

# **INSTITUTIONS, HUMAN CAPITAL AND ECONOMIC GROWTH: A NEW THEORETICAL AND EMPIRICAL APPROACH**

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**JULY 2009**

# INSTITUTIONS, HUMAN CAPITAL AND ECONOMIC GROWTH: A NEW THEORETICAL AND EMPIRICAL APPROACH

## *Resumo*

Neste artigo apresentamos um modelo de crescimento econômico endógeno baseado em capital humano. A decisão de acumular capital humano está associada às instituições da economia. O primeiro resultado é que a função de capital humano derivada de forma endógena é similar a proposta por Lucas (1988) de forma *ad hoc*. As instituições são divididas em dois tipos. A primeira é denominada de estrutural e a segunda de instituições políticas. No primeiro caso, a composição é dada por condições geográficas, religião e biotipo. No segundo caso, as instituições representam as políticas sociais, as instituições políticas, sistema legal e as políticas econômicas. O principal resultado do modelo é a compreensão da ligação entre instituições e acumulação de capital humano e físico. As instituições estruturais são a chave das condições iniciais ditando a razão pessoas educadas/não-educadas que formam a condição inicial do processo de desenvolvimento de longo prazo. No entanto é a decisão de acumulação de capital humano que cria o processo endógeno de desenvolvimento tecnológico formando junto um processo de crescimento sustentado. As instituições políticas estão encarregadas de transmitir a totalidade ou não deste mecanismo ao crescimento econômico. Estimativas em painel de dados dos países demonstraram fortes evidências dos resultados propostos pela nova teoria.

**Palavras Chaves:** *Instituição, capital humano, crescimento econômico e econometria*

**JEL:** O43 e O47

## *Abstract*

In this paper, we present a new economic growth model based on human capital. The decision on acquiring human capital depends upon existing institutions in the economy. As a result, an endogenous human capital accumulation function arises, which is similar to the *ad hoc* one proposed by Lucas (1988). There are two kinds of institution present in this process. The first one is the structural institution represented by geographical conditions, religious belief and biotype. The second one is the policy institution represented by economic policies, legal system and political behavior. The main outcome of the theoretical model is its contribution to a better understanding of the link between institutions and the input accumulation process. Our economic growth model shows that the structural institution is the key to setting up the initial ratio of educated to non-educated labor or the historical development path. Moreover, it is the human capital accumulation that triggers the technology development process as well as forming a self-sustained mechanism that generates continuous growth. As for the policy institution, it is in charge of transmitting totally or partially input growth to the long-run economic growth. The panel dynamic regression estimate showed striking evidence of the importance of the proposed model for understanding long-run economic growth.

**Keys-Words:** *Institutions, human capital, economic growth e econometric*

JULY 2009

## **1.0 Introduction**

There is a strong debate in the literature about the importance of institutions and educational developments in determining economic growth. The importance of institutions for growth was recently showed by Hall and Jones's (1999) paper. However, a view that is more recent advocates that education policy comes first in explaining better institutions and therefore growth, according to Glaeser et al. (2004). Nonetheless, when we think of democracy or political institutions as representing institutions, the causal effect of education on institutions was shown to be non-existent by Acemoglu et al. (2005). According to them, education and institutional development are guided by omitted factors represented by country fixed effects. More precisely, according to them, both follow "historical development paths". Therefore, in our view, the literature can be seen as belonging to two groups. The first group views economic growth and development depending upon modern policies, including modern institutions. The second group, however, sees actual economic growth and development as depending upon its historical path.

Here, we develop a model that shows how both views may be right, since there is an interaction between these two groups. In our model, there are two kinds of institutions. The structural institution is a less volatile type of institution represented in our view by three elements: i) geographical conditions, including land quality, ii) religious belief, including ethnical formation, and iii) dominant biotype. We show that the structural institution indeed sets up the initial condition or the initial path for the historical development path as advocated by Easterly and Levine (1997), Hall and Jones (1999), Kenny (1999) and Acemoglu et al. (2005) among others. The policy institution represents a more volatile set of conditions. This institution is represented in our view by i) the dominant polity institutions; ii) the economic policies, including corruptive behavior, iv) legal system efficiency, etc. In simple words, policy institution represents the modern policies and institutions. For instance, fiscal policies that deviate expenditure away from education or basic infrastructure investment to a more frugal expenditure may be as harmful to growth as the structural one represented by land quality. However, they are much more easily fixed over a length of period compared with, for instance, religious beliefs. Among several studies that reflect the policy institution role, we have Barro (1991), Rebelo (1991), Levine and Renelt (1991, 1992), Mankiw, Romer and Weil (1992) and Lee (1993). These authors are among the pioneers studying the impact on the growth of the policy institution as defined by us. One of the objectives of this paper is to show how we may combine these definitions into a model of economic growth and development in order to understand their relationship better.

We first derive a model where only the structural institution is present. The second step is the inclusion of the policy institution in a dynamic model. By making their interaction clearer through the model, we are able to comprehend better the econometric tests that will be performed.

Some of the results of our very simple model follow. The structural institution gives us the initial ratio of human capital to non-educated labor in the economy. The initial human capital is the one that set the initial condition for the historical development path. This is achieved by triggering early technology development. The accumulation process of both forms a self-sustained mechanism of long-run growth. Nonetheless, the policy institution present in the economy may help enhance the impact of the human capital and technology on the economic growth rate. In other words, structural institutions might give us the initial amount of knowledge and by extension technology, but it is the decision on knowledge accumulation as a policy behavior that might improve or diminish the historical growth path.

Moreover, bad policy institutions may cause the impact of human capital on growth to be dismal while good institutions can enhance the human capital impact over median and long-term growth. This is the view that is present in the model. As mentioned before, the main objective of the model is to shed some light on the ongoing discussion about structural and/or modern institution effect on growth.

This view is a further development of the one presented by Dias and McDermott (2006) on explaining the mechanisms of economic growth, institutions and the educational sector. According to the authors, a private institution represented by entrepreneurs is important for enhancing human capital accumulation. However, knowledge accumulation is also important for policy institution improvement. There is a feedback

effect. Different from the authors, we seek a more general model that links micro and macro aspects of institutions and human capital accumulation.

## 2.0 The Model

### 2.1 Introduction

In this section, we develop a model that incorporates the importance of the educational sector as proposed by Uzawa (1965). The first outcome of the model is that the *ad hoc* human capital accumulation function introduced by Lucas (1988) is endogenous to the system. The second step of the model development is to theorize about the inclusion of the structural institution in the dynamic model. Its inclusion generates the second outcome, which is the importance of the initial amount of human capital in the economy for its development path.

The overall model description is as follows. The economy is divided into two main sectors: goods and educational. The first produces goods that are used by the second sector in producing education for non-educated individuals. This is the market incentive for non-educated individuals to become educated (human capital) in our model. However, this perfect market works under the effect of structural institution; therefore, it explains why some economies might have more human capital than others under the same set of conditions. Furthermore, we introduce the effect of the policy institution. It influences the overall macro policies that might be good or bad for the economy. The main result is as follows: i) if the structural institution is dominant, then long-run economic growth follows the “historical development path”; ii) if the policy institution is dominant, then long-run productivity growth follows the “modern policy growth path”.

### 2.2 The Goods Sector

The goods sector depends on educated and non-educated labor. This modern production sector enables us to see the interaction between the goods and the human capital sectors. Therefore, it makes it easier for us to explain the earlier ratio of human capital and non-educated labor in the economy as well as the role of institutions. The overall production of the goods sector is given by

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

where  $y(g)$  is the output of the goods sector;  $n$  is the amount of non-educated labor being used;  $h$  is the amount of educated or human capital in the production; and  $A$  is the technological index coefficient. Here,  $A$  represents the technology embodied in the physical capital at any point in time; and  $a$  is the amount of input allocated to this sector.

If we divide (1) by the total number of workers  $N = n+h$ , then we can think of equation (1) as being in per capita terms. In this case,  $n$  and  $h$  would be the percentage of non-educated and educated labor in the economy, respectively.

Firms choose the combination of educated and non-educated workers, taking the level of technology embodied in the equipment, installations, inputs, etc., as given. 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; so, at any point in time, the technology is given. The profit function is then

$$(2) \quad \Pi = a A n^{1-\beta} h^\beta - w_h h - w_n n,$$

where  $w_h$  and  $w_n$  are the real wages in terms of goods. Profit maximization taking  $A$  as given leads to the following wage equations:

$$(3) \quad w_h = \beta a A n^{1-\beta} h^{\beta-1}$$

$$(4) \quad w_n = (1 - \beta) a A n^{-\beta} h^\beta.$$

The educated labor real wage is positively related to the level of technology and non-educated labor; however, it is a declining function of the level of human capital or educated labor. The real wage for non-educated workers is positively related to the human capital and level of technology, but a declining function of the size of the non-educated workforce. It is easy to see that income distribution or income ratio between educated and non-educated labor is related to their existing amount.

$$(5) \quad \left( \frac{w_h}{w_n} \right) = \left( \frac{\beta}{1 - \beta} \right) \frac{n}{h}.$$

As non-educated labor becomes educated, there is a continuous reduction in the income distribution ratio over time.

### 2.3 The Educational Sector

The educational sector can be viewed from two angles. The first one is endogenous in the sense that no policy institution has any effect on it. The second one is exogenous, where policy institutions do affect its outcome. We start with the first case by deriving the endogenous condition of the educational sector. We assume that the educational sector has a similar production function to the goods sector. Therefore, both sectors share the existing input in order to produce different outputs. More specifically,

$$(6) \quad y(e) = A[(1 - a)n]^{1-\beta} [(1 - a)h]^\beta = (1 - a) A n^{1-\beta} h^\beta = (1 - a) y(g).$$

Therefore, if we think in terms of investment made by society, equation (6) represents the amount invested in education. The investment is equivalent to the output of equation (6). Considering the non-zero profit condition, Euler's theorem states that the income from the output will be shared by the educated and non-educated labor proportionally. In this way, it represents the social cost for producing the educated labor. By dividing equation (6) by  $h$ , we have the cost of producing one unit of educated labor. On the other hand, the social gain to be accrued from this new unit of educated labor is equivalent to the wage of this same educated labor on the market, equation (3). This is equivalent to saying that  $y(e)/h = w_h$ . Solving this social equilibrium condition, we have that

$$(7) \quad a = \frac{1}{1 + \beta} \text{ and } (1 - a) = \frac{\beta}{1 + \beta}.$$

Therefore, the optimal amount to be invested in education by society is equivalent to its contribution to the goods sector. Substituting the above result back into equation (6), we obtain

$$(8) \quad y(e) = \left( \frac{\beta}{1+\beta} \right) A n^{1-\beta} h^\beta.$$

The above equation represents the endogenous amount of human capital investment at any point in time. In the coming two sections, we exploit the exogenous condition or the institution effect on human capital accumulation. More precisely, the structural institution is considered at the micro level, individual decision, while the policy institution at the macro level.

#### 2.4 The Individual Decision to Educate and the Structural Institution Effect

The individual decision on knowledge accumulation is dictated by economic aspects or market conditions. The non-educated agent looks at the future gain accruing from knowledge accumulation and compares it with the cost of obtaining such knowledge.

The prevailing wage for educated labor in the economy generates an endogenous incentive for knowledge accumulation. The present value of the benefit accruing from human capital accumulation per worker is the sum of all future wages given by the following equation:

$$(9) \quad W = \int_t^\infty w_h e^{-r\delta(s-t)} ds = \int_t^\infty \left( \frac{\beta}{1+\beta} \right) A n^{1-\beta} h^{\beta-1} e^{-r\delta(s-t)} ds,$$

where  $r$  is the discount rate. As one may see, the discount rate is multiplied by the quality of the structural institution in the economy. Better institutions ( $0 < \delta < 1$ ) cause the present value of the wage to be higher, since they reduce the discount rate. Therefore, it generates an incentive for knowledge accumulation. Neutral institutions ( $\delta=1$ ) do not interfere in the decision on human capital accumulation, which is dominated by pure market conditions. Bad institutions ( $\delta > 1$ ) raise the discount rate, which reduces the incentive for future knowledge accumulation.

The average cost to acquire knowledge for a non-educated worker is given by the division of equation (8) by  $n$  plus the income given up during that time equivalent to equation (4). This is an accumulated process up to time  $t$  when  $n$  becomes  $h$ . Moreover, both costs are updated over time by a rate  $\varphi$ . More precisely, we have

$$(10) \quad C = \int_0^t \left[ \left( \frac{\beta}{1+\beta} \right) A n^{-\beta} h^\beta + \left( \frac{1-\beta}{1+\beta} \right) A n^{-\beta} h^\beta \right] e^{\varphi(t-s)} ds.$$

We think of  $\varphi$  as a potential rate of return to education, since it updates the investment made in education, according to equation (8).

The number of non-educated people that will become human capital is obtained from equating equations (9) and (10).

$$(11) \quad \int_t^\infty \left( \frac{\beta}{1+\beta} \right) A n^{1-\beta} h^{\beta-1} e^{-r\delta(s-t)} ds = \int_0^t \left( \frac{1}{1+\beta} \right) A n^{-\beta} h^\beta e^{\varphi(t-s)} ds.$$

The solution for time will be the following:

$$(12) \quad t = \left( \frac{\log\left(\frac{n}{h}\right)}{\varphi - r\delta} \right) + C^*,$$

where  $C^*$  is the integral constant. As we may see, as educated labor increases proportionally to non-educated labor, the time is shortened. The same effect can be achieved with better institutions ( $0 < \delta < 1$ ) as well as a higher return to education rate ( $\varphi$ ).

The initial condition that sets up the early path for educated and non-educated labor is

$$(13) \quad h = \left( \frac{\varphi\beta}{r\delta} \right) n.$$

As we may see, good structural institutions may help the initial ratio of human capital ( $h(o)$ ) to common labor ( $n(o)$ ) at the beginning of the process to be higher. However, this is true for an economy where the human capital market is present ( $\varphi > 0$ ). Also, higher human capital participation in the economy (a higher  $\beta$ ) would increase the incentive for knowledge accumulation. On the other hand, bad structural institutions ( $\delta > 1$ ) may cause low initial human capital at the beginning of the process, which may last for a long time. Under this last case, exogenous institutional reform may help the human capital accumulation process and by extension economic productivity.

## 2.5 The Macroeconomics of Investing in Education: The Role of Policy Institution

At macro level, the amount set aside by the economy to be invested in human capital would be transformed into the next period's human capital increase. The amount of this increase is a function not only of the investment  $y(e)$ , but also of the economic policies, democratic and legal institutions, market rule, etc., which we named policy institution. This is equivalent to saying that

$$(14) \quad \dot{h} = f[y(e)].$$

Thus, policy institutions may cause the investment  $y(e)$  to enhance, be neutral or even reduce the effectiveness of human capital investment. The possible causes for the negative impact are corruption, egalitarian behavior, inaccessible legal system, bad economic policies, etc.

While the endogenous process gives an optimum amount to be invested in human capital, the exogenous interference in this process may be good or bad, depending upon the quality of policy institution. To make things easier, we assume that equation (9) at the macro level is a linear function of the policy institution or

$$(15) \quad \dot{h} = f[y(e)] = \frac{1}{\psi} \left( \left( \frac{\beta}{1+\beta} \right) A n^{1-\beta} h^\beta \right).$$

In this view,  $\psi$  stands for the quality of the policy institution in the economy. If  $\psi = 1$  institutions are neutral, for  $0 < \psi < 1$ , institutions have a positive influence on human capital accumulation at aggregate level; and for  $\psi > 1$ , institutions play a negative role. By solving equation (13) for  $n$  and substituting into the above equation, we obtain

$$(16) \quad \dot{h} = \frac{A}{\psi} \left( \frac{\beta}{1+\beta} \right) \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} h .$$

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). The human capital accumulation proposed by the author was  $\dot{h} = (1-u)\delta^*h$ , where  $u$  represents the effort devoted to human capital accumulation and  $\delta^*$  is the maximum rate. As we may see, the maximum rate in equation (16) is given by the ratio of the technology index over policy institution quality while the  $(1 - u)$  by the remaining variables.

It is also interesting to notice that bad geographical conditions, land quality, an unfavorable biotype and constrained religious behavior may affect the rate of human capital accumulation favorably. They might give a bad initial condition, but they also spur knowledge accumulation once it starts. What is our explanation for this behavior? Poor land quality, biotype and ethnic and religious diversity may be very bad at earlier stages since they generate a conflict of preferences and a struggle for leadership. However, they generate competition and diversity of abilities for survival. These are essential elements for the knowledge accumulation process as an objective. Thus, over the long run, the cost of diversity in preferences requires much more educated labor, hence helping the knowledge accumulation process.

## 2.6 The Dynamic Model

The overall production in the economy is equivalent to the sum of the production of equations (1) and (6). We solve equation (13) for  $n$  again and plug into this result.

$$(17) \quad y = Y/N = A \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} h$$

The output per worker in the economy was found by dividing (17) for  $N = h + n$ . Thus, the ratio  $h/N$  is simply the proportion of educated labor in the economy, which we represented by the non-italic  $h$ . Thus,  $h$  is the percentage of human capital in the overall workforce. According to equation (17), the average economy productivity is a linear function of educated labor.

The representative consumer/worker has the following welfare function

$$(18) \quad u(c) = \int_0^t \frac{c^{1-\sigma} - 1}{1-\sigma} e^{-\rho t} dt \text{ for } \sigma \neq 1.$$

The average human capital in the economy can be found by dividing  $h$  by  $N$ ; however, this is also the proportion of educated labor in the economy. As before, let us make  $h = h/N$ , then average knowledge accumulation or the knowledge accumulation by the representative consumer is equivalent to differentiating this ratio regarding time. Also in this model, the representative consumer is entitled to choose the distribution of innovation in the economy. More specifically, this consumer must find the optimum share of technology between the two sectors. Let us say that  $A$  is the overall index of technology. Let us also assume that this index is linearly related to the stock of per capita physical capital  $vk$ , with  $v \geq 1$ . Thus, if the goods sector index of technology is equivalent to  $(1 - z)vk$ , then  $zvk$  is in the human capital accumulation sector, with  $0 < z < 1$ . So, human capital accumulation of the representative consumer would be



$$(19) \quad \dot{h} = \frac{zvk}{\psi} \left( \frac{\beta}{1+\beta} \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} h - \eta h \right),$$

where  $\eta$  is the exogenous population growth rate. The technology accumulation process is very simple. The amount not consumed is invested in the technology-enhancing process through physical capital accumulation. To make it even simpler, we also assume the rate of technology depreciation to be null.

$$(20) \quad \dot{k} = (1-z)vk \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} h - \eta k - c.$$

The full model is comprised of equations (18)–(20). The Hamiltonian function for this problem is the following:

$$(21) \quad H = \frac{c^{1-\sigma} - 1}{1-\sigma} + \lambda_1 \left[ (1-z)vk \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} h - \eta k - c \right] + \lambda_2 \left[ \frac{zvk}{\psi} \left( \frac{\beta}{1+\beta} \right) \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} h - \eta h \right].$$

The solution to the above equation comprises the following set of equations:

$$(22) \quad \frac{\partial H}{\partial c} = 0$$

$$(23) \quad \frac{\partial H}{\partial z} = 0$$

$$(24) \quad \dot{\lambda}_1 - \rho\lambda_1 = \frac{-\partial H}{\partial k}$$

$$(25) \quad \dot{\lambda}_2 - \rho\lambda_2 = \frac{-\partial H}{\partial h}.$$

The transversality conditions are

$$(27) \quad \lim_{t \rightarrow \infty} \mathbf{k}(t) e^{-\rho t} = 0$$

$$(28) \quad \lim_{t \rightarrow \infty} \mathbf{h}(t) e^{-\rho t} = 0.$$

The solution to equation (23) is

$$(29) \quad \lambda_1 = \frac{\lambda_2}{\psi} \left( \frac{\beta}{1+\beta} \right) \text{ or } \lambda_2 = \frac{\lambda_1 \psi}{\beta} \left( \frac{1+\beta}{\beta} \right).$$

Solving equation (24) using equation (29), we obtain

$$(30) \quad \frac{\dot{\lambda}_1}{\lambda_1} = \rho + \eta - \left[ v \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} h \right].$$

Applying the same principle to equation (25), we obtain

$$(31) \quad \frac{\dot{\lambda}_2}{\lambda_2} = \rho + \eta - \left[ \left( \frac{v}{\psi} \right) \left( \frac{\beta}{1+\beta} \right) \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} k \right].$$

The transversality conditions give us the maximum attainable growth of inputs as being

$$(32) \quad \frac{\dot{k}}{k} = -\frac{\dot{\lambda}_1}{\lambda_1} + \rho$$

$$(33) \quad \frac{\dot{h}}{h} = -\frac{\dot{\lambda}_2}{\lambda_2} + \rho.$$

By substituting equations (30) and (31) into (32) and (33), we obtain

$$(34) \quad \frac{\dot{k}}{k} = \left[ v \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} h \right] - \eta$$

$$(35) \quad \frac{\dot{h}}{h} = \left[ \left( \frac{v}{\psi} \right) \left( \frac{\beta}{1+\beta} \right) \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} k \right] - \eta.$$

The growth rates of the factors depend upon each other in an inverse way. Physical capital depends upon human capital and vice versa. The productivity growth rate of the economy can easily be shown to be the sum of equations (34) and (35). This is achieved by taking the log of (17) and differentiating regards time.

$$(36) \quad g = \frac{\dot{y}}{y} = v \left( \frac{r\delta}{\phi\beta} \right)^{1-\beta} \left[ h + \frac{1}{\psi} \left( \frac{\beta}{1+\beta} \right) k \right] - 2\eta.$$

It is interesting to see that the inputs are important for productivity growth as well as the institutions ( $\delta, \psi$ ). The institutions do affect the coefficients of the inputs and not directly as in the reviewed institution literature. The policy institution ( $\psi$ ) only affects the physical capital coefficient on economic growth. As explained before, countries with bad structural institutions ( $\phi > 1$ ) tend to have higher economic growth compared with the ones with better institutions. For instance, countries with excellent natural resources may also have a lower historical economic growth rate. Another interesting aspect is that countries with a high rate of return to education ( $\phi$ ) also tend to have a lower impact on economic growth from their input accumulation.

This last result is observed in empirical estimates of Mincer's (1974) type. For instance, Psacaropoulos and Patrinos (2004) reports the rate of return to education for Jamaica as high as 28%, while the United States averages 9%. Another important aspect is that negative economic growth is possible under our framework as long as the input growth rates are less than twice the population growth rate. In other words, population growth control seems to be an important policy for helping long-run economic growth.

The way we see the historical development path is as follows: the structural institution helps the early step by setting up  $h(o)$  from  $n(o)$ , according to equation (13). This amount of initial human capital will start a slow process of fostering technology growth (equation (34)). Later on, according to equation (35), the technology process will help accelerate the human capital growth process in a feedback way. This generates a self-perpetuating accumulation mechanism.

This self-perpetuating mechanism can be enhanced by a good policy institution ( $\psi$ ). Over the historical development of countries, those that undertake institution reforms in the form of a better political system, more efficient economic policies and improved legal system should have seen a great effect of physical capital on human capital accumulation (equation (35)). This growth in knowledge accumulation should then also have led to more physical capital accumulation (equation (34)), therefore generating an improvement in the historical development growth path. We believe this is the symbiotic relationship that we see happening among the economies over the very long run.

Despite the importance of the policy institution in the theoretical model, input accumulation is the driving factor behind economic growth. Structural and policy institutions can make the effect of the input accumulation process on economic growth bigger or smaller, depending upon their quality. Therefore, the model predicts that countries that undergo policy institution reform should see growth improvement over the long run.

## *2.7 The Econometric Issues of the Model*

The econometric aspect of the proposed growth model is related to the causal relationship between institutions, input accumulation and economic growth. As we may see from our model, some of the definitions of institutions used can be well regarded as just an initial measure of human capital. Examples of those are the ones used by Acemoglu et al. (2001, 2002), according to Glaeser et al. (2004). However, we cannot disregard its effect, as was shown by Acemoglu et al. (2005).

Besides the causality issue, there is also the one made by Kenny and Williams (2001). The authors call our attention to the huge institutional difference among countries. Since this institutional difference affects the input coefficients in the econometric regression, according to our model, we must therefore find a way to deal with the heterogeneous problem.

The causality and heterogeneity can be best dealt with through a dynamic panel model where differences among countries are captured across and over time. Moreover, a dynamic panel model allows us to obtain the historical development path or long-run average growth rate as the model constant. The structural difference among countries will be captured through indicator variables. In other words, by segregating countries by region, we expect to capture conditions such as religious belief, biotype and geographical homogeneity. This might be claimed to be too simplifying but it is a very simple way of testing a structural institution as proposed by the model. Also, time indicator variables will be used to capture changes over time accruing from the policy institution. The initial or structural effect over the sample can be established by looking to the first- and second-order autoregressive process. In sum, we can learn a great deal from this econometric specification.

The exogeneity condition of the variables can easily be established, according to Woodridge (2002). The contemporaneous exogeneity condition proposed by the author runs as follows. Consider the dynamic specification of the model:

$$(37) \quad y_{it} = x_{it} \beta + y_{it-1} \alpha + \eta_i + u_{it},$$

where  $y_{it}$  is the dependent variable vector,  $x_{it}$  and  $\beta$  are the vectors of the independent variables and coefficients to be obtained in the estimates,  $\eta_i$  represents the fixed effects and  $u_{it}$  the component error vector. Under contemporaneous exogeneity, the errors should not be correlated with the explaining variables, the initial condition or the fixed effects,  $E(u_{it}|x_{it}, y_{it-1}, \dots, x_{i1}, y_{i0}, \eta_i) = 0$ . This is equivalent to performing two tests:

- i) First, the second-order regressive process on the panel residuals should not be present,  $E(u_{it}|u_{it-1}, \dots, u_{i1}) = 0$ ;
- ii) Second, the instrument variables must be exogenous,  $E(u_{it}|x_{it}, \dots, x_{i1}) = 0$ .

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

$$(38) \quad y_{it} - y_{it-1} = (x_{it} - x_{it-1})\beta + (y_{it-1} - y_{it-2})\alpha + (u_{it} - u_{it-1}).$$

By estimating equations (37) and (38) using as instruments for the first equation the variable in differences and for the second equation the variable in levels as proposed by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998), we should solve the problem of instrument quality.

The variables to be used in the equation system estimate are from two sources: Barro and Lee (1996) and the GDN – Growth Development Network (Easterly and Levine, 2001). This is balanced panel data for 95 countries for the years 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995 and 2000. The variables are as follows: 1) five-year average output per capita growth rate –  $gyl$ ; 2) five-year average human capital growth rate –  $ghk$ ; 3) five-year average growth rate of physical capital per worker –  $gk$ ; 4) level of human capital –  $hk$ ; 5) per capita level of physical capital –  $kl$ ; 6) the average ratio of physical capital per output in the economy; 7) the policy institution proxy – interaction between physical capital per capita and the ratio of physical capital output –  $kky$ ; 8) time indicator variables; and 9) regional indicator variables –  $eap$ ,  $lac$ ,  $mena$ ,  $sa$ ,  $ssa$  and  $te$  (East Asia pacific countries, Latin American countries, Middle East and North Africa, South Asian countries, Sub-Saharan countries, transitional economies; omitted was  $ac$  – advanced countries). The two variables that deserve explanation are human capital and the policy institution proxy. The human capital function follows Hall and Jones's (1999) piecewise function. We use the rate of returns for primary, secondary and tertiary education from Psacaropoulos (1994). The function is as follows:  $hk = e^{0.201*pyr25+0.139syr25+0.11hyr25}$ , where  $pyr25$ ,  $syr25$  and  $hyr25$  are countries' average years of schooling for primary, secondary and tertiary education from Barro and Lee (2000).

The policy institution proxy follows the reasoning of our theoretical model. According to that, the ratio of physical and capital output of a country ( $K/Y$ ) should represent most of the economic policy being practiced. Included in such policy are the levels of opening up, domestic technology investment, international investment, macroeconomics policies, etc. By multiplying the coefficient of ( $K/Y$ ) by ( $K/L$ ), physical capital per capita, we expect to correct the levels of  $K/L$  for such a policy institution in each country by year. For example, in some years, the ratio of  $K/Y$  can be low due to government expansionary fiscal or monetary policy. Therefore, such economic policies' effects would appear in the coefficient of physical capital output ratio in our view.

**Table 1 – The Summary of the Variables**

Variable	Overall Mean Sample	Standard Deviation	Number of Observations
gyl	0.0141	0.0304	N=760, n=95, T=8
gkl	0.0206	0.0420	N=760, n=95, T=8
ghk	0.0117	0.0141	N=760, n=95, T=8
yl	8,345.13	7,349.03	N=855, n=95, T=9
kl	15,816.37	19,966.26	N=855, n=95, T=9
hk	2.583	1.4125	N=855, n=95, T=9
kky	44,920.78	66,619.68	N=855, n=95, T=9

Source: Barro and Lee (2000)

According to the above table, the 5-year average growth rate of output per capita during the period 1960 through 2000 among the countries was 1.41%. The average 5-year growth rate of physical capital was 2.06%. The average 5-year human capital growth rate was 1.17%. The physical capital per capita was US\$ 15,816.37 and the human capital equivalent 2.58.

We start by running the specification tests proposed by Hausman (1978), comparing the fixed and random models. Although not shown, the results are that the fixed effect model was shown to be the most appropriate. The Breusch and Pagan (1980) and Baltagi and Li (1995) tests also corroborate the result that the fixed effect is the best specification. The groupwise heteroskedasticity proposed by Greene (2000) and the Wooldridge (2002) test for serial correlation were both shown to be significant. Thus, the most appropriate model is one that takes into consideration fixed effects, heteroskedasticity and autoregression. The dynamic version estimates do take all these into consideration and also allow us to verify the exogeneity conditions.

**Table 2 – Dynamic Models:  
Dependent – Long-Run Economic Growth (gyl)**

Variables	(1)	(2)	(3)	(4)
Constant	-0.011 (0.06)**	-0.020 (0.008)**	-0.280 (0.014)**	-0.202 (0.041)
L.gyl	0.003 (0.006)	-0.014 (0.073)	0.0131 (0.149)	-0.041 (0.074)
ghk	0.677 (0.219)*	0.736 (0.247)*	1.088 (0.337)*	0.688 (0.229)*
gkl	0.491 (0.162)*	0.531 (0.169)*	0.667 (0.164)*	0.507 (0.162)*
kky	-1.56e-07 (3.83e-08)*	-2.07e-07 (4.73e-08)*	-1.67e-07 (7.00e-08)**	-2.07e-07 (1.29e-07)
kl	3.71e-07 (1.39e-07)*	4.29e-07 (2.34e-07)***	4.27e-07 (3.05e-07)	4.54e-07 (1.63e-07)*
hk	0.0038 (0.0024)	0.0065 (0.0028)**	0.0060 (0.0035)***	0.0064 (0.0044)
Time indicators	yes	yes	yes	yes
Set of instruments				
1) Lags of kl and hk	three	four	four	four
2) Regional indicators	yes	yes	no	yes*
N=n*T	760	665	665	665
AR(1)	0.00	0.00	0.00	0.00
AR(2)	0.76	0.76	0.46	0.88
Hansen–Overid	0.61	0.61	0.73	0.57
Hansen–Exogeneity	0.64	0.66	0.93	0.99

The average five-year growth rates of physical and human capital account for most of the long-run growth rate of the economy. The policy institution proxy was shown to be significant in every estimate, except in column (4) of the above. This non-significance was due to the inclusion of regional dummies as independent variables. The colinearity between the policy institution proxy and regional indicators does attest to the quality of the policy institution variable. Therefore, the kky indeed captures the regional policy differences among the economies. While regional indicator variables capture the fixed effects, the kky has the advantage of also capturing the policies' changes overtime. As we can see, kky is shown to be negative in every specification. Therefore, on average, the policy institution has not benefited long-run economic growth. The constant represents the long-run growth rate of the economies in our sample. The negative sign might indicate that population growth has yet to be overcome by most of the economies, as predicted by our model. The instruments in all the regressions were just the level of physical and human capital. By lagging those three to four periods, we were able to capture the physical and human capital accumulation effects over the five-year growth average of the variables as posited by the theoretical model. Moreover, with regional indicators being used as an instrument, the empirical model captures the structural institution or their long-run omitted factors. These omitted factors include our structural institution definition. Hence, as predicted by the model, input accumulation and policy institution are important elements for long-run economic growth.

### ***3.0 Conclusion***

The economic growth model showed the importance of the interaction between human capital and the set of institutions present in the economy for explaining the development process. The structural institutions play a key role in setting up the initial ratio of educated to non-educated labor in the economy. However, the decision on human capital accumulation is the key to fostering technological advances, which leads to improvements in the rate of return to human capital accumulation, therefore forming a self-sustained mechanism of growth and economic development. The size of the growth of the economy and by extension the time length to becoming developed depends upon the quality of the policy institutions. These institutions are in charge of transmitting the self-sustained mechanism to the output growth. So, potential growth may differ among countries as a result of two things: the endogenous mechanism of human capital accumulation and the quality of the policy institutions. The main result is that the initial condition can only dictate the economic growth path if the human capital accumulation process is not present in the economy.

Our modest empirical tests corroborate the model results, especially showing that human capital growth constitutes more than 60% of the average long-run growth rate of the economy. Policy institutions in general are negative for growth by lowering the growth impact of physical capital to the long-run output growth. Hence, overall policy institutions need to improve their quality in order to become contributors to economic growth.

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