The role of human assets in economic growth: theory and empirics

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The Role of Human Assets in Economic Growth: Theory and Empirics

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Abstract

In this paper, we introduce a new variable called *Human Assets* and study its effects on economic growth both theoretically and empirically. The first part builds an endogenous growth model which demonstrates that Human Assets increase economic growth. The second part employs the new Dynamic Common Correlated Effects Estimator for heterogeneous cross-sectionally dependent dynamic panels to empirically study the impact of Human Assets on economic growth. The results corroborate the theoretical predictions that Human Assets act positively on economic growth. The positive impact of Human Assets on growth is maintained when we use small sample bias corrections and sensitivity to the choice of lag orders. The paper also illustrates, theoretically and empirically, that the magnitude of the effect of Human Assets on growth is huge compared to most other determinants of economic growth. Finally, we discover that human capital does not affect the growth rate once we control for Human Assets.

Keywords: Dynamic Common Correlated Effects Estimator; Heterogeneous Panels; Dynamic Optimization; Endogenous Growth Theory; Human Assets; Undernourishment; Under five mortality; Adult literacy; Secondary Enrolment

JEL Classification: C61, C63, I15, I25, O15, O41, O47, O50

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1 Introduction

The notion of Human Assets is a wide-ranging view that encompasses people's education, health and nutrition. The idea of Human Assets is thus broader than the concept of human capital as traditionally conceived in economic growth models. In many growth models human capital is only confined to education. The view point of Human Assets is that a well-nourished, healthy person can accumulate more and good human capital; or a well-educated individual can manage to become healthy and well-nourished; etc. In fact, it is any possible combination of these three elements that make a person an asset in the economy in which he evolve. This may not be transparent in developed countries where good health and good nutrition are already, in most cases, taken as granted. That is why many studies focus only on good education as a determinant of growth. But in developing countries, and particularly in Least Developed Countries (LDCs), where health and nutrition problems are palpable, we can observe, in many cases, that people cannot accumulate high quality education. Therefore, it is the marriage of the three elements that is powerful and make the individual who possesses them an asset and an indispensable actor in the development of his country. A well-nourished, healthy and well-educated person can contribute more in the growth of the economy than an individual who lacks one or more of these elements. Good nutrition, health and education increase people's creativity, productivity, capabilities, technological and scientific innovation skills, technological absorption, adaptation to changes in markets and economic conditions, openness, entrepreneurship, . . . , all of which positively and greatly influence the growth rate.

Lucas (1988) proposed the first endogenous growth model with human capital. In this model, all factors of production can be accumulated. Human capital is an input and can vary through investment. To obtain sustained growth, the willingness to spend in human capital must be non-decreasing in human capital. Meaning that the output of human capital has to be constant returns to scale in human capital. Barro and Sala-i Martin (2004) find that the average years of male higher and secondary school-completion variable significantly affects growth while male and female primary school-accomplishment variables, and the female school-achievement variable are not statistically correlated to growth. Mankiw, Romer and Weil (1992) demonstrates that an improved Solow model that incorporates accumulation of both physical and human capital gives an outstanding explanation of cross-country data.

Grossman (1972) article is one of the first models of health production. In this model a person is considered as equally a consumer and producer of health. Health is a capital stock that depreciates through the years when there is no investment in health. Health is an investment commodity that provides happiness to consumers indirectly through rarer sick days. It is also a consumption commodity that brings direct utility and happiness. Agents undergo a cost when they invest in health because they must bargain resources and time allocated to health against of other choices. The optimal amount of health that an agent will demand is characterized by these elements. The model gives prospects about the consequences of variations in prices of other commodities and healthcare, technological modifications, and labor markets results like salaries and employment. Bloom, Canning and Sevilla (2004) estimating a production function model, discover that health has a significant and positive impact on growth. Barro (2013) develops a series of models that prolong the neoclassical growth structure to introduce the notion of health capital. He demonstrates that improved health contributes to economic growth but also good economic conditions are favorable to more accumulation of health capital. The models show that health acts directly on productivity. They illustrate as well that health has an indirect impact on productivity because an augmentation in health increases the demand for human capital which additionally boosts productivity.

Arcand (2001) is one of the pioneering studies on the theoretical and empirical impacts of nutrition on economic growth. He finds that there is a huge and significant effect of nutrition on growth. This result is robust to the utilization of three dissimilar datasets and the use of many estimation techniques. The influence of nutrition on growth works directly over its action on labor productivity and indirectly over enhancements in life expectancy which subsequently generates quicker economic growth.

Similarly to the works cited above, this paper examines the connection between human capital, health, nutrition and economic growth. But instead of analyzing the individual effect of each of the previous elements on growth, it combines them into a single concept called *Human Assets*. It is the first study to merge all these three elements in a single notion and explore its impact on economic growth both theoretically and empirically. Specifically, it makes several contributions. On the theoretical side, this paper is the first to introduce a fully-micro-founded endogenous economic growth model that illustrates the explicit effect of Human Assets on long-run growth. On the empirical side, the paper has many innovations. First, we use the new database on Human Assets created by the United Nations Committee for Development Policy (UN-CDP) and extended by Closset, Feindouno and Goujon (2014a) to empirically capture the notion of *Human Assets*. Second, in the growth regressions, we employ the newly invented Dynamic Common Correlated Effects Estimator of Chudik and Pesaran (2015a)[1]. This theoretical model, this variable and estimation technique have not been used in previous studies. The theoretical endogenous growth model demonstrates that Human Assets and their components increase economic growth. The econometric results confirm the theoretical previsions that Human Assets affect growth positively. This result remains unchanged when we perform various robustness checks including: small sample bias corrections and sensitivity to the choice of lag orders. Our research also demonstrates that the size of the impact of Human Assets on growth is larger than most other determinants of economic growth. Lastly, we find out that human capital does not influence the growth rate after we control for Human Assets.

The remaining of the paper is organized in the following manner: the first section presents the theoretical model, the second section exposes the empirical investigations and the last part concludes.

[1]See also Ditzen (2016) for further details on the implementations.

2 Theoretical Model

In this section, we expose the theoretical model and illustrate how the main equations are obtained.

2.1 Model Specification

The agent picks out a consumption path that maximizes his global utility function subject to some dynamic and other constraints, and the initial values of capital stocks. His optimization program is given by:

$$Max_{\{C(t),IV_K(t),IV_H(t),IV_S(t)\}} U(0) = \int_0^{\infty} \frac{\left(C(t)^{1-\sigma} - 1\right) e^{-\rho t}}{1-\sigma} dt \tag{1}$$

Subject to:

$$HAI(t) = (1-m)^{\phi} H(t)^{\beta} S(t)^{\gamma} \tag{2}$$

$$Y(t) = A(1-m)^{\phi} K(t)^{\alpha} H(t)^{\beta} S(t)^{\gamma} \tag{3}$$

$$Y(t) = C(t) + IV_K(t) + IV_H(t) + IV_S(t) \tag{4}$$

$$\frac{d}{dt}K(t) = IV_K(t) - \delta K(t) \tag{5}$$

$$\frac{d}{dt}H(t) = IV_H(t) - \delta H(t) \tag{6}$$

$$\frac{d}{dt}S(t) = IV_S(t) - \delta S(t) \tag{7}$$

And

$$K(0), H(0) \text{ and } S(0) \text{ are given}$$

In equation (1), $C(t)$ is consumption, σ^{-1} measures the constant intertemporal elasticity of substitution in consumption, ρ represents the subjective rate of time preference. We have $\rho > 0$ and $\sigma > 0$. Equality (2) gives the Human Assets Index (HAI) as a geometric mean of the complement of undernourishment $(1-m)$, human capital $H(t)$ and health capital $S(t)$[2]. The parameters ϕ, β and γ represent, in this case, the weights in the

[2] In the theoretical model, the Human Assets Index (HAI) is modeled as geometric mean for convenience. But in the empirical section, it is computed as an arithmetic mean. We can go from the geometric specification to the arithmetic implementation by taking the natural logarithm of the former.

geometric mean. We set $\phi + \beta + \gamma = 1$. Equation (3) defines output $Y(t)$ as a Cobb-Douglas production function where A is total factor productivity; undernourishment m is a parameter that negatively affects compound total factor productivity; α, β and γ constitute the shares of physical capital $K(t)$, human capital $H(t)$ and health capital $S(t)$ in the production respectively. The production function exhibits Constant Returns to Scale to physical, human and health capitals together. Thus we have: $0 < \alpha < 1$; $0 < \beta < 1$; $\gamma = 1 - \alpha - \beta$. The last expression can be equivalently written as $\alpha + \beta + \gamma = 1$. We also impose $0 < \phi < 1$ and $0 < m < 1$. The resource constraint of the economy is represented by equivalence (4). It says that income $Y(t)$ is equal to consumption $C(t)$ plus investments in physical $IV_K(t)$, human $IV_H(t)$ and health $IV_S(t)$ capitals respectively. Equalities (5) to (7) give the laws of motions of physical, human and health capital stocks respectively. In these equations, $\delta \in (0, 1)$ is the depreciation rate for all types of capitals. The last three expressions tell us that the initial capital stocks, $K(0)$, $H(0)$ and $S(0)$ are given.

2.2 Economic Equilibrium

The present value Hamiltonian, $H(\cdot)$, of the agent is:

$$\begin{aligned} H(\cdot) = & \frac{\left(C(t)^{1-\sigma} - 1\right) e^{-\rho t}}{1-\sigma} \\ & + \lambda(t)\left(A(1-m)^{\phi} K(t)^{\alpha} H(t)^{\beta} S(t)^{\gamma} - C(t) - \delta K(t) - IV_H(t) - IV_S(t)\right) \\ & + \mu(t)\left(IV_H(t) - \delta H(t)\right) + \xi(t)\left(IV_S(t) - \delta S(t)\right) \end{aligned} \tag{8}$$

The variables $\lambda(t)$, $\mu(t)$ and $\xi(t)$ are the costate variables. The first order conditions for this problem are:

The derivative of the Hamiltonian with respect to consumption.

$$C(t)^{-\sigma} e^{-\rho t} - \lambda(t) = 0 \tag{9}$$

The derivatives of the Hamiltonian with respect to investments in human and health capitals respectively.

$$-\lambda(t) + \mu(t) = 0 \tag{10}$$

$$-\lambda(t)+\xi(t)=0 \tag{11}$$

We take the derivative of the Hamiltonian with regard to the three state variables, set the results equal to the negative of the derivative of the costate variables for each capital relative to time and rearrange the equations to get.

$$\lambda(t)\left(A(1-m)^{\phi}K(t)^{\alpha-1}\alpha H(t)^{\beta}S(t)^{\gamma}-\delta\right)=-\frac{d}{dt}\lambda(t) \tag{12}$$

$$\lambda(t)A(1-m)^{\phi}K(t)^{\alpha}H(t)^{\beta-1}\beta S(t)^{\gamma}-\mu(t)\delta=-\frac{d}{dt}\mu(t) \tag{13}$$

$$\lambda(t)A(1-m)^{\phi}K(t)^{\alpha}H(t)^{\beta}S(t)^{\gamma-1}\gamma-\xi(t)\delta=-\frac{d}{dt}\xi(t) \tag{14}$$

Combining equations (9) and (12), doing lots of algebra and oversimplifications, we get:

$$\frac{\frac{d}{dt}C(t)}{C(t)}=\frac{A(1-m)^{\phi}K(t)^{\alpha-1}\alpha H(t)^{\beta}S(t)^{\gamma}-\delta-\rho}{\sigma} \tag{15}$$

Similarly joining equalities (10), (11), (12), (13) and (14) performing more long tedious algebra and simplifications, we obtain:

$$H(t)=\frac{K(t)\beta}{\alpha} \tag{16}$$

$$S(t)=\frac{K(t)\gamma}{\alpha} \tag{17}$$

Substituting equation (16) and (17) in (15) and simplifying, we have:

$$\frac{\frac{d}{dt}C(t)}{C(t)}=\frac{A(1-m)^{\phi}\alpha^{-\beta+1-\gamma}\beta^{\beta}\gamma^{\gamma}-\delta-\rho}{\sigma} \tag{18}$$

This equation shows that the growth rate $\frac{\frac{d}{dt}C(t)}{C(t)}$ is function of only the parameters of the model. Hence the growth rate is endogenous in the sense that it is engendered from inside the system as a direct outcome of internal mechanisms.

2.3 Transversality and Growth Conditions

In order to have positive endogenous consumption growth, we need:

$$\delta + \rho < A\,(1-m)^{\phi}\,\alpha^{-\beta+1-\gamma}\beta^{\beta}\gamma^{\gamma} \tag{19}$$

Therefore, provided that this assumption is satisfied, we will experience continuous growth in $C\,(t)$. Solving the differential equation in (18) with respect to $C\,(t)$ yields:

$$C\,(t) = C\,(0)\,\mathrm{e}^{\frac{\left(A(1-m)^{\phi}\alpha^{-\beta+1-\gamma}\beta^{\beta}\gamma^{\gamma}-\delta-\rho\right)t}{\sigma}} \tag{20}$$

The transversality condition with respect to physical capital stock is provided by the following expression:

$$\lim_{t\to\infty} \lambda\,(t)\,K\,(t) = 0 \tag{21}$$

Replacing the costate variable and consumption by their respective values in the previous equality and rearranging yields:

$$\lim_{t\to\infty} \left(C\,(0)\,\mathrm{e}^{\frac{\left(A(1-m)^{\phi}\alpha^{-\beta+1-\gamma}\beta^{\beta}\gamma^{\gamma}-\delta-\rho\right)t}{\sigma}}\right)^{-\sigma} \mathrm{e}^{-\rho\,t}K\,(t) = 0 \tag{22}$$

Simplifying further, we get:

$$\lim_{t\to\infty} C\,(0)^{-\sigma}\,\mathrm{e}^{-t\left(A(1-m)^{\phi}\alpha^{-\beta+1-\gamma}\beta^{\beta}\gamma^{\gamma}-\delta\right)}K\,(t) = 0 \tag{23}$$

We see that for the transversality condition to hold, we need:

$$\delta < A\,(1-m)^{\phi}\,\alpha^{-\beta+1-\gamma}\beta^{\beta}\gamma^{\gamma} \tag{24}$$

2.4 Effect of the Human Assets Index on the Growth Rate

We can show that at the steady-state all variables grow at the same rate[3]:

$$\frac{\frac{\mathrm{d}}{\mathrm{d}t}C\,(t)}{C\,(t)} = \frac{\frac{\mathrm{d}}{\mathrm{d}t}K\,(t)}{K\,(t)} = \frac{\frac{\mathrm{d}}{\mathrm{d}t}H\,(t)}{H\,(t)} = \frac{\frac{\mathrm{d}}{\mathrm{d}t}S\,(t)}{S\,(t)} = \frac{\frac{\mathrm{d}}{\mathrm{d}t}Y\,(t)}{Y\,(t)} = \psi \tag{25}$$

Taking the natural logarithm and derivative with respect to time of equation (3), we find:

[3]Proof available upon request.

$$\frac{\frac{\mathrm{d}}{\mathrm{d}t}Y(t)}{Y(t)} = \frac{\alpha \frac{\mathrm{d}}{\mathrm{d}t}K(t)}{K(t)} + \frac{\beta \frac{\mathrm{d}}{\mathrm{d}t}H(t)}{H(t)} + \frac{\gamma \frac{\mathrm{d}}{\mathrm{d}t}S(t)}{S(t)} \tag{26}$$

Doing the same thing for equation (2), we get:

$$\frac{\frac{\mathrm{d}}{\mathrm{d}t}HAI(t)}{HAI(t)} = \frac{\beta \frac{\mathrm{d}}{\mathrm{d}t}H(t)}{H(t)} + \frac{\gamma \frac{\mathrm{d}}{\mathrm{d}t}S(t)}{S(t)} \tag{27}$$

Combining equations (26) and (27), we have:

$$\frac{\frac{\mathrm{d}}{\mathrm{d}t}Y(t)}{Y(t)} = \frac{\alpha \frac{\mathrm{d}}{\mathrm{d}t}K(t)}{K(t)} + \frac{\frac{\mathrm{d}}{\mathrm{d}t}HAI(t)}{HAI(t)} \tag{28}$$

The growth rate of the Human Assets Index (HAI) positively affects the growth rate of output and its contribution is larger than that of the physical capital stock. This is one of the predictions of the theoretical model. Hence, in the empirical part, we expect a positive sign for the Human Assets Index (HAI). We also anticipate the magnitude of its coefficient to be large.

2.5 Numerical Simulations

In order to perform the numerical experiments, we first calibrate the parameters. We take these parameters mostly from the literature. $\delta = 0.05$, $\rho = 0.02$, $\sigma = 3$ and $\alpha = 0.3$ are from Barro and Sala-i Martin (2004). $A = 3$ is a normalization. $\beta = 0.35$ is from Brunner and Strulik (2002) and $\gamma = 0.35$ is set such that the Constant Returns to Scale property is respected. $m = 0.108$ is the world average value of the prevalence of undernourishment in percentage of the population from the World Development Indicators (April 2017). $\phi = 0.30$ is chosen such that the sum of the exponents of the Human Assets Index (HAI) is equal to 1. Moreover, these parameter values satisfy the Transversality and Growth Conditions discussed above.

Table 1 provides the sign of the numerical derivative of the growth rate with respect to the parameters. A rise in the parameters $(1-m)$, β and γ increases the real interest rate. This pushes the agent to augment future consumption compared to present consumption. This last action generates high investment and hence causes an increase in the growth rate. Since each individual component of the Human Assets Index act positively on growth, we expect this variable to also have a positive effect on growth. Thus the numerical simulations confirm our analytical derivation for the general index in subsection 2.4. The parameters A and α act similarly to growth as the previous ones. If σ is big, the agent prefers to smooth consumption by moving assets to today. This creates low growth because it engenders small rates of investment. The other remaining parameters also have a negative impact on growth.

Table 1: Sign of the Numerical Derivative of the Growth Rate with Respect to the Parameters

Parameter	A	m	ϕ	α	β	γ	δ	ρ	σ	$1-m$
Sign	+	−	−	+	+	+	−	−	−	+

3 Empirical Investigations

This section presents the estimation methods, the data and variables, and the econometric results.

3.1 Estimation Methods

To empirically analyze the effect of the Human Assets Index (HAI) on growth, we estimate the following econometric model:

$$\ln\left(gdpcap_{i,t}\right) - \ln\left(gdpcap_{i,t-1}\right) = c_i + \phi_i \ln\left(gdpcap_{i,t-1}\right) + \alpha_i HAI_{i,t} + \boldsymbol{\beta}_i' \boldsymbol{x}_{i,t} + \sum_{l=0}^{p_T} \boldsymbol{\delta}_{i,l}' \bar{\boldsymbol{z}}_{t-l} + e_{i,t} \quad (29)$$

Where $\ln\left(gdpcap_{i,t}\right)$ is the logarithm of real GDP per capita; $\ln\left(gdpcap_{i,t-1}\right)$ pinpoints the lagged value of the logarithm of real GDP per capita; $\ln\left(gdpcap_{i,t}\right) - \ln\left(gdpcap_{i,t-1}\right)$ expresses the growth rate of real GDP per capita; $HAI_{i,t}$ is the Human Assets Index (HAI); $\boldsymbol{x}_{i,t}$ illustrates a vector of control variables: logarithm of general government final consumption expenditures over GDP, logarithm of openness (exports + imports over GDP), logarithm of terms of trade (exports prices over imports prices), logarithm of investment over GDP, logarithm of 1 + the inflation rate, logarithm of domestic credit to private sector over GDP (financial development), logarithm of the human capital index; $\overline{\mathbf{z}}_{t-l}$ indicates the cross-sectional (CS) averages of the dependent and all the independent variables; p_T designates the number of lags of the cross sectional averages; $e_{i,t}$ is the error term; i specifies the countries and t the time; all parameters are heterogeneous and the coefficients of interest are ϕ_i, α_i and $\boldsymbol{\beta}_i'$.

To estimate equation (29) we employ the Dynamic Common Correlated Effects Estimator developed by Chudik and Pesaran (2015a). They demonstrates that the model is consistently estimated if $\sqrt[3]{T}$ lags of the cross section averages are augmented. Following Chudik and Pesaran (2015a), Ditzen (2016), and setting $\boldsymbol{\pi_i} = (\phi_i, \alpha_i, \boldsymbol{\beta}_i')'$, the mean group coefficients are obtained according to the following formula:

$$\hat{\boldsymbol{\pi}}_{\mathrm{MG}} = \frac{\sum_{i=1}^{\mathrm{N}} \hat{\boldsymbol{\pi}}_{\boldsymbol{i}}}{\mathrm{N}} \tag{30}$$

When N, T and p_T tend towards infinity and under full rank of the factor loadings, all the two sets of parameters in (30) are reliably computed with a rate of convergence of $\sqrt{\mathrm{N}}$. The asymptotic distribution of the mean group coefficients and the nonparametric consistent asymptotic variance-covariance matrix are calculated according to:

$$\sqrt{\mathrm{N}}\left(\hat{\boldsymbol{\pi}}_{\mathrm{MG}} - \boldsymbol{\pi}\right) \xrightarrow{d} \mathrm{N}\left(\mathbf{0}, \boldsymbol{\Sigma}_{\mathrm{MG}}\right) \tag{31}$$

$$\hat{\boldsymbol{\Sigma}}_{\mathrm{MG}} = \frac{\sum_{i=1}^{\mathrm{N}} \left(\hat{\boldsymbol{\pi}}_{\boldsymbol{i}} - \hat{\boldsymbol{\pi}}_{\mathrm{MG}}\right)\left(\hat{\boldsymbol{\pi}}_{\boldsymbol{i}} - \hat{\boldsymbol{\pi}}_{\mathrm{MG}}\right)'}{\mathrm{N}-1} \tag{32}$$

To correct for small sample time series biases, Chudik and Pesaran (2015a) employ the Jackknife Bias Correction and the Recursive Mean Adjustment methods. The formula for the Jackknife Bias Correction method is given by:

$$\tilde{\boldsymbol{\pi}}_{\mathrm{MG}} = 2\hat{\boldsymbol{\pi}}_{\mathrm{MG}} - \frac{1}{2}\left(\hat{\boldsymbol{\pi}}^{\boldsymbol{a}}_{\mathrm{MG}} + \hat{\boldsymbol{\pi}}^{\boldsymbol{b}}_{\mathrm{MG}}\right) \tag{33}$$

In this equation, $\hat{\boldsymbol{\pi}}^{\boldsymbol{a}}_{\mathrm{MG}}$ represents the Mean Group Dynamic Common Correlated Effects estimation for the first half of the existing time period and $\hat{\boldsymbol{\pi}}^{\boldsymbol{b}}_{\mathrm{MG}}$ denotes the same technique applied to the second half. The Recursive Mean Adjustment procedure is provided by:

$$\tilde{\omega}_{\text{it}} = \omega_{\text{it}} - \frac{\sum_{s=1}^{t-1} \omega_{\text{is}}}{t-1} \tag{34}$$

In this equality $\omega_{\text{it}} = \left(\ln\left(gdpcap_{i,t}\right) - \ln\left(gdpcap_{i,t-1}\right), \ln\left(gdpcap_{i,t-1}\right), HAI_{i,t}, \boldsymbol{x}'_{i,t}\right)'$. In our regression tables we also include the test for cross sectional dependence devised by Chudik and Pesaran (2015b) and Pesaran (2015). The decision of the test is that the error terms are weakly cross sectional dependent in the null hypothesis.

The Dynamic Common Correlated Effects Estimator developed by Chudik and Pesaran (2015a) takes into account the panel time series nature of the data, parameter heterogeneity, cross-section dependence and dynamics. Since our data are annual data from 1980 to 2011, we are dealing with panel time series (large N, large T). Micro-panel techniques such as fixed effects and panel data GMM designed for large N and small T are inappropriate for our current study. The impact of the Human Assets Index (HAI) on growth might be different across countries according to their institutions and particularities. This, because countries might not have the same distribution of the components of the Human Assets Index (HAI). For instance, in some economies, undernourishment could not be a major problem but health might represent an issue, and, in some other countries, education could be a problem but not health, etc. It is thus crucial to consider heterogeneities in countries. As pointed out by Chudik, Mohaddes, Pesaran and Raissi (2013), conditioning only on country-specific-variables does not guaranty cross-sectional error independence because there could be omitted common factors, probably associated with the independent variables, which affect these countries. Not considering these linkages could result to biased estimated coefficients. In equation (29), we have the lagged value of the logarithm of real GDP per capita on the right-hand side. This makes of our equation dynamic. Hence, we must think about the dynamics of the regressed equations. The Dynamic Common Correlated Effects Estimator addresses all the issues raised previously and allows us to consistently estimate the effect of the Human Assets Index on economic growth. These are the reasons why we use this estimator in this paper.

3.2 Data and Variables

The Human Assets Index (HAI) data were first created by the United Nations Committee for Development Policy (UN-CDP). The retrospective series of the Human Assets Index (HAI) are developed by the FERDI (Fondation pour les Études et Recherches sur le Développement International) under the works of Closset et al. (2014a) and Closset, Feindouno and Goujon (2014b). It is a blended quantity including two measurements of education (Gross secondary school enrolment ratio, Adult literacy rate) and two measurements of health (Percentage of the population undernourished, Mortality rate for children aged five years or under). Thus, this dataset capture the notion of Human Assets we theorized earlier because it encompasses people's education, health and nutrition. All the four elementary components are regularized according to a min-max technique to obtain four measures that vary between 0 and 100. This implies that the composite Human Assets Index (HAI) also varies between 0 and 100 and is calculated as the straightforward arithmetic mean of the four measurements according to the following formula:

$$HAI = \frac{U + U5M + LR + SE}{4} \tag{35}$$

Where U is the Undernourishment index; $U5M$ represents the Under-five mortality index; LR indicates the Adult literacy index and SE designates the Secondary Enrolment index. Due to historical data accessibility problems for various developing countries, the building of retrospective Human Assets Index (HAI) data poses numerous difficulties. This is why Closset et al. (2014a) employ approximation methods and econometric techniques to reliably impute the missing data. They calculate two measurements of the Human Assets Index (HAI): the first one named Human Assets Index From Official Sources (HAI FOS) employs incomplete official data. This variable is in certain occasions filled with simple interpolations. The second one named Human Assets Index With Filled Gaps (HAI WFG) broaden the country-year coverage by means of econometric methods to impute the missing observations. In this paper, we employ the variable Human Assets Index With Filled Gaps (HAI WFG) in our estimations because it contains more available data points[4]. In the estimation tables, the variable Human Assets Index With Filled Gaps

[4] Regressions based on the Human Assets Index From Official Sources (HAI FOS) are available upon request.

(HAI WFG) is simply named *Human Assets Index*.

The sample of study contains 19 developing countries with annual data from 1980 to 2011. The choice of the sample is based on the availability of data, the choice of the variables of the study and because the Human Assets Indices are available only for developing countries. The data essentially come from the World Bank (World Development Indicators, 2014), the Fondation pour les Études et Recherches sur le Développement International (FERDI, 2014)[5] and the Penn World Tables 8.0. An increase of the Human Assets Index indicates an improvement. This way of formulating the Human Assets Index allows us to be consistent through both of our theoretical and empirical models.

3.3 Econometric Results

In this part, we will present the main estimation results and the robustness analysis.

3.3.1 Main Estimation Results

Table 2 gives the estimation results of the relationship between the Human Assets Index and growth using the Dynamic Common Correlated Effects (CCE) Estimator for all Countries. In this table, the coefficient of the lagged real GDP per capita is significant and negative in all regressions. The negative coefficient indicates conditional convergence with respect to real GDP per capita. This convergence is conditional in that it concludes that the growth rate of real GDP per capita is bigger the lagged real GDP per capita is small, only if the other regressors are kept constant. The coefficient indicates that conditional convergence is very high because it is carried out at a rate of 67.73% per year[6]. All five equations show that the Human Assets Index is statistically significant at all conventional levels and have the expected sign. This implies that an augmentation of the Human Assets Index raises the growth rate. The above-mentioned results, empirically corroborate what we have found in the theoretical part. Specifically, this means that a rise in the Human Assets Index increases the real interest rate. This pushes the agent to augment future consumption compared to present consumption. This last action generates high investment and hence causes an increase in the growth rate. Our findings

[5] Closset et al. (2014a) and Closset et al. (2014b).
[6] From equation (4).

illustrate that, the positive effect of the Human Assets Index on growth is robust to the introduction of different control variables. In fact, through the five equations we have varied the introduction of the control variables but the coefficient of the Human Assets Index retains its expected sign and is always statistically significant. The magnitude of the effect of the Human Assets Index on growth is very high. Referring to regression (5), a rise in the Human Assets Index by 1 percentage point increases the growth rate by 0.796 percentage points. This is a very high value, suggesting that the Human Assets Index has a huge augmenting impact on growth. Staying on the same equation, we see that, a raise in investment over GDP by 1% increases growth by only 0.115 percentage points. Hence the Human Assets Index augments growth more than investment. This result validates what we found in the theoretical portion in subsection 2.4. This outcome suggests that investing in Human Assets stimulates growth more than investing in physical capital. Something that is neglected in most developing countries. We observe that the standard errors of the coefficients of the Human Assets Index are relatively small. This implies that the corresponding confidence intervals, though not reported, are tinier meaning that the coefficients of the Human Assets Index are estimated with great precision. The number of observations are stable in all nine equations, hence the phenomenon we are studying covers most of our sample. Although we do not report the number of countries, it is always 19 in all the equations. The CD Statistic and its p-value that test for cross sectional dependence, show that we do not reject the null hypothesis which states that the error terms are weakly cross sectional dependent in all estimations. Investment acts positively on growth. This outcome was found by many empirical growth studies.

3.3.2 Robustness Analysis

Table 3 presents the results of the estimations using the Jackknife bias correction technique. This procedure allows for small sample time series bias corrections. It employs the formula exhibited in equation (33). Similarly, to the main regressions, the Human Assets Index influences positively economic growth. As in the main estimations, the effect of the Human Assets Index is very high in all five equations. Consequently, the Human Assets Index is very beneficial to growth even after correcting for small sample time series biases. As for the main regressions, the number of observations and the number of countries are very stable. The CD Statistic establishes that we do not reject the null hypothesis which states that the error terms are weakly cross sectional dependent in all equations. The results for the Jackknife bias correction technique corroborate those found in our main regressions. There is conditional convergence with respect to real GDP per capita in all estimations. Investment continue to have a positive impact on growth.

In Table 4 we take into account the Recursive mean adjustment method. Like the Jackknife bias correction, this procedure allows for small sample time series bias corrections. It utilizes the formula displayed in equality (34). As in the main regressions, there is conditional convergence in all estimations. All five equations show that the coefficients of the Human Assets Index variable are positive and statistically significant. Here also, our variable of interest is robust to the introduction of control variables because we have mixed the introduction of control variables but the coefficients of the Human Assets Index variable keep their sign and continue to be significant in all equations. Similarly, the absolute value of the impact of the Human Assets Index on growth is very large. In all regressions, the CD Statistic demonstrates that we do not reject the null hypothesis which claims that the error terms are weakly cross sectional dependent. Contrarily to the main estimations, most control variables are statistically significant. Investment and terms of trade have a positive impact on growth while inflation and government consumption act negatively on economic growth. These results using the Recursive mean adjustment method support those found in our main estimations.

Chudik and Pesaran (2015a) underline that it is hard to identify in practice the finest lag order since this is function of several unidentified characteristics of the true data generating process including the sample size. They highlight the necessity to explore the reactiveness of the outcomes to the choice of the lag order when the data generating process is unrevealed. Hence, table 5 gives the regressions using the dynamic CCE estimator with sensitivity to the choice of lag orders. Until now, we have been using a lag order of 1. The first three equations in table 5 employ a lag order of 2 and the remaining equations utilize a log order of 3. All coefficients that are statistically significant in this table have the correct expected signs. We observe that there is conditional convergence in all equations. The magnitude of the impact of the Human Assets Index is also very large. The number of observations are fairly reasonable. In all equations, the CD Statistic reveals that we do not reject the null hypothesis which asserts that the error terms are weakly cross sectional dependent. The results found in this table demonstrate that the general conclusions we found in our main regressions, do not drastically change even if we take into account more lags of the cross sectional averages.

In table 6, we include the Human Capital Index in our regressions. We observe that the Human Capital Index is not statistically significant in all of our estimations. Contrarily, the Human Assets Index is significant in all equations. These results illustrate that human capital does not affect growth once we control for Human Assets. Hence these outcomes demonstrate that it is the Human Assets, which encompass human capital, health and nutrition, that matter for growth not a partial measurement like human capital.

4 Conclusion

This paper investigates the relationship between Human Assets and economic growth both theoretically and empirically. The theoretical part shows that Human Assets and their components augment economic growth. Using novel advances on panel time series heterogeneous dynamic cross-section dependent panel data methods, we find that Human Assets have a strong positive impact on growth. A rise in the Human Assets Index by 1 percentage point increases the growth rate by 0.796 percentage points. These results remain unchanged when we perform various robustness checks. Our research also reveals that the size of the impact of Human Assets on growth is larger than most other determinants of economic growth. To finish, our results demonstrate that human capital does not influence the growth rate after we control for Human Assets.

Though the results found were informative, some extensions could be made. We could extend the theoretical model to a three sectors growth model. This would allow us to study transitional dynamics in more details. We did not empirically isolate the channels through which the Human Assets Index act on growth, though we did this theoretically. We did not employ instrumental variables regressions in the empirical part because it is difficult to find instruments for the Human Assets Index variable. For improving the measurement and the computation of the Human Assets Index we could employ: panel data co-integration, time series GMM and piecewise interpolation. These avenues of research are left for our future studies.

From economic policy perspectives, the results illustrate that Human Assets could have a positive and sizable impact on growth and that efforts made to augment Human Assets might increase investment, productivity and growth.

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Table 2: Regressions using the Dynamic CCE Estimator for all Countries

Dependent Variable: Growth Rate of Real GDP per Capita					
Regressors	(1)	(2)	(3)	(4)	(5)
Lagged Real GDP per Capita	-0.432***	-0.452***	-0.490***	-0.492***	-0.451***
	(0.0710)	(0.0721)	(0.0814)	(0.0643)	(0.0756)
Human Assets Index	0.577*	0.626***	0.581**	0.686***	0.796**
	(0.345)	(0.236)	(0.253)	(0.234)	(0.353)
Terms of Trade			0.0374		0.0312
			(0.0400)		(0.0661)
Investment	0.131***	0.118***	0.113***	0.105***	0.115***
	(0.0195)	(0.0216)	(0.0278)	(0.0173)	(0.0237)
Inflation		-0.0737	-0.132	-0.100	-0.103
		(0.0746)	(0.0849)	(0.0753)	(0.112)
Government Consumption				-0.0455	-0.0670
				(0.0379)	(0.0434)
Constant	0.466	1.409	1.418	0.337	0.236
	(0.805)	(0.859)	(1.207)	(0.996)	(1.225)
Observations	568	568	568	568	568
CD Statistic	-1.246	-0.789	0.0217	-1.641	0.476
P-value CD Statistic	0.213	0.430	0.983	0.101	0.634

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3: Regressions using the Dynamic CCE Estimator with the Jackknife Bias Correction Technique

Dependent Variable: Growth Rate of Real GDP per Capita					
Regressors	(1)	(2)	(3)	(4)	(5)
Lagged Real GDP per Capita	-0.385***	-0.396***	-0.441***	-0.485***	-0.410***
	(0.0856)	(0.0856)	(0.105)	(0.0645)	(0.105)
Human Assets Index	0.661*	0.698**	0.834**	0.668**	0.862**
	(0.399)	(0.279)	(0.336)	(0.261)	(0.432)
Terms of Trade			0.0327		0.0330
			(0.0352)		(0.0705)
Investment	0.138***	0.115***	0.111***	0.0889***	0.0769**
	(0.0236)	(0.0263)	(0.0283)	(0.0161)	(0.0385)
Inflation		-0.113	-0.148	-0.0823	-0.0398
		(0.0834)	(0.0922)	(0.0854)	(0.134)
Government Consumption				-0.0442	-0.0636
				(0.0378)	(0.0549)
Constant	1.283	2.173**	1.724	0.284	-0.747
	(0.816)	(1.022)	(1.161)	(1.161)	(1.341)
Observations	568	568	568	568	568
CD Statistic	-0.837	-0.211	0.0196	-0.735	0.651
P-value CD Statistic	0.403	0.833	0.984	0.462	0.515

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: Regressions using the Dynamic CCE Estimator with the Recursive Mean Adjustment Method

Dependent Variable: Growth Rate of Real GDP per Capita					
Regressors	(1)	(2)	(3)	(4)	(5)
Lagged Real GDP per Capita	-0.462***	-0.478***	-0.271***	-0.346***	-0.705***
	(0.0610)	(0.0797)	(0.0599)	(0.0708)	(0.0669)
Human Assets Index	0.561*	0.487*	0.798*	0.948*	0.827*
	(0.297)	(0.288)	(0.420)	(0.486)	(0.491)
Terms of Trade		0.0921**		0.0268	0.0569
		(0.0467)		(0.0647)	(0.0491)
Investment	0.112***	0.115***			0.0927***
	(0.0188)	(0.0197)			(0.0182)
Inflation	-0.0843*	-0.0936	-0.134*	-0.167	
	(0.0483)	(0.0719)	(0.0723)	(0.104)	
Government Consumption			-0.106*	-0.123*	-0.0447
			(0.0581)	(0.0723)	(0.0735)
Financial Development			-0.00163	0.0106	
			(0.0310)	(0.0362)	
Openness					-0.0246
					(0.0297)
Constant	0.0216	0.0539	0.0304	0.0351	0.0235
	(0.0528)	(0.0550)	(0.0386)	(0.0681)	(0.0871)
Observations	549	549	539	539	549
CD Statistic	-1.170	-0.899	0.0786	-0.572	0.0605
P-value CD Statistic	0.242	0.369	0.937	0.567	0.952

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5: Regressions using the Dynamic CCE Estimator with Sensitivity to the Choice of Lag Orders

Dependent Variable: Growth Rate of Real GDP per Capita					
Regressors	(1)	(2)	(3)	(4)	(5)
Lagged Real GDP per Capita	-0.405***	-0.455***	-0.378***	-0.541***	-0.490***
	(0.0903)	(0.0887)	(0.0872)	(0.0849)	(0.118)
Human Assets Index	0.724*	0.710*	0.519*	0.815**	0.864*
	(0.436)	(0.390)	(0.304)	(0.355)	(0.501)
Government Consumption			-0.0465		-0.0619
			(0.0688)		(0.0563)
Terms of Trade		0.0654*	0.00794	0.0781	
		(0.0374)	(0.0605)	(0.0552)	
Inflation			-0.180*		
			(0.105)		
Investment	0.145***	0.129***		0.130***	0.124***
	(0.0264)	(0.0215)		(0.0267)	(0.0295)
Constant	0.929	1.508	-1.263	1.332	0.786
	(0.956)	(1.123)	(0.945)	(1.720)	(1.496)
Observations	549	549	549	530	530
CD Statistic	-1.276	-1.301	0.215	-0.997	-0.827
P-value CD Statistic	0.202	0.193	0.830	0.319	0.408
Number of lags of CS Averages	2	2	2	3	3

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
CS means Cross Sectional

Table 6: Regressions using the Dynamic CCE Estimator: Controlling for Human Capital

Dependent Variable: Growth Rate of Real GDP per Capita			
Regressors	(1)	(2)	(3)
Lagged Real GDP per Capita	-0.441***	-0.609***	-0.411***
	(0.0785)	(0.0773)	(0.151)
Human Assets Index	0.649**	0.562*	1.078***
	(0.307)	(0.298)	(0.387)
Human Capital Index	-0.733	0.125	-0.202
	(0.593)	(0.654)	(1.177)
Openness	0.00914		0.0272
	(0.0350)		(0.0339)
Inflation	-0.0606	-0.188***	-0.0624
	(0.0773)	(0.0642)	(0.0844)
Financial Development	-0.0214		0.0287
	(0.0200)		(0.0329)
Government Consumption		-0.00750	
		(0.0398)	
Investment		0.101***	
		(0.0192)	
Terms of Trade			0.0782
			(0.0580)
Constant	0.786	2.278**	1.564*
	(0.873)	(0.961)	(0.856)
Observations	560	568	560
CD Statistic	-1.274	-1.327	-0.650
P-value CD Statistic	0.202	0.185	0.516

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$