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Human capital formation and economic growth across the world: a panel data econometric approach

Capital humano y crecimiento económico en el mundo: un enfoque econométrico de datos en panel

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Abstract

This paper estimates 12 dynamic panel data models to assess the impact of human capital formation and other key variables on the economic growth of 52 countries over a 13-year period. Several methodological and empirical contributions are made to assemble country groups, lower measurement errors and reduce the omitted variable bias while keeping the models parsimonious. Among other things, the evidence indicates that the responsiveness of economic growth to physical capital accumulation, institutional development, human capital formation, and total factor productivity varies across country groups to a certain extent. The policy implications of these findings are relevant on several grounds.

Keywords: *dynamic panel data models, economic growth, human capital formation, total factor productivity, institutional development.*

Resumen

En este trabajo se estiman 12 modelos dinámicos de datos en panel para evaluar el impacto del capital humano y otras variables en el crecimiento de 52 economías durante un período de 13 años, haciendo asimismo contribuciones metodológicas y empíricas para integrar los grupos de naciones y para elevar la confiabilidad de las estimaciones sin comprometer la parsimonia del modelo. La evidencia indica que el impacto del capital físico, el desarrollo institucional, el capital humano, y la productividad total de los factores en el crecimiento económico varía según el grupo de países, lo cual reviste importantes implicaciones de política económica.

Palabras clave: modelos dinámicos de datos en panel, crecimiento económico, formación de capital humano, productividad total de los factores, desarrollo institucional.

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Introduction

This research makes use of several panel data models to evaluate the effects of education and other key variables on the economic growth of countries with different Inequality-adjusted Human Development Indices (IHDIs). To that end, four country groups are considered based on the IHDIs reported by the United Nations Development Programme in 2017: (i) very high, (ii) high, (iii) medium, and (iv) low. The Human Development Index (HDI) is defined as an index that takes account of three important components of human achievement: decent standard of living, long and healthy life, and knowledge. The Inequality-adjusted HDI must then be thought of as the HDI adjusted for three types of inequalities: inequality in income distribution, inequality in life expectancy and inequality in education.

As opposed to considering only the Gross National Income (GNI) per capita to classify countries, our approach allows for achieving greater homogeneity within each group to perform a more clear-cut comparative analysis across different country groups, using annual data from 2002 to 2014. From the start, a few relevant precisions must be made. First, some of the variables of interest come from the Penn World table (PWT, 2015), version 9.0, which prevented us from including data beyond 2014. Second, given that many countries do not provide enough data about certain variables and given the convenience of having groups with a similar number of nations for comparative purposes, the first and second groups consist of 15 countries each, whereas the third and fourth groups include 12 and 10 countries, respectively (see Appendix 1). Third, for each country group we chose those nations with the highest IHDIs subject to the availability of reliable data, with the aim of strengthening the homogeneity within the groups. Fourth, to reduce measurement errors, in the case of the third and fourth country groups (i.e. the groups with medium and low IHDIs) we left out those nations with an overall level of statistical capacity below average[1]. And fifth, the dependent variable in the growth models estimated here is the Gross Domestic Product (GDP) per capita, which means that the IHDIs are used only for the classification of country groups.

To further increase the robustness of the findings, we considered two additional country groups, one including the first and second country groups together (i.e. the 30 countries falling into the very high and high-IHDI category) and the other including the third and fourth

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[1] The overall level of statistical capacity is a composite indicator taking account of three important aspects of the country's ability to provide high-quality data: methodology, source data assessment, and periodicity and timeliness.

country groups (i.e. the 22 countries falling into the medium and low IHDI-category). Along these lines, we assembled six panel data sets in all, each of which was used to estimate two panel data models: one with period fixed effects and one without them. Period effects (or period dummy variables) were incorporated to control for technological innovation, business cycles and other time-related processes.

As shall be seen, the use of six panel data sets and two model specifications gave rise to a total of 12 panel data models, which take part in the comparative analysis. All such models are dynamic (i.e. they include a lagged dependent variable as part of the regressors) and were estimated through the Arellano-Bond Generalized Method of Moments (GMMs) over the 2002-2014 period. It will be shown that, under certain conditions, the Arellano-Bond GMMs estimator is not only free of endogeneity problems, but it is also consistent, asymptotically efficient and basically requires no information about the distribution of the error term.

In principle, we relied on Mankiw *et al.* (1992) to specify a dynamic panel data model that takes account of human capital accumulation, in addition to the standard sources of growth considered by Solow (1956). Nonetheless, the model specified in this paper includes an even broader set of explanatory variables, which makes it an extended version of the model proposed by Mankiw *et al.* (1992). Although the set of regressors was selected according to economic theory and previous empirical literature, it had to be restricted to a certain extent because not all countries provide complete and reliable data for all the potentially relevant variables.

The main contributions of this paper lie in: (i) the use of the IHDI rather than the GNI to assemble more homogenous country groups; (ii) the use of the overall level of statistical capacity to rule out countries whose statistical systems are unreliable, which is expected to lower measurement errors; (iii) the incorporation of a "composite" variable reflecting the overall "institutional development" not only to reduce the omitted variable bias, but also to keep a relatively parsimonious model; (iv) the specification of dynamic panel data models, so that the effects of the regressors are conditioned on the past behavior of the model's dependent variable; and (v) the implementation of the Arellano-Bond GMMs estimator with and without period fixed effects, which allows one to compare the findings not only across different country groups but also across different model specifications.

Broadly speaking, this paper shows that the main sources of economic growth are physical capital accumulation, human capital formation, and total factor productivity (TFP). This core empirical evidence is not only highly significant from the statistical standpoint, but also holds quite well across country groups and model specifications. Nevertheless, economic

growth is even more responsive to changes in human capital formation and TFP in low-IHDI countries. On the other hand, institutional development stimulates economic growth in countries with high-to-very-high IHDIs. When period fixed effects are incorporated, such a variable promotes growth in medium-IHDI countries as well. As shall be explained below, the finding that low-IHDI economies do not seem to respond to institutional development is consistent with previous empirical evidence, suggesting that institutional development must reach a certain tipping point to produce tangible effects on economic growth. Lastly, we present some evidence that corruption control can enhance economic growth in the prosperous countries while discouraging it in the poorest countries, which is consistent with the Grease the Wheels Hypothesis (GWH).

The rest of the paper is organized as follows. Section 1 is a brief review of the empirical literature focusing on the link between human capital accumulation and economic growth. Section 2 is a step-by-step explanation of the theoretical framework, whereas Section 3 describes the econometric methodology and specifies the empirical model. Section 4 deals with data issues and model estimation, in addition to interpreting the empirical evidence. Finally, as part of the conclusions, we summarize the empirical evidence and call attention to its policy relevance.

1. Review of the empirical literature

The seminal work of Mankiw *et al.* (1992) disentangles the effects of human capital from the effects of physical capital on economic growth by means of an augmented version of Solow's growth model. The growth model proposed by Mankiw *et al.* (1992) is often referred to as the Mankiw–Romer–Weil (MRW) model, in order to grant the proper credit to the authors. As we show below, the growth rate of output is a function of not only human and physical capital, but also of labor and total factor productivity under MRW's specification. To assess the empirical validity of such a model, MRW build a panel data with annual series from 1960 to 1985 for three broad samples of countries: the first comprises 22 Organization for Economic Co-operation and Development (OECD) nations with populations above one million. The second consists of 98 non-oil countries for which reliable data were available. And the third sample involves 75 nations for which data were not reliable under the guidelines developed by Summers and Heston (1988). The empirical results reported by MRW support the notion that cross-country dispersion in GDP per capita is basically due to disparities in saving rates, population growth rates and education.

It is worth mentioning that not all papers find a positive relationship between human capital accumulation and GDP growth. The investigations of Pritchett (1996) and Caselli *et al.* (1996) contend that human capital exerts a negative influence on economic growth. Nonetheless, Pritchett (1996) and Caselli *et al.* (1996) take no account of the discrepancies in the quality of education across nations (Dessus, 2001), which means that their counterintuitive result could come from an omitted variable bias. Dessus (2001) overcomes this shortcoming by specifying a growth model that includes variables associated with schooling quality (such as the pupil-teacher ratio in primary education), which is then estimated with panel data comprising 83 countries over the 1960-1990 period.

Based on a panel data consisting of around 100 countries from 1960 to 1995, Barro (1999) shows that human capital formation is a determinant of economic growth with the caveat that empirical estimations are, to some extent, sensitive to the degree of international openness, the regulatory environment, and the amount of public resources allocated to schooling and health, among other important sectors of the economy.

Cohen and Soto (2007) make use of a new data set for school attainment in the case of the OECD countries, which spans from 1960 to 2000. To increase the accuracy of the data, they complement the OECD information regarding years of education with the surveys provided by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Along these lines, using refined data on years of schooling as a proxy for human capital, they demonstrate that this variable is not only statistically significant in cross-country growth regressions, but also in panel data growth regressions.

Based on a sample of developed and developing economies over the 1970-2000 period, Owen *et al.* (2009) make an in-depth analysis concerning the sources of heterogeneity in the growth process. The authors classify the countries under study according to the average and volatility of the economic growth rates. Under this approach, the main two sources of parameter heterogeneity in the growth equations are the quality of institutions and the rule of law. After controlling for these two institutional features, the authors find that traditional sources of heterogeneity, such as geographic location, fail to achieve statistical significance. The implication here is that growth models must take account of institutional development indicators to yield more accurate estimates of the impact of human capital accumulation.

To show that education is a key contributor to growth, Banerjee (2012) resorts to a panel data model involving 55 nations during the 1980-2007 interval. The evidence in this case points to the conclusion

that human capital stimulates economic growth through two channels. The first has to do with the effect of human capital on capital productivity, whereas the second relates to the diffusion and assimilation of new technologies that human capital formation facilitates. According to Banerjee (2012), education leads to higher growth by way of these two channels.

To assess the returns of human capital investment in countries with different income levels, Qadri and Waheed (2013) conduct a cross-section empirical analysis involving 106 nations. For each variable included in the growth equation, the authors calculate the corresponding average over the period 2002-08. The use of an average is intended to increase the robustness of the findings, which essentially leads to conclude that human capital investments yield higher returns in low-income nations than in middle-and-high-income nations.

The investigation of Zhu and Li (2017) focuses on measuring the economic complexity of 210 nations by means of the methodology of reflections, so that the effect of economic complexity and human capital on economic growth can be assessed. Economic complexity, according to Zhu and Li (2017), can be thought of the economy's production capabilities. In this perspective, they find that: (i) human capital formation and economic complexity exert a positive influence on the short and long-term economic growth; and (ii) when considered together as an interactive (or multiplicative) variable, human capital and economic complexity render a positive effect on economic growth as well. The implication is that higher economic complexity tends to magnify the positive effect of human capital on economic growth.

Along the same lines, based on a panel data set including 132 countries and 15 years (i.e. from 1996 to 2011), Ali *et al.* (2018) show that human capital has a robust positive impact on economic growth only when social capabilities are brought into the picture. Put differently, these authors produce evidence indicating that an improvement in economic opportunities and a stronger legal system can significantly enhance the effects of human capital accumulation on economic growth. These authors also argue that, broadly speaking, human capital tends to lose statistical significance in growth equations when panel data is used rather than cross-section data. Nonetheless, once social capabilities are incorporated into the panel data model, the effect of human capital on economic growth regains its statistical significance.

Ogundari and Awokuse (2018) resort to annual data from 1980 to 2008 for 35 Sub-Saharan African countries, with the purpose of studying the effects of two types of human capital on economic growth: education and health. Their estimations, based on the system GMMs estimator, point to the conclusion that both measures of human capital have

an influence on economic growth. However, health is more important than education to foster the economic growth of the Sub-Saharan nations.

There are three recent papers stating that the economic structure determines to a certain degree the effects of human capital on GDP growth, namely Cadil *et al.* (2014), Texeira and Queirós (2016), and Ahmad and Khan (2019). First, Cadil *et al.* (2014) provide some evidence that the effect of human capital on economic growth is conditional on the economic structure in the case of the European Union (EU) nations. Put differently, they show that a highly educated population can coexist with persistently low economic growth and elevated unemployment levels. The explanation to this finding lies in the mismatch between the economic structure of countries such as Spain and Cyprus and the qualifications of their labor force, which ultimately prevents those countries from capitalizing their human capital endowments.

Second, Teixeira and Queirós (2016) focus on the interplay between human capital and industrial specialization as a source of growth in two groups of countries. Using a dynamic panel data model, they show that the interaction between human capital and structural change in high-technology industries exerts a positive influence on GDP growth in the more advanced nations of the OECD over the 1960-2011 period. When the same technique is applied to the less advanced OECD economies, namely the Mediterranean countries during the 1990-2011 period, they find that human capital exerts a positive effect on economic growth. However, in these less advanced nations the interplay between human capital and high-tech industries has a negative impact on growth. According to Teixeira and Queirós, this negative relationship in the Mediterranean nations is caused by the shortage of knowledge-intensive industries which, in turn, leads to high unemployment rates among the most qualified workers.

A similar conclusion is then reached by Ahmad and Khan (2019) in the case of 67 developing countries. Based on quinquennial data over the 1960-2014 period and a dynamic panel data model estimated through system GMMs, these authors show that the demographic transition and human capital are both important contributors to growth. However, the demographic transition cannot make a positive contribution to economic growth unless the labor markets are flexible enough to employ the young people joining the working-age population. So, once again, a case is made in that the economy must generate enough employment opportunities to absorb human capital, so that this factor of production can stimulate economic activity.

Based on the system GMMs estimator and annual data from 1960 to 2008, Vedia-Jerez and Chasco (2016) provide empirical evidence that physical and human capital, macroeconomic policies and institutional

development are all relevant drivers of long-term economic growth in South America. In fact, this paper concludes that physical capital makes it possible to employ human capital and take advantage of education and training.

Barcenilla and López-Pueyo (2018) consider the effects of different types of human capital on total factor productivity (TFP) and thus on the economic growth of the EU countries over the 1950-2011 period. Using a panel data model, they show that unskilled human capital raises TFP by way of imitating or absorbing foreign technologies, whereas skilled human capital is important to improve TFP by way of innovation processes. Barcenilla *et al.* (2019) study the effects of imitation and innovation on the TFP of two groups of EU countries over the same period (1950-2011). In the case of the low-income EU countries, they find a greater capacity to imitate foreign technology as they lie farther from the global technology frontier.

Lastly, according to He and Xu (2019) the discrepancies regarding the main sources of growth in different groups of countries stem from neglecting non-linear relationships as well as cross-country heterogeneity. Using an alternative non-parametric approach with convergence and robustness checks, these authors conclude that equipment investments and life expectancy are consistent determinants of growth across nations during the 1960-1992 period.

In summary, the empirical literature posits GDP per capita growth as a function of the following measurable variables: education quantity, the pupil-teacher ratio in primary education (or some other measure of education quality), physical capital, international openness, regulatory framework, the quality of institutions, the rule of law, and total factor productivity. On the other hand, some authors argue that the effects of human capital on economic growth depend on other variables, such as economic complexity (Zhu and Li, 2017), social capabilities (Ali *et al.*, 2018) and economic structure (Cadil *et al.*, 2014; Texeira and Queirós, 2016; and Ahmad and Khan, 2019). Broadly speaking, these three papers point out that the more advanced nations possess better conditions to employ a highly qualified workforce than the less advanced nations. Along these lines, Vedia-Jerez and Chasco (2016) contend that physical capital allows for employing human capital and for taking advantage of education and training. Given this literature review, the data restrictions and the need to specify a relatively parsimonious model, this paper calls attention to the role played by human and physical capital, TFP, international openness, corruption control and a composite institutional variable.

2. Theoretical framework

This section sets up the model to assess the impact of human capital accumulation and other variables on GDP per capita growth, relying on the augmented version of the neoclassical growth model proposed by MRW (1992). MRW's model is later subjected to further extensions. In this manner, MRW depart from the production function depicted by equation (1):

$$Y = K^\alpha H^\beta (AL)^{1-\alpha-\beta} \qquad\qquad 0<\alpha+\beta<1 \qquad\qquad (1)$$

where Y is aggregate output while K and H denote physical and human capital, respectively. Furthermore, L is labor and A depicts the state of technology. In fact, A represents total factor productivity (TFP) in this setting. Given that $0<\alpha+\beta<1$, physical and human capital exhibit decreasing returns to scale and this model can reach a steady state solution. The dynamic behavior of the variables in equation (1) is given by equations (2) through (5):

$$\dot{K} = s_K Y - \delta K \qquad\qquad (2)$$

$$\dot{H} = s_H Y - \delta H \qquad\qquad (3)$$

$$\frac{\dot{L}}{L}\left(\equiv \frac{dL/dt}{L}\right) = n \qquad\qquad (4)$$

$$\frac{\dot{A}}{A}\left(\equiv \frac{dA/dt}{A}\right) = g \qquad\qquad (5)$$

where S_K and S_H stand for the fractions of output invested in physical and human capital, respectively, and δ is the depreciation rate. Therefore, from equations (2) and (3) we know that physical and human capital bear a positive relationship with S_K and S_H, and a negative relationship with the depreciation rate, which is the same for K and H. On the other hand, equations (4) and (5) imply that $L = L_0 e^{nt}$ and $A = A_0 e^{gt}$, where L_0 and A_0 represent the initial values of L and A, respectively. This means that L and A grow exogenously at rates n and g, respectively.

This background allows MRW to establish that the interaction variable AL in equation (1) grows at a rate $n+g$. Now, as AL represents the effective units of labor, $y=Y/AL$ is the output per effective unit of labor while $k=K/$

LA and *h=H/LA* are physical and human capital per effective unit of labor, respectively. The next step is to obtain the trajectory of *k* and *h*. In the case of *k=K/LA*, we first take logs on both sides of the equation, differentiate with respect to time, and then make use of the fact that *K=kLA*. Equation (6) illustrates this procedure:

$$\frac{\dot{k}}{k} = \frac{\dot{K}}{K} - \left(\frac{\dot{L}}{L} + \frac{\dot{A}}{A}\right) = \left(\frac{sY - \delta K}{K}\right) - (n+g) = \left(\frac{sY}{K} - \delta\right) - (n+g) = \left(\frac{sy}{k}\right) - (n+g+\delta) \quad (6)$$

In equation (7) we isolate $\dot{k}$:

$$\dot{k} = s_K y - (n+g+\delta)k \quad (7)$$

By way of a similar procedure, the dynamics of *h=H/LA* can be obtained. Put differently, we take logs on both sides of the equation, differentiate with respect to time, use the fact that *H=hLA*, and finally isolate $\dot{h}$. The result is given by equation (8):

$$\dot{h} = s_H y - (n+g+\delta)h \quad (8)$$

Next, we need to set equations (7) and (8) equal to zero and then obtain the steady-state values for physical and human capital per effective unit of labor, which are given by equations (9) and (10):

$$k^* = \left(\frac{s_K^{1-\beta} s_H^{B}}{n+g+\delta}\right)^{1/(1-\alpha-\beta)} \quad (9)$$

$$h^* = \left(\frac{s_K^{\alpha} s_H^{1-\alpha}}{n+g+\delta}\right)^{1/(1-\alpha-\beta)} \quad (10)$$

Notice that the steady-state values *k** and *h** are increasing in the fractions of output that are invested in physical capital (S_K) and human capital (S_H), respectively, and decreasing in population growth (*n*), TFP growth (*g*) and the depreciation rate (δ). Finally, to obtain the MRW's augmented Solow growth model, we proceed to insert *k** and *h** into equation (1), which is the production function, and then take logs.

$$\ln\left(\frac{Y}{L}\right) = \ln A_0 + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln s_K + \frac{\beta}{1-\alpha-\beta}\ln s_H \quad (11)$$

In fact, equation (11) is an income per capita equation, according to which income per capita bears a positive relationship with physical capital accumulation, human capital formation and TFP growth, on the one hand, and a negative relationship with population growth, on the other. The empirical form of equation (11) is given by equation (12):

$$\ln y_t = \beta_1 + \beta_2 g_t + \beta_3 \ln(n + g + \delta)_t + \beta_4 \ln s_{K,t} + \beta_5 \ln s_{H,t} + v_t \quad (12)$$

where $y_t = Y_t / L_t$, $B_1 = \ln A_0$, $B_3 = -\dfrac{\alpha + \beta}{1 - \alpha - \beta}$, $B_4 = \dfrac{\alpha}{1 - \alpha - \beta}$, and $B_5 = \dfrac{\beta}{1 - \alpha - \beta}$, g_t, g_t is TFP growth, and v_t is a stochastic error term. Given that $B_1 = \ln A_0$, MRW state that the intercept term stands for the initial value of A. To properly study the effects of human capital accumulation on GDP per capita growth, some extensions will be made to equation (12) in the next section.

3. Estimation technique and empirical modeling

As stated at the outset, this paper makes use of the Arellano-Bond dynamic panel Generalized Method of Moments (GMMs) to estimate 12 dynamic panel data models. The Arellano-Bond estimator (Arellano and Bond, 1991) relies to certain extent on the GMMs proposed by Hansen (1982). Given that this econometric method is robust to endogeneity problems, it is highly recommended when the explanatory variables are likely to be correlated with the stochastic disturbance term. Another major advantage of this technique is that it can be applied even when the behavior of the error term is unknown. We will show that not only do these features are useful to achieve consistency and asymptotic efficiency, but they also make conventional significant tests (i.e. t- and F-tests) more reliable when the distribution of the disturbance term is not known.

To explain the Arellano-Bond GMMs, we must first rewrite equation (12) to describe a panel data model consisting of N cross-section units and T periods. Equations (13) accomplishes such a task:

$$\ln y_{it} = \beta_{1i} + \beta_2 g_{it} + \beta_3 \ln(n + g + \delta)_{it} + \beta_4 \ln s_{K,it} + \beta_5 \ln s_{H,it} + v_{it} \quad (13)$$

where subscripts i and t denote the nation and the year, respectively, whereas β_{1i} represents an intercept term that may vary from one country to another but remains constant over the years. In fact, this type of intercept term is useful to capture the unobserved heterogeneity across nations. The Arellano-Bond GMMs estimator is applied to a dynamic panel data model, which means that at least one lagged dependent variable ($\ln y_{t-1}$)

must be added as part of the regressors. The lagged dependent variable provides the model with a partial adjustment mechanism that conditions the effects of the other regressors. Now, the effects of the other explanatory variables must take account of the past behavior of the dependent variable. Moreover, the unobserved heterogeneity is not dealt with anymore through an intercept term that varies from one nation to another, but by way of a composite error term as shown in equation (14):

$$\ln y_{it} = \gamma \ln y_{it-1} + \beta_2 g_{it} + \beta_3 \ln(n + g + \delta)_{it} + \beta_4 \ln s_{K,it} + \beta_5 \ln s_{H,it} + u_{it} \quad (14)$$

where γ is a first-order autoregressive coefficient and $u_{it} = \mu_i + v_t$. Thus, u_{it} is a composite error term consisting of a cross-section error term (μ_i) and a combined error term (v_{it}), which varies across individuals and across time. Note that the heterogeneity among nations is now captured by μ_i, which has replaced β_{1i}. To lay the foundations of this method, in principle we must assume that $\mu_i \sim \text{IID}(0, \sigma_\mu^2)$ and $v_{it} \sim \text{IID}(0, \sigma_v^2)$. Of course, these assumptions will be subsequently relaxed. To simplify things, equation (14) must be rewritten as equation (15):

$$\ln y_{it} = \delta \ln y_{it-1} + x_{it}'\beta + \mu_i + v_{it} \quad (15)$$

where x'_{it} is a row vector of K explanatory variables and β is a column vector of K parameters. Initially, K equals 4 but will grow as new explanatory variables are incorporated into the model. In practice, equation (15) entails two potential problems: first, if the dependent variable ($\ln y_{ti}$) is correlated with the cross-section error term (μ_i), so does the lagged dependent variable ($\ln y_{t-1}$). What is more, $\ln y_{it-1}$ and the combined error term (v_{it}) can also be correlated. The second potential problem is that one or more variables in row vector x'_{it} are endogenous and, therefore, correlated with u_{it}. In either case, the OLS estimator would be biased and inconsistent. The Arellano-Bond GMMs removes the cross-section error term (μ_i) first, thereby eliminating one part of the potential correlation problem. This is done by rewriting the model in first differences as in equation (16):

$$\Delta \ln y_{it} = \gamma \Delta \ln y_{it-1} + \Delta x_{it}'\beta + \Delta v_{it} \quad (16)$$

where Δ is the first difference operator. The next task is to eliminate the correlation between all the regressors and the combined disturbance term (Δv_{it}), which is carried out by generating a series of instrumental variables in a sequential pattern. Such instruments are given by the appropriate lags of the regressors in levels (i.e. the appropriate lags of $\ln y_{it-1}$ and

x'_{it}), which happen to be highly correlated with the regressors in equation (16), that is, with $\Delta \ln y_{it-1}$ and $\Delta x'_{it}$, but uncorrelated with the disturbance term (Δv_{it}). In this manner, the Arellano-Bond GMMs deals with the endogeneity problem. Moreover, when N is greater than T, it can be shown that the Arellano-Bond estimator is not only free of endogeneity problems, but it is also consistent, asymptotically efficient, and to a certain extent requires no information about the distribution of the disturbance term (Arellano and Bond, 1991; Ahn and Schmidt, 1995; and Baltagi, 2008: 147-155). As the reader may recall, six country groups are assembled in this paper according to the IHDI: (i) very high (15 nations), (ii) high (15 nations), (iii) medium (12 nations), (iv) low (10 nations), (v) very high and high (30 nations), and (vi) medium and low (22 nations). Given that T=13 in all cases, the condition that N exceeds T is fulfilled in four out of the six country groups, namely country groups (i), (ii), (v) and (vi). Moreover, for each country group two dynamic panel data models are specified, one with period fixed effects and one without them, so that the condition that $N > T$ is satisfied in eight out of the 12 estimated models. What is more, the core empirical evidence is consistent across country groups and model specifications.

3.1 The extended models

Broadly speaking, the empirical literature places GDP per capita growth as a function of the following variables: human capital formation indicators, physical capital, total factor productivity, international openness, regulatory framework, economic complexity, the quality of institutions, and the rule of law. Based on the theoretical framework, the review of the empirical literature, and availability of reliable data, we will estimate the following empirical model:

$$\Delta \ln y_{it-1} = \gamma \Delta y_{it-1} + \Delta x'_{it} \beta + \Delta v_{it} \qquad (17)$$

where y_{it} is the GDP per capita (as a proxy for GDP per effective unit of labor) at current purchasing power parities (PPPs), whereas x'_{it} is a row vector of 7 variables and β is a column vector containing the corresponding parameters. Equation (17) resembles equation (16), except that in equation (17) vector x'_{it} contains the following seven explanatory variables:
1) g_{it} = total factor productivity growth.
2) $\ln (n+g+\delta)_{it}$ = composite variable including the population growth rate (n) as a proxy for the growth rate of the labor force, the total factor productivity growth rate (g) and the depreciation rate (δ).

3) $S_{K,it}$ = physical capital stock per person (as a proxy for physical capital per effective unit of labor) at current PPPs.
4) $S_{H,it}$ = human capital index, based on years of schooling and returns to education.
5) $trade_{it}$ = international openness, as measured by the sum of exports and imports as a share of GDP.
6) $corrup\_con_{it}$ = corruption control.
7) $inst\_dev_{it}$ = institutional development, which is composite variable reflecting the changes in the following five indicators: regulatory quality, rule of law, government effectiveness, political stability and absence of violence, and voice and accountability. Given that these five indicators are measured on the same scale, we simply make use of the arithmetic average to produce this composite indicator, which in the majority of cases turns out to be statistically significant.

Notice that variables 1) through 4) appear in the original model, whereas variables 5) through 7) are part of the extended model. Thus, a total of three key explanatory variables are added to the benchmark model, one of which is a composite variable intended to assess the country's overall institutional performance. Therefore, in addition to the variables considered in the previous literature (regulatory framework, the quality of institutions or government effectiveness, and the rule of law), we also consider political stability and absence of violence, voice and account-ability, and corruption control. It is worth mentioning that "corruption control" is not part of the composite institutional variable (i.e. is not part of $inst\_dev_{it}$) based on the finding that the effects of anti-corruption policies on economic growth are conditional on the performance in other major areas of governance (Méon and Weill, 2010; Dreher and Gassebner, 2013; Kéita and Laurila, 2016; and Huang, 2016), such as the ones included in the composite variable ($inst\_dev_{it}$).

4. Econometric Analysis

In the case of each nation, we gathered annual data over the 2002-2014 period for each of the variables of the extended model.[2] Unfortunately, the data obtained from Penn World table, version 9, does not go beyond 2014.[3] More details in this regard can be found in Feenstra *et al.* (2015). Table 1 displays the summary statistics for all the relevant variables of the model.

[2] See table 1.
[3] This is the case of total factor productivity, average depreciation rate of capital stock, physical capital stock per person at current PPPs, and the human capital index.

Table 1
Summary statistics: sample averages for each country group over the 2002-2014 period and coefficients of variation

Variable/ Country Group	Very High IHDI N=15 T=13	High IHDI N=15 T=13	Medium IHDI N=12 T=13	Low IHDI N=10 T=13
γ	42,242.47 (0.28)	10,772.35 (0.39)	5699.23 (0.42)	1862.63 (0.56)
S_K	158,143.1 (0.29)	31,676.21 (0.42)	15,865.72 (0.57)	4171.19 (0.59)
S_H	3.39 (0.07)	2.79 (0.11)	2.25 (0.17)	1.56 (0.23)
g	-1.02 (3.58)	2.50 (2.53)	0.79 (5.60)	0.35 (40.36)
trade	108.82 (0.61)	84.89 (0.34)	76.69 (0.28)	67.47 (0.32)
corrup_con	0.77 (0.20)	0.36 (0.27)	0.34 (0.28)	0.30 (0.42)
inst_dev	0.92 (0.06)	0.63 (0.12)	0.59 (0.13)	0.47 (0.19)

Note:
IHDI = Inequality-adjusted Human Development Index.
The estimated coefficients of variation appear within parentheses.
Source: own estimations based on data from Penn World Table (2015), version 9.0, World Bank Development Indicators, and The Political Risk Services (PRS) Group.

The two key summary statistics are the sample average and the estimated variation coefficient (EVC) for each variable of each country group over the 2002-2014 period. The EVC for a given variable of a given country group is calculated as follows:

$$EVC = (S/\bar{Y})(1+1/4TN) \qquad (18)$$

where S is the sample standard deviation, $\bar{Y}$ is the sample average, and TN is the panel sample size. Thus, (1+1/4TN) is the small sample bias-correction factor developed by Sokal and Rohlf (1995). Along these lines, the EVC is an unbiased and normalized measure of dispersion.

As we move across country groups in table 1, we can see that the lower the IHDI, the lower the average GDP per capita (γ). Moreover, the lower the IHDI, the more volatile the GDP per capita. Thus, not only do poor countries have lower GDP per capita levels, but they also face more volatility in this variable. The same finding applies to physical capital stock per person (S_K), the human capital index (S_X), corruption control (corrup_con), and institutional development (inst_dev). All these

variables consistently decrease as we move from richer to poorer countries and become more volatile at the same time. Furthermore, international openness goes down as we shift from richer to poorer countries, whereas the pattern of volatility for this variable is unclear. Last but not least, total factor productivity growth (*g*) is negative for the very high IHDI-country group, perhaps as a result of the detrimental impact of the global financial crisis (2007-2011). The high IHDI-country group reports the highest total factor productivity growth and, as the IHDI goes down, not only does this variable fall, but it also becomes more volatile.

It is worth mentioning that for variables 1) through 4) described in Section 3.1, as well as for the dependent variable and its lagged value, we took logs and then proceeded to differentiate. In the case of the rest of the variables, we simply differentiated them because they are stated in either percentages or fractions, which among other things means that they do not tend to grow continuously overtime. Moreover, it is convenient to acknowledge that the empirical evidence stemming from the use of governance indicators, such as variables 6) and 7), must be interpreted with caution for the following reasons. First, institutional performance indicators are based on survey data not only of households and firms, but also of public sector institutions and private information providers, which aim at producing professional assessments. In any event, such data are based to a large extent on subjective responses or mere perceptions, which give rise to margins of error. Due to the margins of error, small changes from one period to another in a given country, or from one nation to another in a given year, may not be statistically significant (Kaufmann *et al.*, 2010). Second, perception-based measures of institutional performance may be biased to a certain degree, given that different respondents may uphold different views on what constitutes a good performance in a given dimension of governance (Kaufmann *et al.*, 2007). By the same token, even expert index-builders, such as the World Bank, sometimes produce and rely on ordinal (qualitative) indices rather than cardinal (quantitative) indices (Apreda, 2007). In this context, further research is required to determine the magnitude of the margin of errors as well as the extent of the biases involved in assessing institutional performance, so that more reliable empirical works can be conducted in this field. For the time being, however, we have to rely on two basic propositions: 1) even perceptions matter as they are relevant to firms when making investment decisions and to citizens when casting their vote (Kaufmann *et al.*, 2010), and 2) there is only little evidence of systematic biases in perceptions, meaning that the empirical analysis can lead to robust findings as long as we are aware of the drawbacks involved in the use of governance indicators (Kaufmann *et al.*, 2007).

4.1 Estimated panel regression models

Table 2 exhibits the dynamic panel regression model estimated for each country group. Six country groups are considered based on the IHDI: (i) very high, (ii) high, (iii) medium, (iv) low, (v) very high and high, and (vi) medium and low. The first two country groups consist of 15 nations each, whereas the third and fourth comprise 12 and 10 countries, respectively. Therefore, the fifth and sixth groups include 30 and 22 countries, respectively. Those are the values for N in each case while $T=13$ in all cases (See Appendix 1 for more details). The estimation methodology is the Arellano-Bond dynamic panel GMMs. Table 3 employs the same methodology, but in that case period dummy variables are incorporated into the model to take account of what is known as period fixed effects.

Table 2

Dynamic panel data models for countries with different levels of Inequality-adjusted Human Development Indices Econometric method: The Arellano-Bond Generalized Method of Moments

Dependent variable: $\Delta \ln y_{it}$

Country group	Very High $N=15$ $T=13$	High $N=15$ $T=13$	Medium $N=12$ $T=13$	Low $N=10$ $T=13$	Very High and High $N=30$ $T=13$	Medium and Low $N=22$ $T=13$
Variable	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
$\Delta \ln y_{it\text{-}1}$	0.146***	0.159***	0.510***	0.095*	0.202***	0.103***
$\Delta \ln S_{K,\,it}$	0.377***	0.348***	0.185***	0.278***	0.304***	0.303***
$\Delta \ln S_{H,\,it}$	0.090	0.278**	0.279***	0.994***	0.545***	0.520***
$\Delta \ln (n+g+\delta)_{it}$	0.003	-0.002	0.008	-0.134**	0.015	-0.131***
Δg_{it}	0.837***	1.624***	0.915***	2.201***	1.373***	2.196***
$\Delta trade_{it}$	0.002***	0.002***	0.002***	-0.003**	0.002***	-0.002***
$\Delta corrup\_con_{it}$	0.142**	0.388***	0.0550	-0.303***	0.543***	-0.269***
$\Delta inst\_dev_{it}$	0.308***	0.295**	0.149	-0.149	0.244	0.293

Notes:
T denotes the number of periods (i.e. years) while N denotes de number of cross-section units (i.e. countries).

Δ is the first difference operator.

Asterisks '*', '**', and '***' denote statistical significance at the 10,5 and 1% significance levels, respectively.

Source: own estimations based on data from Penn World Table (2015), version 9.0, World Bank Development Indicators, and The Political Risk Services (PRS) Group.

Table 3
**Dynamic panel data models for countries with different levels of
Inequality-adjusted Human Development Indices
Econometric method: The Arellano-Bond Generalized Method of
Moments with period fixed effects
Dependent variable: $\Delta \ln y_{it}$**

Country group	Very High N=15 T=13	High N=15 T=13	Medium N=12 T=13	Low N=10 T=13	Very High and High N=30 T=13	Medium and Low N=22 T=13
Variable	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*
$\Delta \ln y_{it}$	0.277***	0.142***	0.575***	0.050	0.260***	0.048
$\Delta \ln S_{K,\,it}$	0.465***	0.243***	0.140***	0.313***	0.301***	0.327***
$\Delta \ln S_{H,\,it}$	0.181***	0.246**	0.119**	1.516***	0.330***	0.714***
$\Delta \ln (n+g+\delta)_{it}$	0.015	0.069***	0.002	-0.185***	0.088***	-0.190***
Δg_{it}	0.806***	1.237***	0.817***	2.412***	1.048***	2.348***
$\Delta\,trade_{it}$	0.001***	-0.0006	0.001**	-0.001	0.001	-0.002
$\Delta\,corrup\_con_{it}$	0.035	0.344***	0.064	-0.240**	0.140	-0.051
$\Delta\,inst\_dev_{it}$	0.230***	0.535***	0.249**	0.071	0.853***	0.744**
Dummy_2004	-0.007	0.015	0.002	-0.020	7.19E-05	-0.011
Dummy_2005	-0.007	0.023**	0.004	-0.031	-0.001	-0.025*
Dummy_2006	-0.049***	0.009	7.73E-05	0.017	-0.017**	0.002
Dummy_2007	0.004	0.019**	0.002	-0.051**	0.007	-0.028**
Dummy_2008	-0.001	0.028***	0.007	-0.025	0.020***	-0.01
Dummy_2009	-0.057***	-0.041***	-0.012	-0.014	-0.040***	-0.014
Dummy_2010	0.040***	0.047***	0.047***	0.040	0.051***	0.040***
Dummy_2011	-0.001	0.035***	0.014*	-0.020	0.020**	0.010
Dummy_2012	-0.009	0.013	-0.027***	0.002	-0.009	0.009
Dummy_2013	-0.012**	NA	0.004	-0.007	NA	-0.005
Dummy_2014	0.002	NA	0.002	-0.009	NA	NA

Notes:
T denotes the number of periods (i.e. years) while N denotes de number of cross-section units (i.e. countries).
NA = Not Applicable.
Δ is the first difference operator.
Asterisks '*', '**', and '***' denote statistical significance at the 10,5 and 1% significance levels, respectively.
Source: own estimations based on data from Penn World Table (2015), version 9.0, World Bank Development Indicators, and The Political Risk Services (PRS) Group.

The analysis of tables 2 and 3 allows for drawing the following conclusions:

1) GDP per capita growth is mainly driven by physical capital accumulation ($\Delta \ln S_{K,\,it}$), human capital formation ($\Delta \ln S_{H,\,it}$) and total factor productivity (Δg_{it}). The estimated coefficients of these variables are highly significant in all but one case, which is the coefficient of human capital formation in very high IHDI-countries when period fixed effects are omitted (see table 2). In the other 11 cases depicted in Tables 2 and 3, the estimated parameters are highly significant. To a lesser extent, institutional development can also be regarded as a source of growth. Without period dummy variables (table 2), institutional development is statistically significant only in the very high and high IHDI-countries. However, once period dummy variables are brought into the picture (table 3), the economic growth of all country groups but one (the low IHDI-countries) seem to respond positively to institutional development.

2) Economic growth is more responsive to human capital formation and total factor productivity (TFP) in low-IHDI countries than in the other three country groups (i.e. the country groups falling into the medium, high, and very high IHDI-category). Thus, the poorest countries can get significantly larger benefits not only from devoting more resources to education and training, but also from investing more in research and development activities, which are directly related to TFP. As noted earlier, Qadri and Waheed (2013) also find that human capital investments produce a larger impact on growth in low-income countries than in middle- and high-income countries. However, while Qadri and Waheed (2013) make use of cross-country regressions to reach this conclusion, our analysis here is based on dynamic panel data models.

3) Conversely, the elasticity of economic growth with respect to capital stock is the largest in countries with very high IHDIs. The rationale behind this is that the richest countries possess a more qualified workforce and more consistent macroeconomic policies, so they can make more efficient use of their capital stock. This would also imply that the acquisition of new machines, equipment and even technology in developing countries should go hand-in-hand with higher and wiser investments in education and training, so that their workforce is up to new challenges involved.

4) The findings described in paragraphs 2) and 3) become even more evident when period dummy variables are incorporated into the model (table 3), so as to account for time-related changes such as

technical progress, business fluctuations and the like. What is more, given that we deal with dynamic panel data models, the effects of all the exogenous regressors (i.e. the seven variables in vector x'_{it}) are conditioned on the past behavior of GDP per capita.

5) In contrast, the effects of international trade ($\Delta trade_{it}$) on economic growth are unclear. Without period dummy variables, international trade is growth-enhancing in countries with very high, high and medium IHDIs and is detrimental to economic growth in countries with low IHDIs. Notice that the coefficient of international trade in low-IHDI countries is negative and statistically significant at the 5% level, which is consistent with the view that trade can produce a net negative effect on countries lying far behind the global technological frontier. Moreover, trade is a contributor to growth when very high and high-IHDI countries are considered together, but it is an obstacle to growth when medium and low-IHDIs are taken together (table 2). Once period dummy variables are included, it turns out that trade can promote economic growth only in countries with very high and medium IHDIs. In all the other cases, the estimated coefficients associated with international trade are not statistically significant (table 3).

6) Without period fixed effects, corruption control ($\Delta corrup\_con_{it}$) encourages economic growth in very high and high-IHDI countries and discourages it in low-IHDI countries. For countries with very high and high IHDIs taken as a single group, corruption control promotes economic growth. Conversely, for countries with medium and low IHDIs taken as a whole, corruption control slows down economic growth. Notice that the estimated parameters in all these cases are statistically significant either at the 5 or 1% level (table 2). Once period fixed effects are brought into the picture, it turns out that corruption control stimulates growth in countries with high IHDIs and inhibits growth in countries with low IHDIs (table 3). This is consistent with the Grease the Wheels Hypothesis, which postulates that corruption fosters economic growth (or that corruption control lowers economic growth) in countries suffering from overwhelming regulations, a weak rule of law, and a highly ineffective government. As we argue below, this evidence is by no means conclusive, but it is consistent with previous studies in the field.

7) Let us recall that institutional development ($\Delta inst\_dev_{it}$) is a composite variable capturing the average behavior of five indicators of institutional performance. Without period fixed effects, such a composite indicator bears a positive and statistically significant relationship with economic growth in two country groups, namely

the country groups with very high and with high IHDIs. We also note that when these two country groups are analyzed as part of a single panel in the sixth column (i.e. one before the last) of table 2, the statistical significance of this composite variable dissipates. Nonetheless, once period fixed effects are incorporated (table 3), our overall indicator of institutional development becomes statistically significant in five out of the six country groups under study. Given that in all country groups several period dummy variables are statistically significant, in most cases at the 1% level, we view this model specification as the most reliable one. In this context, one can infer that an improvement in the overall institutional performance raises GDP per capita growth in all country groups but one, which is the group comprising the countries with low IHDIs. As part of the conclusions, we make reference to some empirical investigations indicating that, in poor nations, institutional development must reach a certain threshold to produce tangible effects on GDP growth.

8) Period dummy variables are statistically significant around the key stages of the global economic crisis (2007-2011) in all country groups (table 3). The epicenter of such a crisis was certainly the US economy, but most nations of the world were affected to different degrees by way of either financial or real channels. Although this finding suggests a time-related worldwide change, further research would be required to determine whether and, if so, to what extent, such a change is linked to the global economic crisis.

Although the empirical evidence presented here is reasonably robust, we must recall that it was obtained through an instrumental variables approach. An important caveat here is that there are no perfect instruments, which means that instrumental variables may not be as correlated with the endogenous regressors and as uncorrelated with the error term as one may expect. In this case, it can be said that the instruments are weak. Weak instruments are often due to lack of data or to poor choices made by the econometrician, the result being that the endogeneity problem persists. Of course, the AB estimator is not completely devoid of this shortcoming. However, the lack of data is not as severe a problem in this case considering that the instruments are given by the lags of the dependent and the independent variables in levels.

Conclusions and policy implications

This paper makes several contributions in terms of the methodology employed and the empirical findings. In terms of the methodology employed, the following novelties stand out: (i) the use of the IHDI rather than the GNI, in order to assemble more homogenous country groups to perform a clear-cut comparative analysis; (ii) the utilization of the overall level of statistical capacity to rule out nations with unreliable statistical systems, thereby reducing measurement errors; and (iii) the inclusion of a "composite" variable capturing the overall institutional development of each nation, in order to bring down the omitted variable biased while keeping a relatively parsimonious model. It is also worth mentioning that we are specifying dynamic panel data models, so that the effects of the exogenous regressors are conditioned on the historic behavior of the dependent variable. To estimate the dynamic panel data models the Arellano-Bond GMMs is employed, given the reliable properties inherent to this estimator. Finally, we compare the empirical findings obtained with and without period fixed effects, which is useful not only to weigh the importance of the time-related changes taking place in each country group, but also to further reduce the omitted variable bias.

In terms of the findings, the core empirical evidence has been shown to be reasonably consistent across country groups and model specifications. The most important regularity is that the main sources of GDP per capita growth are physical capital accumulation, human capital formation, and total factor productivity. As with Qadri and Waheed (2013), we find that low-IHDI countries are the ones displaying the largest elasticity of economic growth with respect to human capital formation, which suggests that this country group can benefit more than any other from investing more not only in long-term formal education, but also in short-term training programs. In addition, this investigation shows: first, that low-IHDI countries are also the ones exhibiting the largest impact of TFP on economic growth, meaning that research and development (R&D) domestic expenditure and the assimilation and diffusion of foreign technologies (which are key to raise TFP) can be particularly advantageous to this country group. Secondly, this paper shows that very high-IHDI countries are the ones displaying the largest elasticity of economic growth with respect to capital stock, presumably because those nations have relatively more efficient economic policies as well as a more qualified workforce. As opposed to Qadri and Waheed (2013), this paper makes these contributions in a panel data setting rather than in a cross-section regression setting. Within our panel data setting, the use of period fixed effects makes all these findings even more noticeable.

As explained in the previous section, without period fixed effects, corruption control is growth-improving in countries with very high and high IHDIs and is growth-worsening in countries with low IHDIs. With period fixed effects, corruption control is helpful to economic growth in high IHDI countries and is detrimental to growth in low-IHDI countries. In this context, there is some evidence, albeit limited and thus not conclusive, in favor of the Grease the Wheels Hypothesis (GWH). The GWH postulates that corruption promotes economic growth (meaning that corruption "control" lowers growth) in countries where regulations are overwhelming, the rule of law is weak, and the government is highly ineffective (Méon and Weill, 2010; Dreher and Gassebner, 2013; Kéita and Laurila, 2016; Huang, 2016). The implication is that anti-corruption policies in poor countries cannot yield the best results unless they are accompanied by a comprehensive institutional reform.

The composite variable of institutional development bears a positive and statistically significant relationship with GDP per capita growth in the prosperous countries. Without period fixed effects, institutional development gives rise to economic growth in the very high and high IHDI nations. With period fixed effects, which is seemingly the more proper specification, institutional development leads to economic growth in medium, high and very high IHDI countries. In the fifth and sixth country groups (consisting of very high and high IHDI countries, and medium and low IHDI countries, respectively), we also find that institutional development renders a positive and statistically significant effect on economic growth. In this context, the countries falling into the low-IHDI category are the only ones not getting economic growth from institutional development. What is the most plausible explanation for institutional development not causing economic growth in this particular country group? Sassi and Ali (2017) provide important elements to answer this question. Based on a sample of 47 African countries over the 1996-2014 period, these authors show that the rule of law must reach a certain threshold to break the high corruption inertia prevailing in Africa. By the same token, Anh-Than (2008) contends that institutional reform must reach a "critical mass" to move an economy from a bad equilibrium embodying widespread corruption and low human development to a good equilibrium, characterized by little corruption and high human development. Lastly, Aslund *et al.* (2001) focus on the problem of the under-reform trap arguing that a robust underground economy lowers tax collection which, in turn, prevents the government from imposing the rule of law and from providing other public goods, which ultimately creates more incentives for firms to remain in the informal economy. By and large, however, it is fair to say that the body of evidence supports the notion that institutional development fosters

economic growth, at least in the case of countries with medium-to-very-high IHDIs when period fixed effects are considered (table 3). In this regard, an important policy implication is that institutional reform must be not only comprehensive as pointed out earlier, but also far-reaching to produce tangible results in terms of economic growth.

Although economic growth in low-IHDI countries seems to be in principle not responsive to institutional development, it is highly responsive to human capital formation and TFP. While human capital formation is linked to education and training, TFP basically stems from the absorption of foreign technologies as well as from R&D domestic expenditure. It must be kept in mind that not only are human capital formation and TFP two major drivers of growth but, as Banerjee (2012) points out, these two variables are also related to each other insofar as human capital formation facilitates the assimilation and development of more advanced technologies.

A final remark is that the basic model presented here draws on two approaches: 1) the original theory according to which growth is due to factor accumulation and total factor productivity, and 2) the more contemporaneous approach that incorporates institutional development and international openness. A potentially fruitful line of future research, however, lies in the inclusion of what is known as deep roots of development, which have to be found in earlier periods of human history. Among these historical roots, we can mention the very adoption of the right institutional framework or the right technology as well as many geographic factors (Pierskalla *et al.*, 2014; Fedderke *et al.*, 2014). In fact, resorting to the deep roots of development is an alternative way to deal with endogeneity problems and to properly establish long-term causal relationships (Pierskalla *et al.*, 2014).

Appendix 1
Countries included in each country group according to their Inequality-adjusted Human Development Indices

Very high	High	Medium	Low
Norway	Kazakhstan	Moldova	Tanzania
Iceland	Bulgaria	Indonesia	Zimbabwe
Australia	Ukraine	The Philippines	Cameroon
The Netherlands	Serbia	Paraguay	Togo
Germany	Sri Lanka	Egypt	Senegal
Switzerland	Armenia	Nicaragua	Nigeria
Denmark	Uruguay	Bolivia	The Ivory Coast
Sweden	Turkey	Morocco	Mozambique

Appendix 1 (*continuation*)

Very high	High	Medium	Low
Ireland	Mongolia	India	Burkina Faso
Finland	Costa Rica	Guatemala	Niger
Canada	Jordan	Honduras	
Slovenia	Panama	South Africa	
The United Kingdom	Jamaica		
The Czech Republic	Ecuador		
Luxembourg	Mexico		

Source: Own elaboration based on the Inequality-adjusted Human Development Indices reported by the United Nations Development Programme in 2017.

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