 the Colonies declared their independence. This was confirmed, in 1783, by the Treaty of Paris; in 1787, the Constitution of the United States was drafted; and in 1789, the American government began. In the preamble to the twenty-seven charges of tyranny and oppression made against the King in the Declaration of Independence, we find a statement of political philosophy [31] which is a combination of the results of the long English struggle for liberty and the French eighteenth-century reform philosophy and revolutionary demands. [32] …… To it we must trace not only the great blessing of religious liberty, which we have so long enjoyed, but also the final establishment of our common, free,
public-school systems (italic made by us). The beginning of the new state motive for education, which was soon to supersede the religious motive (italic made by us), dates from the establishment with us of republican governments; and the beginning of the emancipation of education from church domination goes back to this wise provision inserted in our National Constitution. (p. 247-248)

In our view, the theories described throughout this literature review establish very accurately the difference between the historical paths of economic development in the Americas. The people who migrated to the US and Canada had some human capital. However, the early institutional arrangement was tied to their origin that was not very favorable to education. Later on, institutional changes reached both sides of the Atlantic and generated further incentives for human capital accumulation and set the basis for a new educational revolution and for improvements in productivity. On the other hand, most of the people who migrated to Latin American countries were endowed with very little human capital (slaves) and faced institutional arrangements that would prevent human capital accumulation. For a much longer period in their history, these early institutions seem to have precluded the accumulation of human capital over time. So, the ratio of qualified to unqualified labor still remains low in Latin American countries today. The next section explores how to develop a formal theory of institutions that supports this view and that can be tested with current data.

3. The Model
This section develops a model that emphasizes the importance of the educational sector as proposed by Uzawa (1965). A major contribution to this model is the derivation of a human capital accumulation function, similar to that introduced by Lucas (1988), from microfoundations. The model assumes that population (N) grows at a constant rate $\eta$ and is comprised of educated ($h$) and non-educated people ($n$); that is, $N=h+n$. The economy is divided into two main sectors: final goods and education. The first produces final goods and demands educated and non-educated labor, rewarding workers according to their marginal productivity. Because productivity differentials are compensated accordingly via higher wages, there exists a market incentive for non-educated individuals to become educated. The educational sector also uses educated and non-educated labor to create new human capital. Labor employed in the educational sector is rewarded according to its social return. Moreover, our model differs from traditional growth models by allowing the service sector (educational sector) to generate income that adds to the total production of the economy.

3.1 The Goods Sector
The production function of the goods sector depends on educated and non-educated labor as follows:

\[ y(g) = A(an)^{1-\beta} (ah)^{\beta} = aAn^{1-\beta}h^{\beta}, \]

where $y(g)$ is final output; $n$ is non-educated labor; $h$ is educated labor or human capital; and $A$ is a measure of technology. Here, $A$ represents the technology embodied in physical capital at any point in time; and $0 < a < 1$ is the proportion of inputs allocated to this sector.
Firms choose the combination of educated and non-educated workers, taking the level of technology embodied in the equipment, installations, inputs, etc., as given. For simplicity, the wages of educated and non-educated workers are derived in \textit{effective real} terms. For instance, the effective real wage of educated workers employed in the production of the final good is given by $w_h^e = \frac{W_h}{A P}$, where $W_h$ denotes nominal wages and $P$ is the price level. The profit function is:

$$\Pi = a n^{1-\beta} h^{\beta} - w_h^e h - w_n^e n,$$

where $w_h$ and $w_n$ are the effective real wages. Profit maximization, taking $A$ as given, leads to the following wage equations:

$$w_h^e = \beta an^{1-\beta} h^{\beta-1},$$

$$w_n^e = (1-\beta)an^{-\beta} h^\beta.$$

The income distribution or wage ratio between educated and non-educated labor is a function of their existing stocks:

$$\left(\frac{w_h}{w_n}\right) = \left(\frac{\beta}{1-\beta}\right) \frac{n}{h}.$$

Equation (5) shows that as non-educated labor becomes educated, there is a continuous reduction in the wage ratio.

\textit{3.2 The Educational Sector}

We assume that non-educated workers can be trained and receive knowledge from educated workers via a simple educational production function given by:

$$y(e) = \left[1 - a \gamma n^{-\beta} \left(\gamma^{-\beta} - a \gamma^{-1}\right)^\beta\right]^{\frac{1}{\gamma}} = \gamma \left(\frac{1-a}{a}\right) \frac{y(g)}{A},$$

where $0 \leq \gamma \leq 1$ measures the quality of institutions. A larger $\gamma$ is associated with better institutions. This specification implies that poor institutions affect the productivity of educated workers in the process of transferring knowledge to non-educated workers. For instance, institutional arrangements that fail to reward educators for their excellence in teaching and research may discourage highly qualified professionals from fully engaging students and therefore negatively affect the leaning process. Moreover, equation (6) can also be interpreted in terms of forgone output or investment made by society to create new human capital. It also implies that as technology advances, human capital creation becomes more complex so that the amount of forgone output necessary to create new human capital increases.

We assume that a society rewards the human capital employed in the educational sector according to its social return, or the average effective cost of producing human capital. This is equivalent to $w_h^e = y(e)/h$. Notice that the quality of institutions plays a major role in determining the social return of human capital. For instance, a society with poor

\footnote{The technology level only changes over time under an investment decision on physical capital. In other words, technology improves only by acquiring new physical capital that has embodied knowledge in it, at any point in time, the technology is given.}

\footnote{$\gamma$ is normalized to range from 0 to 1 for convenience.}
institutions (small $\gamma$) also attributes a low value to human capital, which causes the effective wage of educated labor employed in the educational sector to decrease.

Mobility in the labor market implies that wages for similar labor should equalize across the educational and final goods sector, that is $w^e_k = w^g_k$. Using this equilibrium condition together with equation (3) produces:

$$a = \frac{\gamma}{\gamma + \beta}$$

Substituting equation (7) into equation (6) produces:

$$y(e) = \left(\frac{\gamma \beta}{\gamma + \beta}\right)^{1-\beta} h \beta .$$

Equation (8) implies that, holding all other factors constant, improvements in the quality of institutions increase the productivity of the inputs allocated in the educational sector as well as the production of human capital, that is, $\frac{\partial y(e)}{\partial \gamma} > 0$.

3.3 The Individual Decision to accumulate human capital

Equation (8) describes the aggregate function determining how societies make investments in education, but does not provide microfoundations explaining individual behavior toward investments in human capital. This section fills this gap by developing a model linking the individual knowledge accumulation decision to market conditions. A representative non-educated agent makes a decision regarding investments in education by comparing the future gain accruing from knowledge accumulation with the cost of obtaining such knowledge. The future stream of accrued wages for educated labor in the economy generates an endogenous incentive for knowledge accumulation.

The value of the benefit accruing from human capital accumulation, at time $t$, is the weighted sum of all future wages given by the following equation:

$$W = \int w^e_k e^{-r(s-t)} ds = \int \left(\frac{\gamma \beta}{\gamma + \beta}\right)^{1-\beta} h \beta e^{-r(s-t)} ds,$$

where $r$ is the market discount rate and the ratio $\frac{r}{\gamma}$ is the effective discount rate or the discount rate adjusted by institutional inefficiencies created by poor institutional arrangements. The rationale for adjusting the discount rate by the quality of institutions, $\gamma$, is that poor (good) institutions decrease (increase) the returns to skills. This is consistent with Dias and McDermott (2006), among others. Because $\frac{r}{\gamma}$ updates the investment made in education, the inverse of this ratio (or $\frac{\gamma}{r}$) can be interpreted as the effective rate of return to education.

The opportunity cost (or investment) to acquire knowledge for a non-educated worker is the sum of two components: i) the income given up during the time allotted to acquire knowledge, which is equivalent to equation (4), and ii) the average social cost incurred to transform non-educated labor into human capital, which is given by the division of equation (8) by $n$. The opportunity cost is also affected by the time, $(t-T)$, necessary for $n$ to become $h$. Consider that the costs are updated over time by a rate $\phi$, then:
Therefore, an individual will choose to acquire skills if the future discounted stream of income is equal to or greater than the costs incurred to accumulate human capital. Assuming that, at the margin, a non-educated individual will choose to acquire the skills necessary to become educated, then:

\[
C = \frac{1}{(\gamma + \beta)} \left( \frac{\gamma}{\gamma + \beta} \right) n^{-\beta} h^\beta + \frac{\beta}{\gamma + \beta} n^{-\beta} h^\beta \right] e^{\phi(t-s)} ds = \frac{1}{(\gamma + \beta)} n^{-\beta} h^\beta \right] e^{\phi(t-s)} ds.
\]

Integrating both sides with respect to \( s \), assuming that \( T \to -\infty \), and rearranging the solution produces:

\[
\frac{h}{n} = \left( \frac{\phi \beta y}{r} \right).
\]

Equation (12) implies that there is an optimal ratio of educated to non-educated labor in the economy and that this ratio depends primarily on the quality of institutions (\( \gamma \)), the human capital participation in the economy (\( \beta \)), and the discount rates (\( \phi, r \)) attributed to both the costs and return to human capital accumulation. Good institutions are associated with a larger ratio of educated to non-educated labor and, therefore, to a large population of qualified labor in the economy. Under this last case, exogenous institutional reform may contribute to the human capital accumulation process and by extension improve economic productivity.

Equation (12) can be rewritten to fit the development path, for instance, of colonies in North America (US and Canada). More precisely, let it be rewritten as:

\[
(12a) \quad h(o) = \left( \frac{\phi \beta y}{r} \right)n(o),
\]

where \( h(0) \) represents migration of European human capital. Thus, over time non-qualified people acquired education due to the high effective rates of return to education (\( \gamma /r \)) -- which is determined by institutions -- and the relatively high participation of human capital in the economy (\( \beta \)). In the case of Latin American economies, most of the large initial stock of non-qualified people, \( n(0) \), did not accumulate human capital over time because of the relatively low effective rates of return to education (\( \gamma /r \)) and the small participation of human capital in the economy (\( \beta \)).

Solving equation (12) for \( n \) and substituting into equation (8) produces:

\[
(13) \quad \dot{h} = y(e) = \left( \frac{\phi \beta y}{\gamma + \beta} \right) \left( \frac{r}{\phi} \right)^{1-\beta} h
\]

Hence, this is an endogenous human capital accumulation process that depends upon the quality of the institutions. We can easily compare the above equation with the one proposed by Lucas (1988), which is given by \( \dot{h} = (1-u) \delta^* h \), where \( u \) represents the effort devoted to human capital accumulation and \( \delta^* \) is the maximum rate. The maximum rate in equation (13) is given by the \( \left( \frac{r}{\phi} \right)^{1-\beta} \), while \( (1-u) \) is represented by the remaining parameters. Because equation (13) is derived from microfoundations, it does not carry the ad hoc burden inherent to Lucas’s formulation.
3.4 General equilibrium and the growth path

The model developed in this paper implies that income can be generated both in the final good and educational sectors. Therefore, the overall production in the economy is equivalent to the sum of the production functions given by equations (1) and (6).

\[ Y = y(g) + y(e) = \omega \theta + A \phi, \]

where \( \omega = \left( \frac{\gamma \beta \rho \theta - 1}{\gamma + \beta} \right) \left( \frac{r_0}{\phi} \right)^{1-\beta} \).

Output per person is obtained by dividing (17) by the total population, N.

\[ y = \frac{Y}{N} = \omega \theta + A \phi \]

where \( \nu = h/N \) is the share of educated labor in the economy. According to equation (15), the average labor productivity is a linear function of the share of educated labor, the technology index, and a non-linear function of institutions.

The representative consumer is assumed to have the following welfare function:

\[ u(c) = \int_0^1 \left( \frac{c^{1-\sigma}}{1-\sigma} - 1 \right) e^{-\sigma} \, dt \quad \text{for} \, \sigma \neq 0, \]

where \( c \) denotes consumption per capita. For simplicity’s sake, let \( A \), the index of technology, be linearly related to per capita physical capital in the economy, that is:

\[ A = \bar{g} k \quad \text{and} \quad \bar{k} = \bar{q} + \bar{k} \gamma - c \eta k \]

where \( k \) denotes per capita physical capital. The Hamiltonian function for this problem is:

\[ H = \frac{c^{1-\sigma}}{1-\sigma} + \bar{k} \left( \theta + \bar{k} \gamma - c \eta k \right) \]

The solution to this optimization problem, which has \( c \) as the choice variable and \( k \) as the state variable is well-known and is given by the following equations\(^6\):

\[ \dot{c} = \lambda \]

\[ \dot{\lambda} - \rho = -\bar{c} \eta - \eta \]

Log-differentiating equation (19) and combining it with equation (20) produces:

\[ \dot{c} = \frac{1}{\sigma} \bar{c} \eta - \eta - \rho \]

In a balanced growth path, output per capita and consumption per capita must grow at the same rate. This condition implies that:

\[ g_y = \frac{y}{Y} = c = \frac{1}{\sigma} \bar{c} \eta - \eta - \rho \]

The balanced growth rate of output per capita depends on deeper parameters such as institutions, the intertemporal discount rate, and the share of human capital in the economy. It is important to notice that the effect of institutions on output growth can be

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\(^6\) The optimization conditions require that \( \frac{\partial H}{\partial c} = 0 \), \( \dot{\lambda} - \rho \lambda = -\frac{\partial H}{\partial k} \), and the transversality condition:

\[ \lim_{t \to \infty} k(t) \lambda(t) e^m = 0 \].
interpreted in two different manners. First, it can be seen as having an indirect effect by impacting the coefficient on the share of human capital in the economy (v). Second, it can be interpreted as having a “deeper” effect because institutions determine the early optimal ratio (v) of human capital in the economy. These alternative interpretations have empirical implications as they create complications to estimate and test for the impact of institutions on economic growth. We further analyze this issue in the next section.

The model also shows that institutions impact physical capital accumulation. More precisely, log-differentiating equation (15) together with equation (22) shows that institutions affect the growth rate of physical capital (or the technology index). This implies that countries with good institutions (large α) will grow faster than countries with poor institutions. Another important aspect is that negative economic growth is possible under our framework as long as the weighted share of human capital is less than the population growth rate plus the intertemporal discount rate. In other words, population growth control is an important policy for promoting long-run economic growth.

According to the model, the historical development path is as follows: institutions set the pace for human capital accumulation according to equation (13). Human capital then fosters technology and output growth, which increases the returns to human capital accumulation and induces non-educated workers to invest in education and become educated. This generates a self-perpetuating accumulation mechanism which can be enhanced by improving institutions. Over the historical development of countries, those that undertake institution reforms in the form of a better political system, more efficient economic policies, and an improved legal system should experience sizable positive effects on physical capital and on human capital accumulation. Input accumulation is the proximate driving factor behind economic growth. Institutions affect input accumulation and also determine the size of the impact of input accumulation on economic growth.

4. Econometric Model

The relationship among institutions, input accumulation, and economic growth poses some major econometric issues, such as causality. Besides the causality issue, Kenny and Williams (2001) suggest that the major institutional differences among countries affect the coefficients on inputs in the econometric regressions, so that a well-specified empirical model should also deal with heterogeneity.

Causality and heterogeneity can be best dealt with through a dynamic panel data model, where differences among countries are captured across and over time. Moreover, a dynamic panel data model allows us to obtain the historical development path or long-run average growth rate as the constant in the model. Geographical-related factors, which are intrinsically linked to institutions, are controlled for by adding regional dummies. Also, time indicator variables are used to capture changes in the growth trend. The initial or structural effect over the sample can be established by looking to the first and second order autoregressive process. Consider the following dynamic specification:7

\[ y_{it} = x_{it} \beta + y_{i,t-1} \alpha + \eta_i + u_{it}, \]

where \( y_{it} \) is the dependent variable, \( x_{it} \) is a vector of pre-determined variables, \( \beta \) is a vector of coefficients to be obtained, \( \eta_i \) represents country-specific effects, and \( u_{it} \) is the component error vector. Under contemporaneous exogeneity, the errors should not be

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7See Woodridge (2002) for details regarding our empirical strategy.
correlated with pre-determined variables, so that \( E(u_{it}|x_{it}, y_{it-1}, \ldots, x_{it}, y_{it}, \eta_t) = 0 \). This is equivalent to performing two tests:

1. First, the second-order regressive process on the panel residuals should not be present, \( E(u_{it}|u_{it-1}, \ldots, u_{it1}) = 0 \);
2. Second, the instrumental variables must be exogenous, \( E(u_{it}|x_{it}, \ldots, x_{it1}) = 0 \).

However, these conditions depend heavily upon the quality of the instruments. To acquire better instruments, the dynamic specification should be estimated under an equation system. The second equation that forms the system is the following difference equation:

\[
y_{it} - y_{it-1} = (x_{it} - x_{it-1})\beta + (y_{it-1} - y_{it-2})\alpha + (u_{it} - u_{it-1})
\]

The problem of instrument quality is minimized by using lags of the dependent variable as instruments for the first equation and the lags of the variables in differences for the second equation as proposed by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998).

The data used to estimate the model above are from three sources: Barro and Lee (2010), The Penn World Table 6.3 and the Polity IV Project. This is a panel data for 61 countries for the years 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, and 2005. The variables are as follows: 1) five-year averaged output per capita growth rate; 2) five-year averaged human capital growth rate; 3) five-year averaged growth rate of physical capital per worker; 4) level of human capital; 5) per capita level of physical capital; 6) institution; 7) time indicator variables; and 8) regional indicator variables (East Asia Pacific countries, Latin American countries, Middle East and North African countries, South Asian countries, Sub-Saharan countries, transitional economies, and advanced countries - which were omitted).

The human capital variable is generated following Hall and Jones’s (1999) piecewise function. We use the rate of returns for primary, secondary and tertiary education from Psacharopoulos (1994). The function is as follows: \( hk = e^{0.201^*pyr25 + 0.139^{*}syr25 + 0.11^{*}hyr25} \), where \( p y r 25, s y r 25 \) and \( h y r 25 \) are the countries’ average years of schooling for primary, secondary and tertiary education from Barro and Lee (2010).

The capital stock is calculated using a perpetual inventory system proposed by Easterly and Levine (2001).\(^8\) Other alternatives of physical capital measures were considered. The

\(^8\) Let \( d \) equal the depreciation rate, which we assume equals 0.07. Thus, the capital accumulation equations states that \( K(t+1) = (1 - d) K(t) + I(t) \). To compute the capital per worker ratio we divide \( K(t) \) by \( L(t) \), where \( L(t) \) is the working age population in period \( t \) as defined in the Penn World Tables. To compute the capital-output ratio, we divide \( K(t) \) by \( Y(t) \), where \( Y(t) \) is real GDP per capita in period \( t \). To make an initial estimate of the capital stock, we make the assumption that the country is at its steady-state capital-output ratio. Thus, in terms of steady-state value, let \( k = K/Y \), let \( g = \text{the growth rate of real output, let} i = I/Y \). Then, from the capital accumulation equation plus the assumption that the country is at its steady-state, we know that \( k = i/[g + d] \). Thus, if we can obtain reasonable estimates of the steady-state values of \( i, g, \) and \( d \), then we can compute a reasonable estimate of \( k \). The Penn World Tables have data going back to 1950 on output. Thus, we can compute the initial capital stock estimate as \( k^*Y(\text{initial}) \). To make the initial estimate of \( k \), the steady state capital output ratio, we set \( d = 0.07 \). We construct \( g = \text{the steady-state growth rate as a weighted averaged of the countries average growth rate during the first ten years for which we have output and investment data and the world growth rate. The world growth rate is computed as 0.0423. Based on Easterly et al. (1993, Journal of Monetary Economics), we give a weight of 0.75 to the world growth rate and 0.25 to the country growth rate in computing an estimate of the steady-state growth rate for each individual country, g. We then compute i as the average investment rate during the first ten years for which there are data. Thus, with values for d, g, and i for each country, we can estimate k for each country. To reduce the influence of business-cycles in making the estimate of Y(initial), we use the average real output
additional set of physical capital was computed using small variation in the steady growth rate \( g \) and in the early investment. The steady state growth rate, \( g \), was a simple average of the world growth rate and the first ten years’ average country growth rate. The world growth rate considered was the long run growth rate of 0.02.\(^9\) The early investment was considered as formed by four years instead of ten as in Easterly and Levine (2001). Details about these variables are discussed below as part of the robustness analysis.

We consider two measures of institutions. The first follows the reasoning of our theoretical model. According to equation (12), the ratio of educated to non-educated human capital is a byproduct of a country’s institutions. Institutions affect the incentives for non-educated labor to make the investments necessary to become educated (human capital). Therefore, we use the ratio of people with post-secondary education to people with no-schooling as a proxy for institutions. This measure is labeled as \textit{Structural Institutions}. We also utilize the Polity IV Project adjusted-combined index of democracy and autocracy (polity2) as a measure of \textit{political} institutions.

\subsection{4.1 Results}

The empirical models were selected based on the results of the Arellano-Bond tests for AR(1) and AR(2) in first differences, the Hansen test of over-identifying restrictions, and the Difference-in-Hansen exogeneity test. A set of model estimates that excluded institutions failed in either the difference or system GMM instrument validity tests. These models are not reported in the paper. On the other hand, models 1 thru 4 of Tables 1 and 2 include this paper’s proxy for institutions and pass in both the difference and system GMM instrument validity tests. These results provide evidence that the lack of controls for the quality of institutions may bias the estimates. The discussion below focuses on this sub-set of models that were estimated using a one-step system GMM estimator with robust covariance matrix.

Models 1 thru 4 in Table 1 show that when controlling for human capital, physical capital accumulation and institutions, the coefficients on the constant term are not statistically significant at any standard level of significance. This suggests that the covariates included in the model explain the long-run trend of cross-country per capita output growth.

Models 1 and 4 in Table 1 provide strong evidence that structural institutions matter and affect long-term economic growth. In all regressions, the coefficients on \textit{the first lag of structural institutions} are positive and statistically significant at standard levels of significance. It is worth noting that the coefficient on contemporaneous structural institutions is not statistically significant. This is consistent with the idea that changes in structural institutions do affect growth, but their impacts are only felt in the long-run (Tebaldi and Elmslie, 2011; Hall and Jones, 1999; Acemoglu et al., 2005). In addition, we find that the coefficient on political institutions, measured by the Polity Index of

\footnote{value between 1950-1952 as an estimate of initial output, \( Y(\text{initial}) \). Thus, the capital stock in 1951 is given as \( Y(\text{initial}) \times k \). If output and investment data do not start until 1960, everything is moved up one decade for that country.\(^7\) (Easterly and Levine, 2001).}

\footnote{\(^9\) It was also considered the sample average growth rate. However, the result for the physical capital stock has not changed.}
democracy and autocracy, is not significant in all specifications. The theory developed in section 3 together with empirical findings implies that structural institutions affect productivity and determine an economy’s growth path. However, political institutions on their own affect neither individual behavior and productivity nor long-term economic growth.

Table 1 also provides strong evidence that the growth rates of physical and human capital impact a country’s growth rate of output per capita. However, there are important differences in the dynamic impact of human capital and physical capital on output growth. Table 1 shows that the contemporaneous coefficient on physical capital is positive and statistically significant, but the coefficient on the first lag of physical capital is negative and statistically significant. This suggests that there is a sluggish adjustment likely driven by capital obsolescence, which reduces the impact of capital accumulation in the long-run. In accounting for this effect, however, the long-run impact of physical capital growth on per capita output growth is positive, which implies that physical capital accumulation is a key factor determining the long-run growth rate of an economy. It is also worth noting that the long-run impact of growth of physical capital on economic growth is much larger when controls for quality of institutions are added to the model. This result is consistent with the theoretical model developed in Section 3, which indicates that countries with good institutions will benefit more from physical capital accumulation and grow faster than countries with poor institutions.

Table 1 also shows that human capital growth positively impacts the growth rate of per capita output. However, the effect is observed via the second lag. More precisely, while the coefficient of the second lag of human capital growth is positive and significant, the coefficients on the contemporaneous and first lag of human capital growth are statistically insignificant. This result implies that human capital accumulation affects growth in the long-run, but it takes some time for the increase in human capital to affect economic growth.

Models 3 and 4 in Table 1 are extended versions of the baseline models (models 1-2). They include both the growth and the levels of human capital and physical capital. The coefficients on levels of human and physical capital are insignificant and have the wrong sign in some cases. This result holds in several other specifications not reported in the paper. Hence, the dynamic panel data estimates suggest that growth -- not the levels -- of physical and human capital determine long-run economic growth. This result is consistent with a large body of literature, including Jones (1995) and Tebaldi and Esmie (2008).

Table 2 mirrors Table 1, but its estimates allow considering the potential effect of geography (via regional dummies) on the coefficients of institutions as well as the direct effect of geography on growth. Overall, the qualitative results discussed above hold when regional dummies are included in the model. However, the coefficients on structural institutions and human capital increases significantly compared to the coefficients.

---

10 This result holds when we excluded: i) the proxy for structural institutions, and/or ii) changed the number of lags for this variable.
11 Interaction terms between political and structural institutions turned out insignificant and were not reported in the paper.
12 The long-run effect is calculated as the sum of all coefficients on physical capital growth.
13 The estimates excluding structural institutions from the model are not reported in the paper. We will gladly provide the results upon request.
reported in Table 1. This indicates that omitting controls for geography bias the coefficients estimates. It also suggests that the effect of geography on output growth takes place indirectly via its impacts on both human capital growth and structural institutions.\textsuperscript{14} Table 3 reports estimates using variations of the measure of physical capital proposed by Easterly and Levine (2001). The estimates using the alternative measure of physical capital and early investment have not changed the main results. These results are consistent with those reported in Tables 1 and 2 and imply that the methodology considered in calculating the stock of physical capital does not affect the estimates. Therefore, we opted for commenting on just the results based on the more well-known Easterly and Levine methodology.

5. Final Remarks

The theoretical growth model developed in Section 3 demonstrates the importance of the interaction between human capital and institutions for explaining the development process. Institutions play a key role in setting up the path of human capital accumulation, which fosters technology and output growth. Productivity then contributes to increase the returns to human capital accumulation and induces non-educated workers to invest in education and become educated. This generates a self-perpetuating accumulation mechanism. This self-perpetuating mechanism can be enhanced by improving institutions.

The empirical estimates corroborate some insights from the theoretical model. We find that structural institutions positively affect long-term economic performance. However, political institutions are found to be not correlated with productivity and long-term economic growth. Hence, structural institutions need to be improved in order to contribute to long-run economic growth. The empirical estimates also show that growth of physical and human capital - instead of levels - determines long-run economic growth. The major policy implication is that the futures of economies are tied to structural institutions. The theory and evidence in this paper puts the historical development in the following perspective: If early institutions cause the rate of return to education to be too low, then knowledge accumulation will be very dismal initially, affecting economic growth. However, this condition can be broken by implementing institutional reforms that change the perception of the potential return to education by individuals. Hence, due to the link between institutions and education, these changes take place almost simultaneously. The acceleration in the growth rate of human capital also generates further improvements in structural institutions.

This paper and the ones discussed in the literature review offer several perspectives for linking institutions to economic development. However, relevant questions about institutional change are still open to debate. For instance, is institutional change dependent upon a knowledge threshold? Is this knowledge threshold related to the level of a structural institution? Further research may provide answers to these questions.

\textsuperscript{14} The relationship between institutions and geography is discussed in Hall & Jones (1999); La Porta \textit{et al.}(1999), McArthur & Sachs(2001), Acemoglu \textit{et al.} (2001) and Acemoglu & Johnson (2005).
References


<table>
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<tr>
<th>Dependent Variable: Growth of GDP Per Capita (gyl)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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* t statistics in brackets; * p < 0.10, ** p < 0.05, *** p < 0.01
All regressions are estimated using a one-step system GMM estimator with robust covariance matrix and include i) two lags as instruments in both the first difference equation and level equation, ii) time dummies. In all regressions, the null hypothesis of the Hansen Overidentification and Difference-in-Hansen/ exogeneity tests are rejected at the 1% level of confidence.
Table 2 – Dynamic Panel Data Estimates: Include Regional Dummies

<table>
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<tr>
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*Statistics in brackets; * \(p < 0.10\), ** \(p < 0.05\), *** \(p < 0.01\)

All regressions are estimated using a one-step system GMM estimator with robust covariance matrix and include i) two lags as instruments in both the first difference equation and level equation, ii) time and regional dummies. In all regressions, the null hypothesis of the Hansen Overidentification and Difference-in-Hansen/exogeneity tests are rejected at the 1% level of confidence.
<table>
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<tr>
<th>Dependent Variable: Growth of GDP Per Capita (gyl)</th>
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</table>

$t$ statistics in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

All regressions are estimated using a one-step system GMM estimator with robust covariance matrix and include i) two lags as instruments in both the first difference equation and level equation, ii) time dummies. In all regressions, the null hypothesis of the Hansen Overidentification and Difference-in-Hansen/exogeneity tests are rejected at the 1% level of confidence.

Notes: (1) Easterly and Levine (2001); (2) Authors.