

WHAT DOES THE HUMAN DEVELOPMENT INDEX TELL US ABOUT CONVERGENCE?

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Abstract

This study seeks to find out whether there existed an empirically discernable and robust tendency in the world for countries to converge in terms of human development over the last three decades. Human development is measured by the Human Development Index trend and convergence across countries is tested for by the conventional cross-country methods of β - and σ -convergence. We perform similar analyses on those countries that joined the European Union before its 2004 enlargement and on all current members of the EU too. Our results indicate convergence for all three groups of countries we consider, that is relatively backward countries managed to increase their HDI more than developed countries.

JEL Classification: B23, E13, I31, O47

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1. Introduction

The belief that initially laggard countries are getting closer to and in the long-run may even catch up with the leaders seems to satisfy mankind's natural desire for justice, equality and fair play. No wonder, hence, that it has been around for a long time. In the economic literature, in particular, it can be traced back to at least as far as the mid 19th century, when Mill (1848) envisaged the worldwide spread of democracy, literacy and international trade and predicted that richer countries would allow poor economies to catch-up by focusing on the distribution of wealth rather than on increasing it; and Marx (1853) thought that the interference of British steam and free trade with the traditional Indian way of life and the colonizers' neglect of large public works were spurring a social revolution in Hindustan (DeLong, 1988).

Notwithstanding these early works, it is fair to say that the real surge of interest in the issue of convergence across countries stemmed from the emergence of the modern study of economic growth in the mid 1950s. In their classic articles Abramowitz (1956), Solow (1956, 1957), and Swan (1956) argued that on top of capital and labour the third major factor of economic growth is technological change, which is actually an alias for everything else than the two basic inputs that can contribute to the steady-state growth of an economy. The new, Solow-Swan neoclassical growth model surpassed the Harrod-Domar model by treating labour and technological progress as

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distinct factors of production and assuming that the capital-output ratio is not an exogenous constant but an adjusting variable that drives an economy towards its steady-state growth path. As regards this path, based on the assumptions of exogenous labour augmenting technological progress, diminishing marginal returns to labour and capital but constant returns to scale, in the Solow-Swan model every economy has a stable steady-state growth rate (g), which is determined by the labour force growth rate (n), the rate of technological progress (θ), and the capital depreciation rate (δ).

At steady-state, all the level variables except labour – i.e., capital stock, output and consumption – grow at the rate of $n+\theta$, their per capita ratios grow at the rate of θ , while the per effective capita ratios remain constant. Importantly, a permanent change in the savings rate results in new steady-state per effective labour ratios, but has only a temporal impact on the actual growth rates and leaves the steady-state growth rate unaltered.¹ Consequently, if a group of countries have different initial capital-effective labour ratios but share the same pool of technology and labour force growth rate, then they are also characterised by a common steady-state growth rate. Moreover, if these countries have the same propensity to save then, in the long-run, they are expected to approach a common steady-state capital per effective capita, output per effective capita, and consumption per effective capita ratios. On the other hand, if these countries differ both in their initial capital-labour ratios and in their propensities to save, then their steady-state per effective capita ratios are also different.

In other words, in the Solow-Swan model, if some countries differ at most only in their initial capital per effective labour ratios, then poor countries – poor in terms of initial capital-effective labour ratio – tend to grow faster than rich countries, and they are expected to converge to each other. If they also differ in their savings ratios or any other structural characteristic, such as preferences, technologies, population growth, government policies, etc., then they still approach their respective steady-states at a common steady-state growth rate, but their steady-state ratios are different. Based on this distinction, in the empirical growth literature absolute convergence means that the per capita incomes of countries tend to converge to each other independently of their initial conditions, while conditional convergence means convergence after differences in the steady states across countries have been controlled for.

In the Solow-Swan model the steady-state growth of an economy depends on labour force growth, technological progress, and capital depreciation. According to the calculations of Solow (1957), out of these three factors exogenous technological progress is by far the most important; its role in the US output per capita growth in the first half of the 20th century was estimated to be 87.5%. This unbelievable high figure suggests that the overwhelming majority of economic growth is determined by variables not included in the Solow-Swan model itself.

In response to this shortcoming of the neo-classical model, new macroeconomic growth models based on various microeconomic foundations emerged in the late

¹ This is the well-known Solowian paradox of thrift.

1980s and early 1990s, spearheaded by Romer (1986, 1990), Lucas (1988), and Rebelo (1991). These models assume that technological change is induced by previous economic conditions; that the steady-state growth rate of per capita ratios is determined by variables within the model, such as taste, tax policy or some technology parameters; and that returns to scale is constant. Moreover, they rely on positive externalities, spillover effects, investment in human capital, permanent accumulation of knowledge, and/or accumulable factors of production in order to guarantee non-diminishing marginal product of capital (including human capital) at the macro level. Under non-diminishing returns, however, economies can grow without limits and without ever converging to each other. Hence, contrary to the neoclassical model, the first-generation endogenous growth models do not predict convergence.

This major difference in the implications of the neoclassical and early endogenous growth models, accompanied by the emergence of the first reasonably large but still consistent historical data sets of Maddison (1982, 1983) and Heston and Summers (1984), has generated massive empirical research on cross-country growth, with special regard to convergence in per capita income or labour productivity. Starting, among others, with Baumol (1986), Dowrick and Nguyen (1989), Barro (1991), Barro and Sala-i-Martin (1992), and Mankiw, Romer and Weil (1992), numerous papers have been published with the aim of confirming or falsify the convergence hypothesis and, ultimately, to support the neoclassical growth model or to reject it in favour of some endogenous growth model.²

Without questioning the importance of this issue, it is essential to acknowledge, though, that the absolute convergence hypothesis does not naturally spring out from the Solow-Swan model or from the neoclassical growth model in general, and that not all endogenous growth models imply divergence (see e.g. Barro and Sala-i-Martin, 1997; Kejak, Seiter and Vavra, 2004). Besides, prior to the neoclassical versus endogenous growth controversy, Abramowitz (1986) found that between 1870 and 1979 the productivity growth rates of the 16 industrialized countries in the Maddison (1982) data set were inversely related to the corresponding productivity levels. He interpreted this finding as favourable to the catch-up hypothesis, which asserts that having a relatively low level of productivity carries a potential for rapid advance in the future, and offered vintage growth models based on embodied technological progress as a simple but sensible explanation of it.³ Namely, if the latest technology is always embodied in new capital equipments, then the productivity growth of the most advanced country, which is supposed to be at the frontier of knowledge, is limited by the rate of technological progress. In less advanced countries, however, where not only the latest vintage is in use, productivity growth is jointly determined by the rate of technological progress and by the technological gap between the latest vintage and the obsolete one. Hence, given that technology is a public good, laggard countries

² A very interesting review about this controversy and about growth economics between 1986 and 1995 is provided by McCallum (1996).

³ About vintage models see e.g. Kónya (1994).

have the potential to grow relatively faster than advanced countries, and the larger their backwardness the brighter their prospects are, granted that they have the capability to employ the most recent technologies.⁴

Another reason why one should not limit the concept of convergence to the neoclassical versus endogenous growth controversy is that the development of countries is a far more complex phenomenon than per capita income or labour productivity growth. For developing nations, once they manage to escape from the strangler grip of famine, other dimensions of human life, like health, education, working conditions, leisure time, environment, and social justice etc. become increasingly important. For them, the promise of catching up with the 'first' world means not only higher income but higher standard of living in its broadest possible sense. This kind of convergence has not been modelled yet in such a neat way as income convergence by the neoclassical growth theory. Nevertheless, it certainly deserves attention. Moreover, in general, we agree with Costantini and Lupi (2005) that applied econometrics has other tasks than merely validating or refuting economic theories.

The Human Development Index (HDI), published since 1990 by the United Nations Development Programme in its annual Human Development Report (HDR), has made possible to study convergence among countries in terms of a more comprehensive measure of development than per capita income. Based on the HDI, recently Mazumdar (2002), Sutcliffe (2004) and Noorbakhsh (2006) tackled this issue, and our paper is a further step in this direction. In particular, our objective is to find out whether there existed an empirically discernable and robust tendency in the world for human development convergence over the last three decades.

Based on the conventional concepts of and tests for σ - and β -convergence, the brief answer to this question, is 'yes'. Our results indicate that, as far as human development is concerned, the world experienced convergence between 1975 and 2004. This process, however, was agonizingly slow. During the same time period, there was also human development convergence among those countries that joined the European Union (EU) before its 2004 enlargement, and all current members of the EU converged to each other too between 1995 and 2004.

The rest of this paper is structured as follows. The methodology to test for convergence is discussed in Section 2, while Section 3 is about the Human Development Index. The three above-mentioned studies, which are the most closely related to our study, are briefly reviewed in Section 4. Our empirical results are reported in Section 5. Finally, the summary is in Section 6.

⁴ About this issue, see Abramovitz and David (1996, pp. 21-23).

2. Methodology

There are several notions of convergence in the literature. Primarily driven by the nature of our data, we consider only the two most frequently applied conventional concepts, called β -convergence and σ -convergence, respectively. The first is concerned with the mobility of different countries within a static distribution of world income, while the second relates to whether the cross-country distribution of world income shrinks over time.

We say that β -convergence occurs when poor countries tend to grow faster than rich ones and hence in a cross-section of countries there is a negative correlation between average growth rate and initial income. In particular, if $y_{i,t}$ denotes GDP per capita of country i in period t , then the annualised GDP per capita growth rate of this country between periods t and $t+T$ is

$$\gamma_{i,t,t+T} = \frac{1}{T} \ln \frac{y_{i,t+T}}{y_{i,t}} = \frac{\ln y_{i,t+T} - \ln y_{i,t}}{T}, \quad T > 0 \quad (1)$$

and if the following regression

$$\gamma_{i,t,t+T} = \alpha + \beta \ln y_{i,t} + \varepsilon_i \quad (2)$$

has a negative slope parameter, then the data exhibits absolute β -convergence (Sala-i-Martin, 1996). This convergence may be unconditional or conditional on some country specific variables. In the latter case regression (2) must be augmented by a set of conditioning independent variables which specify each country's steady state.

Given β , the rate of convergence can be calculated as follows (Evans, 1997). Suppose that an economy is one unit below (above) its balanced-growth path in period t . If there is convergence, i.e. $\beta < 0$, then this economy can be expected to grow $|\beta|$ units per period faster (slower) over the next T periods than the population average of all economies, so by period $t+T$ it is expected to reach a level of $1+\beta T$ units below (above) its balanced-growth path. Hence, if r denotes the constant annual rate at which economies tend to converge toward their parallel balanced-growth paths, then

$$(1+r)^T = 1 + \beta T$$

and

$$r = 1 - (1 + \beta T)^{\frac{1}{T}} \quad (3)$$

As regards the second notion of convergence, σ -convergence occurs in a group of countries if the standard deviation of their log real per capita GDP values tends to decrease over time. That is, if

$$\sigma_{t+T} < \sigma_t \quad (4)$$

where σ_t is the standard deviation of $\ln y_{i,t}$ across i .

These two concepts of convergence are related to each other, since from (1) and (2)

$$\frac{\ln y_{i,t+T} - \ln y_{i,t}}{T} = \alpha + \beta \ln y_{i,t} + \varepsilon_i$$

$$\text{And } \ln y_{i,t+T} = \alpha T + (\beta T + 1) \ln y_{i,t} + T \varepsilon_i \quad (5)$$

that is, σ_{t+T} depends on β .

Considering only two countries, A and B , Sala-i-Martin (1996, p. 1021) illustrated the relationship between β -convergence and σ -convergence with simple time-series plots in the $(\ln y_{i,t}; t)$ coordinate system. If we assume that country A is initially more advanced than country B , and that on the whole both countries experience growth between periods t and $t+T$, then there are two possible scenarios.

First, suppose that country A grows slower than country B , but in period $t+T$ country A is still more advanced than country B . This pattern implies β -convergence since in the $(\ln y_{i,t+T}; \ln y_{i,t})$ coordinate system A would have a larger first coordinate but a smaller second coordinate than B , so the straight line connecting them, i.e. regression (2), would slope downward. Moreover, the deviation between A and B is smaller in $t+T$ than in t , so there is also σ -convergence. Second, suppose that country A grows faster than country B , so the advantage of country A over country B is even bigger in period $t+T$ than in period t . This pattern implies both β -divergence and σ -divergence.

In the above cases, which are probably the most realistic scenarios, β -convergence and σ -convergence coincide, and so they do when overall both countries decline, but in period $t+T$ country A is still more advanced than country B . If, however, country A declines and country B grows, and by period $t+T$ country B becomes more advanced than country A , then there is still β -convergence, just like in the first case, but whether there is σ -convergence too depends on how far country B springs ahead. Hence, in general, β -convergence is a necessary but insufficient condition for σ -convergence.

These notions of convergence were first applied to the labour productivity of 16 industrialized countries in the Maddison (1982) data set by Abramowitz (1986) and Baumol (1986), and their overall conclusion was that the higher a country's productivity level in 1870 the more slowly that level grew in the following century. Nevertheless, the authors themselves were the first to warn against taking their empirical results on face value, for several reasons. Abramowitz (1986) mentioned, for example, that observed labour productivity is determined not only by technology

but also by the richness of the country's natural resources, by the available stock of physical and human capital and by its ability to employ current best-practice technology; that Maddison's sample is biased because all 16 countries in it were advanced in 1979, so they obviously had managed to make use of modern technologies; and that even in this sample convergence is almost entirely a post-World War II phenomenon. Baumol (1986) also mentioned the *ex post* sample selection bias, and that $\ln y_t$ turns up with opposite signs on both sides of regression (2), biasing the results towards a spurious negative relationship. This does not necessarily mean, however, that the negative relationship found in the Maddison (1982) data set is a tautology because regression (2) is equivalent to regression (5) whereby a slope estimate significantly below one implies β -convergence. Moreover, Baumol (1986) re-estimated regression (2) using the Summers and Heston (1984) data set which covers 72 countries over 1950-1980, and found no significant relationship and not even an insignificantly negative relationship.⁵

It is also worth mentioning that regression (2) is unusual in the sense that it specifies average growth rate as a function of the initial level, while in general current level is determined by past growth. Yet, in this particular case regression (2) makes sense since it is based on the assumption that a country's potential to grow in the future mainly depends on its lag behind the leaders.

Dowrick and Nguyen (1989), Barro (1991), Barro and Sala-i-Martin (1992), and Mankiw *et al.* (1992), among others, also ran cross-country regressions of observed growth rates on initial levels without and with conditioning variables for population growth, savings rate, human capital etc. In general, these authors detected convergence in various data sets, but they were criticised by Quah (1993) on the ground that while income convergence across countries should manifest itself in a series of cross-section income distributions that exhibit decreasing variability in time, these cross-country regressions average out the time dimension. Moreover, neither β -convergence nor σ -convergence can grasp all aspects of the development of cross-country income distribution over time and the possible evolution of convergence clubs. Further, Bernard and Durlauf (1995) criticised the cross-section approach because it considers only the two extreme possibilities, when no countries are converging or all countries are converging, ignoring a host of intermediate cases. Instead, Quah (1993) and Bernard and Durlauf (1995) proposed new definitions of convergence and various time-series approaches to convergence, while Islam (1995) endorsed a panel-data method for studying growth convergence. Without questioning the merits of these approaches, we cannot apply them in this paper because while the conventional techniques require HDI data only for the initial and final periods, the time-series and panel-data techniques would necessitate a far more detailed data set, which is not available yet.

⁵ Also, Baumol and Wolff (1988) tested for convergence in sub-samples of the Summers and Heston (1984) data set selected on the basis of the countries' ranking in 1950 and detected convergence among the top 15 countries and also among all non-least-developed countries. These results suggest that convergence is likely conditional.

3. Human Development Index

The Human Development Index has been published each year since 1990 by the United Nations Development Programme in its annual Human Development Report. Its emergence, and that of other composite measures of human development, was motivated by the discontent with income as a single measure of well-being (see e.g. Crafts, 1999).

The HDI strives to grasp three important dimensions of human development: living a long and healthy life, being educated, and having a decent standard of living. Longevity is measured by life expectancy, education by a weighted average of the adult literacy rate and the combined primary, secondary, and college/university enrolment rate (with the adult literacy rate being weighted twice as heavily as the enrolment rate), and income by the log of GDP per capita at purchasing power parity in USD (UNDP, 2006, p. 263).

Each of these raw variables ($X_j, j = 1, 2, 3$) is mapped onto a unit-free index by the following formula:

$$I_{i,j} = \frac{x_{i,j} - \min(x_j)}{\max(x_j) - \min(x_j)} \quad (6)$$

where subscript i refers to country and j to variable, \min and \max are the lowest and highest values the given variable is expected to attain, and HDI is then calculated as a simple average of the three indices (UNDP, 2006, p. 394).

In spite of its advantages over simple income measures, the HDI has attracted criticism for the equal weighting of the three indexes, and for the omission of such important indicators as pollution, human rights, income inequality, unemployment, crime etc. Nevertheless, so far, it has proven to be the most enduring and useful composite index for measuring the complex relationship between income and well-being.

Although the HDI has been published annually since 1990, because of revisions to data and/or changes in methodology, the statistics presented in different editions of the HDR are not directly comparable. For this reason, the HDR Office strongly advises against trend analysis based on data from different editions (UNDP, 2006, p. 275). Instead, it recommends using HDI trends which are based on consistent data and methodology and are currently available at five-year intervals for the period 1975-2004 (UNDP, 2006, pp. 288-291).

4. Previous Studies on Convergence in HDI

To our best knowledge, there are only three papers in the literature which aimed to study convergence by measuring standard of living with the human development index instead of per capita GDP or labour productivity, namely Mazumdar (2002), Sutcliffe (2004) and Noorbakhsh (2006). Since our work is closely related to them, in this section we briefly review these previous studies and highlight the differences between them and our study.

Mazumdar (2002) examined whether the HDI converged across countries over the 1960-1995 period for the full sample of 91 countries, as well as for three groups of countries classified by their levels of human development. The author performed three tests for β -convergence based on the following regressions (Baumol and Wolff, 1988):

$$\ln \frac{y_{i,t+T}}{y_{i,t}} = a_0 + a_1 y_{i,t} + a_2 y_{i,t}^2 + a_3 \ln y_{i,t} + \varepsilon_i \quad (7)$$

$$\ln \frac{y_{i,t+T}}{y_{i,t}} = a_0 + a_1 y_{i,t} + a_2 y_{i,t}^2 + \varepsilon_i \quad (8)$$

and

$$\ln \frac{y_{i,t+T}}{y_{i,t}} = a_0 + a_1 \ln y_{i,t} + \varepsilon_i \quad (9)$$

where $y_{i,t}$ is the HDI of country i in year t . The results indicated divergence for all four cases, suggesting that the economies of the world were becoming more dissimilar over the period 1960-1995 in respect of the HDI.

Our major concern about this study is the data it was based upon. Reportedly, Mazumdar (2002) obtained the HDI values for 1960 and 1995 from the 1998 issue of the Human Development Report. UNDP (1998), however, does not report any HDI data for 1960. In fact, it is mentioned on the HDRs' website⁶ that "Comparable data are not available for many countries for all components of the HDI before 1975, so 1975 is the first year for which the HDI was calculated."

Sutcliffe (2004) focused on the relationship between globalization and world inequality, and only touched on the issue of convergence in human development by studying the HDI trends of 99 countries in 1975, 1980, ..., 1995 and 2001. On the basis of the evolution of descriptive statistics (mean, standard deviation, coefficient of variation) and the following regression

⁶ <http://hdr.undp.org/en/statistics/faq/question,78,en.html>.

$$\ln \frac{y_{i,t+T}}{y_{i,t}} = a_0 + a_1 y_{i,t} + \varepsilon_i \quad (10)$$

where again $y_{i,t}$ is the HDI of country i in year t , the author concluded that the given countries converged to each other. Nevertheless, eventually he rebuffed the whole idea of HDI convergence for two reasons.

First, he argued that developed countries necessarily have their HDIs close to one because in these countries life expectancy has been close to its biological limit, adult literacy and (primary) educational enrolment have been practically hundred percent, and the impact of the only variable without natural upper limit, i.e. per capita income, on measuring the difference between the rich and the poor is strongly restricted by taking the logarithm of per capita income. In our opinion, this is not a reasonable criticism because in the HDI life expectancy and education are measured in relative terms compared to the difference between the potentially ever changing maximum and minimum values. As regards per capita income, the logarithmic transformation certainly brings the values closer to each other, but this is true for the extreme values too.

Second, Sutcliffe (2004) is on the opinion that HDI convergence has been seized on by the IMF, for example, to mitigate the acknowledged downside of the long-run economic history of the world economy. This might be true, but it does not eradicate the fact that, apart from income, health and education are crucial determinants of the quality of life.

Noorbakhsh (2006) used a slightly updated data set on HDI from 1975 to 2002 at intervals of five years up to 2000 and then 2002, and found evidence of weak β -convergence and σ -convergence for different sub-sets of countries and regions of the world. As regards this most recent study, we have three points to make.

First, Noorbakhsh's (2006) basic cross-sectional regression was similar to regression (10), but for each year $y_{i,t}$ denoted the ratio of HDI of country i to the average of HDI for the sample of countries under consideration. This definition of $y_{i,t}$ is not quite novel⁷, but its advantage is unclear. To see this, let's introduce the $y_{i,t} = x_{i,t} / \bar{x}_t$, $x = HDI$ notations, and manipulate Noorbakhsh's regression as follows:

$$\frac{1}{T} \ln \frac{y_{i,t+T}}{y_{i,t}} = \frac{1}{T} \ln \left(\frac{x_{i,t+T}}{\bar{x}_{t+T}} \div \frac{x_{i,t}}{\bar{x}_t} \right) = \alpha + \beta \ln \frac{x_{i,t}}{\bar{x}_t} + \varepsilon_i \quad (11)$$

and

⁷ Dowrick and Nguyen (1989) used a similar variable in their study of income convergence, but instead of the average they used the reference-country-value as a benchmark.

$$\frac{1}{T} \ln \frac{x_{i,t+T}}{x_{i,t}} = \left(\alpha + \frac{1}{T} \ln \frac{\bar{x}_{t+T}}{\bar{x}_t} - \beta \ln \bar{x}_t \right) + \beta \ln x_{i,t} + \varepsilon_i$$

Hence, equation (11) is empirically equivalent to

$$\frac{1}{T} \ln \frac{x_{i,t+T}}{x_{i,t}} = \alpha^* + \beta \ln x_{i,t} + \varepsilon_i \quad , \quad \alpha^* = \alpha + \frac{1}{T} \ln \frac{\bar{x}_{t+T}}{\bar{x}_t} - \beta \ln \bar{x}_t \quad (12)$$

Since the crucial parameter is β , it makes no difference whether we estimate regression (11), which is given in terms of the ratio of HDI in the i th country to the average of HDI, or regression (12), which is given in terms of the level of HDI. Unfortunately, Noorbakhsh (2006) did not offer any explanation for his preference to regression (11).

Second, Noorbakhsh (2006) estimated equation (11) for a sample of 93 medium and low human development countries and justified the exclusion of the high human development countries by the likely existence of convergence clubs wide apart from each other. However, we are not really interested in whether underdeveloped countries are converging to the developing countries, let alone to each other. The really important question is whether they are getting closer to the developed countries. To this end, it is better to consider all countries simultaneously and to augment equation (11) with dummy variables in order to distinguish the low, medium and high human development countries from each other.

Third, apart from absolute convergence, Noorbakhsh (2006) also tested for conditional convergence. He selected six conditioning variables - foreign direct investment, trade, foreign aid, gross domestic investment, the average annual growth rate of public sector expenditure on education and health, all given as a percentage of GDP, and the number of telephone lines per population -, but only trade and gross domestic investment proved to be significant. Since education and health are incorporated in the HDI, this is not a completely surprising outcome. Nevertheless, it is doubtful whether conditional convergence, in general, should interest us at all. What is the point in studying whether countries converge to their steady states if these goal posts are not getting closer to each other, maybe even are diverging from each other?

Finally, it is important to mention that Mazumdar (2002), Sutcliffe (2004) and Noorbakhsh (2006) tested for β -convergence by estimating regressions (7)-(11) and its augmented variants with OLS, without testing and correcting for heteroscedasticity. Given the wide range of countries in their samples, it is quite likely that their OLS results suffer from heteroscedasticity with all its usual negative consequences. Most importantly, the usual t tests for $\hat{\beta}$ can be highly misleading.

5. Empirical Results

Our primary aim is to test for σ - and β -convergence in human development across the world over the last three decades. In order to do so, we analyse the HDI trend values obtained from Table 2 of UNDP (2006, pp. 288-291). This table presents HDI trend values for seven years, 1975, 1980, ..., 2000, 2004, and for 177 countries, but there are only 93 countries for which all seven HDI trend values are available.⁸ For the sake of comparability, we test for σ -convergence over this latter set of countries only, while β -convergence will be tested for a larger group of 101 countries for which at least the 1975 and 2004 HDI trend values are available.

σ -Convergence

In order to study the possibility of σ -convergence in the HDI, we calculated and plotted the sample standard deviation (SD) and coefficient of variation (CV) of the HDI trend values for the seven years in our sample (see *Figure 1*).

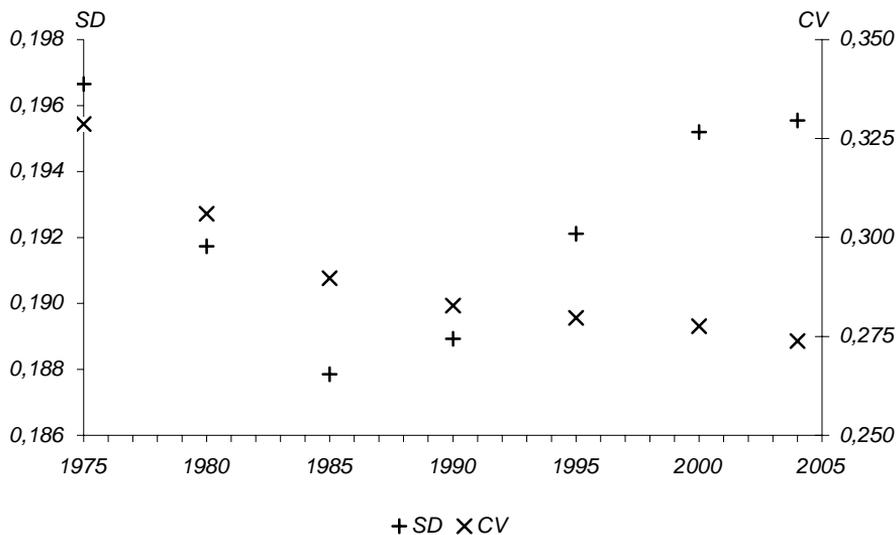


Figure 1: Standard Deviation (SD – Left Axis) and Coefficient of Variation (CV– Right Axis) of the HDI Values of 93 Countries

Although σ -convergence is usually meant to manifest itself in decreasing variability measured by SD , we also consider the development of CV because the mean value of HDI in our sample jumped from 0.598 in 1975 to 0.714 in 2004. Starting with SD , it dropped from its highest value of 0.197 in 1975 to its lowest value of 0.188 in 1985, but after that it increased steadily. On the other hand, CV fell right through the sample period, though a bit faster in the first decade than afterwards. These observations are

⁸ The most notable missing countries are Canada, Germany, Singapore and the former East-European socialist countries with the exception of Hungary.

supported by the simple OLS trend regressions for *SD* and *CV*, respectively, which are reported in *Tables 1-2*.

Table 1: OLS Trend Regression for SD

Dependent Variable: <i>SD</i>				
Method: Least Squares				
Included observations: 7				
	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	0.0847	0.2810	0.3015	0.7752
<i>Year</i>	0.0001	0.0001	0.3838	0.7169
<i>R-squared</i>	0.0286			

Note: *SD* is the standard deviation in the sample of 93 HDI values for seven key years between 1975 and 2004.

Table 2: OLS Trend Regression for CV

Dependent Variable: <i>SD</i>				
Method: Least Squares				
Included observations: 7				
	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	3.6680	0.6703	5.4721	0.0028
<i>Year</i>	-0.0017	0.0003	-5.0377	0.0040
<i>R-squared</i>	0.8354			

Note: *CV* is the coefficient of variation in the sample of 93 HDI values for seven key years between 1975 and 2004.

The linear time trend fitted to the *SD* values has an insignificantly positive slope coefficient and a rather poor fit, while the one fitted to the *CV* values has a significantly negative slope coefficient and a much better fit. Hence, in terms of absolute variability, during the first decade of the sample period the 93 countries in our sample experienced σ -convergence in their HDIs, but the general tendency was exactly the opposite in the next two decades. However, because of the substantial increase of the average HDI between 1975 and 2004, we prefer measuring the variability of HDI with *CV*, which shows a steady decline of relative variability, implying that the 93 countries in our sample were gradually σ -converging to each other.

β -Convergence

In this section we consider all countries for which the 1975 and 2004 HDI trend values are available. The scatter plot of the average HDI growth rates of these 101 countries between 1975 and 2004 against the logarithms of the corresponding initial,

that is 1975, HDI value is displayed in *Figure 2*. It clearly depicts a negative relationship.

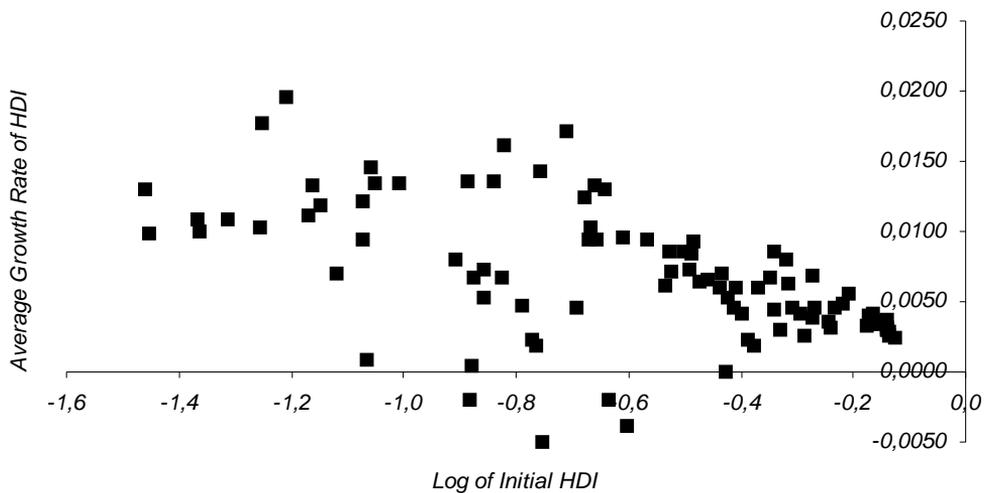


Figure 2: Scatter Plot of Average Growth Rate of HDI (1975-2004) against the Log of Initial HDI (1975)

For the reasons mentioned at the end of Section 4, we have ignored the issue of conditional convergence and, in the light of the earlier studies on convergence in HDI; we have decided to test for absolute β -convergence by estimating the most frequently used specification, regression (2). The OLS results, however, are contaminated by heteroscedasticity⁹, so in *Table 3* and all subsequent tables we report White heteroscedasticity-consistent (HC) standard errors.

The slope estimate (-0.0071) is significantly negative, supporting β -convergence in human development during the 1975-2004 period among the 101 countries in our sample.¹⁰ Given equation (3), from this slope estimate the rate of convergence is about 0.0079.¹¹ It suggests that a laggard country needs a fairly long time, almost nine decades, to make up for half its lag.¹²

⁹ The White heteroscedasticity test with cross terms had a chi-square test statistic of 20.36 ($df = 2$) with 0.0000 p -value, while the Breusch-Pagan-Godfrey test for heteroscedasticity had a chi-square test statistic of 8.61 ($df = 1$) with 0.0034 p -value.

¹⁰ We have also estimated regression (5) and performed t -test with the $\beta^* = \beta T + 1 < 1$ alternative hypothesis. However, apart from the much better fit the results are exactly the same, so we report only the more conventional regression (2).

¹¹ $\hat{r} = 1 - (1 + \hat{\beta}T)^{1/T} = 1 - (1 - 0.0071 \times 29)^{1/29} = 0.0079$

¹² $\hat{T} = \ln 2 / \ln 1.0079 = 88$

Table 3: OLS Regression for β -Convergence

Dependent Variable: <i>AVERAGE</i>				
Method: Least Squares				
Included observations: 101				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	0.0026	0.0004	6.9527	0.0000
<i>Log(HDI75)</i>	-0.0071	0.0009	-8.1289	0.0000
<i>R-squared</i>	0.3217		<i>F-statistic</i>	46.9644
<i>Adj. R-squared</i>	0.3149		<i>Prob (F)</i>	0.0000

Note: *AVERAGE* is the average annual growth rate of HDI between 1975 and 2004, and *HDI75* is the initial HDI value in 1975; both for 101 countries.

Next, in order to see whether low and medium human development countries as groups converge to the group of high human development countries, we augment regression (2) with intercept and slope dummy variables. We rely on the classification of UNDP (2006, p. 275), which defines high human development in 2004 with HDI of 0.800 or above, medium human development with HDI between 0.500 and 0.799, and low human development with HDI of less than 0.500. The results are shown in Table 4.

Table 4: OLS Regression for β -Convergence with Dummy Variables Based on the 2004 HDI Classification

Dependent Variable: <i>AVERAGE</i>				
Method: Least Squares. Included observations: 101				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	0.0012	0.0005	2.5935	0.0110
<i>LOW04</i>	-0.0148	0.0033	-4.4571	0.0000
<i>MED04</i>	-0.0023	0.0013	-1.8364	0.0694
<i>Log(HDI75)</i>	-0.0141	0.0027	-5.1388	0.0000
<i>LOW04 × Log(HDI75)</i>	-0.0052	0.0040	-1.3022	0.1960
<i>MED04 × Log(HDI75)</i>	-0.0010	0.0033	-0.3074	0.7592
<i>R-squared</i>	0.6002		<i>F-statistic</i>	28.5256
<i>Adj. R-squared</i>	0.5792		<i>Prob (F)</i>	0.0000

Note: a) See Table 3. b) *LOW04* and *MED04* are dummy variables for low and medium human development countries in 2004.

Comparing the results in Tables 3 and 4 to each other, the most striking difference is that the slope estimate of the log of HDI in 1975 practically doubled in absolute value. It is strongly significantly negative and implies β -convergence in HDI at a much faster rate ($\hat{r} = 0.0180$), though a laggard country still needs almost forty years to make up

for half its lag. The coefficients of the slope dummy variables, however, are only insignificantly negative at any conventional level. This means that the three straight line segments which represent the relationship between expected average HDI growth rate and initial HDI level for the groups of high, medium and low human development countries in 2004 are parallel and downward sloping, and that at any initial HDI level countries of low human development are likely to enjoy larger (in absolute value) average HDI growth rates than countries of medium human development, which in turn are likely to enjoy larger average HDI growth rates than countries of high human development.

Although this interpretation of the results in Table 4 provide further support for the hypothesis of β -convergence, it can be misleading because it is based on an *ex post* classification of the countries, similarly to the Maddison (1982) sample. For this reason, we re-run the regression using an *ex ante* classification based on the initial HDI values. According to this *ex ante* classification, a country enjoyed high development in 1975 if its HDI was at least 0.673, medium development if its HDI was between 0.420 and 0.673, and low development if its HDI was below 0.420.¹³ The results are in Table 5 below.

Table 5: OLS Regression for β -Convergence with Dummy Variables Based on the 1975 HDI Classification

Dependent Variable: AVERAGE				
Method: Least Squares. Included observations: 101				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0023	0.0007	3.5197	0.0007
LOW75	-0.0052	0.0067	-0.7712	0.4425
MED75	0.0012	0.0027	0.4361	0.6638
Log(HDI75)	-0.0077	0.0037	-2.0704	0.0411
LOW75 \times Log(HDI75)	-0.0039	0.0066	-0.5825	0.5616
MED75 \times Log(HDI75)	0.0018	0.0061	0.2851	0.7762
R-squared	0.3314		F-statistic	9.4194
Adj. R-squared	0.2963		Prob (F)	0.0000

Note: a) See Table 3.b) LOW75 and MED75 are dummy variables for low and medium human development countries in 1975.

Comparing Tables 3-5 to each other, it is evident that the results based on the *ex ante* and *ex post* HDI classifications of the countries are markedly different, but the results ignoring HDI classification (Table 3) and the ones based on the *ex ante* classification (Table 5) are practically the same. This might sound strange first, but in retrospect this outcome is quite logical since the additional dummy variables LOW75 and MED75 have been derived from the original independent variable, HDI75, so they are redundant to a great extent.

¹³ These threshold values were obtained by extrapolating backward the 2004 benchmarks using the observed growth rate of the average HDI level between 1975 and 2004.

To sum up, our results indicate that, as far as HDI is concerned, there was a clear tendency for 'relative' σ -convergence and also β -convergence in the world between 1975 and 2004.

To foster further convergence, more efforts should be devoted to international cooperation, particularly in the fields of education and investment, in order to achieve better standard of well-being for the poorest countries. It is important to take into account the role of education in reducing excessively high average fertility rates in countries with low average years of education, increasing real GDP per capita, improving health expenditure per inhabitant and its other positive effects on social well-being, as seen in Guisan, Aguayo and Exposito(2001), Guisan and Aguayo(2007) and Guisan and Exposito(2006), among other studies. It is also important to point out the importance of favouring investment in industry, tourism, or other sectors which have key impacts on the development of services and real income per capita.

Convergence among EU Countries

The EU, more precisely its forerunner the European Economic Community, was founded in 1958 by Belgium, France, Italy, Luxembourg, the Netherlands and West Germany. Since then the EU had gone through six successive rounds of enlargement, the largest occurring in 2004 when 10 East- and South-European, mainly former socialist countries joined the club, and by the end of 2007 the EU had 27 members.

In this section we test for HDI convergence within the EU. We perform this analysis over two groups of countries and time periods. First, we consider the countries which joined the EU before its 2004 enlargement and then the group of all current or post-2007 EU members. Unfortunately, Germany's HDI trend data are not available for 1975 and 2000 and Slovakia's HDI trend data are missing for 1995 and 2000, so we consider only the other 14 pre-2004 EU members and the remaining 25 post-2007 EU members, and denote these groups as EU14 and EU25, respectively. We test for HDI convergence among the EU14 countries over 1975-2004 and among the EU25 countries over 1995-2004, and compare the results to each other to see whether the enlargement of the EU by the East- and South-European countries is likely to have any impact on this process.

Starting with σ -convergence, *Figure 3* displays the coefficient of variation of the HDI trend values for EU14 and EU25, respectively. Clearly, the EU25 has a considerable larger HDI variability than EU14. More importantly, however, the *CV* of the EU14 HDI trend values almost halved between 1975 and 2004, while that of the EU25 dropped by about 25% from 1995 to 2004.¹⁴ Hence, apart from a small rise of *CV* in

¹⁴ Since the EU25 *CV* sample is rather small, we have fitted a linear time trend only to the seven *CV* values for EU14. The slope estimate is significantly negative practically at any reasonable level and $R^2 = 0.94$.

1995, HDI σ -convergence took place among the EU14 countries during 1975-2004 and also among the EU25 countries during 1995-2004.

Turning to β -convergence, the scatter plots of the average HDI growth rates against the logarithms of the corresponding initial HDI level for the EU14 (1975-2004) and the EU25 (1995-2004) are displayed in *Figures 4-5*, and the corresponding regressions for β -convergence are reported in *Tables 6-7*.

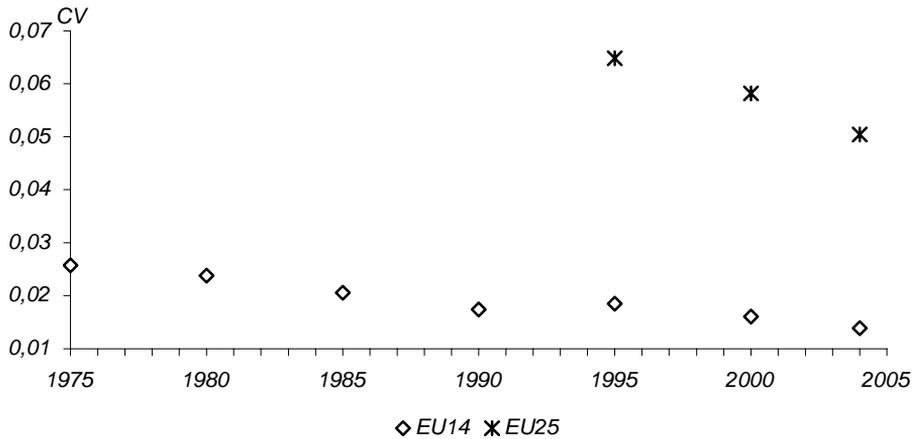


Figure 3: Coefficient of Variation of the HDI Values in EU14 and EU25

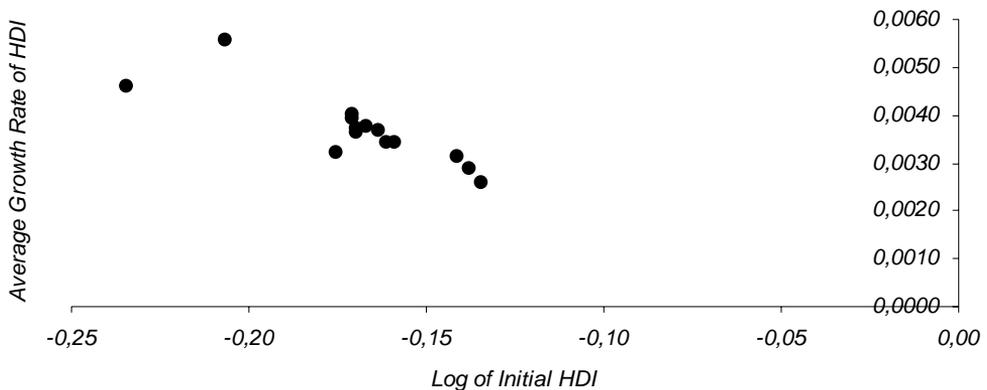


Figure 4: Scatter Plot of Average Growth Rate of HDI (1975-2004) against the Log of Initial HDI (1975) for EU14

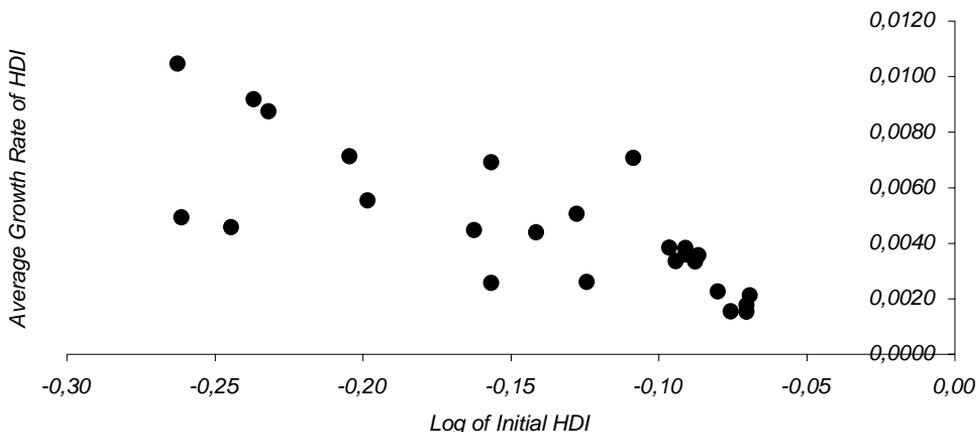


Figure 5: Scatter Plot of Average Growth Rate of HDI (1995-2004) against the Log of Initial HDI (1995) for EU25

Table 6: OLS Regression for β -Convergence

Dependent Variable: <i>AVERAGE</i>				
Method: Least Squares. Included observations: 14				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	-0.0003	0.0011	-0.2952	0.7729
<i>Log(HDI75)</i>	-0.0238	0.0071	-3.3710	0.0056
<i>R-squared</i>	0.7109		<i>F-statistic</i>	29.5023
<i>Adj. R-squared</i>	0.6868		<i>Prob (F)</i>	0.0002

Note: *AVERAGE* is the average annual growth rate of HDI between 1975 and 2004, and *HDI75* is the initial HDI value in 1975; both for EU14.

Table 7: OLS Regression for β -Convergence

Dependent Variable: <i>AVERAGE</i>				
Method: Least Squares. Included observations: 25				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	0.0006	0.0008	0.7800	0.4433
<i>Log(HDI95)</i>	-0.0282	0.0063	-4.4712	0.0002
<i>R-squared</i>	0.5802		<i>F-statistic</i>	31.7853
<i>Adj. R-squared</i>	0.5619		<i>Prob (F)</i>	0.0000

Note: *AVERAGE* is the average annual growth rate of HDI between 1995 and 2004, and *HDI95* is the initial HDI value in 1995; both for EU25.

The correlation is clearly negative between the two variables for both groups of countries and sample periods. In both cases the slope estimate is significantly negative, supporting the hypothesis of β -convergence in HDI within both groups of countries. Although the slope estimates from the two regressions are quite similar (-0.0238 and -0.0282, respectively), due to the different sample periods (1975-2004 and 1995-2004, respectively) the corresponding rates of convergence are slightly different. Namely, from equation (3), $\hat{\tau}$ is 0.0396 for EU14 and 0.0320 for EU25. Nevertheless, there is not much difference between the HDI convergence process among the pre-2004 EU members and among all post-2007 EU countries.

Also notice that the $\hat{\beta}$'s from the previous two regressions are about three times as large (in absolute value) than the one obtained from the sample of 101 countries (-0.0071), so the time required by a laggard country to make up for half its HDI gap compared to other countries in the group is only 18 years for EU14 and 22 years for EU25. This drop from close to 90 years in our original sample is most likely due to the fact that the EU14 and EU25 are relatively homogeneous groups compared to the whole sample of 101 countries.

6. Summary

In this paper we have investigated the possibility of human development convergence in the world between 1975 and 2004 using the Human Development Index trend of the United Nations Development Programme and the conventional concepts of and tests for β - and σ -convergence. Our results indicate that the world had been converging in the sense that relatively backward countries managed to increase their HDI faster on average than more developed countries, though this convergence process was rather slow.

We would like to emphasize the importance of international cooperation and domestic economic and social policies to foster human capital and investment in order to achieve faster convergence and better socio-economic conditions in low income countries in the foreseeable future. Availability of more accurate indicators of the evolution of average number of years of schooling would be highly helpful to analyse the accomplishment of the Millennium Development Goals and development policies in those countries.

We have performed similar analyses on the European Union. In particular, we have tested for HDI convergence from 1975 to 2004 among those countries which joined the EU before the last two rounds of enlargement, and then among all current members over 1995-2004. In both cases we have detected β - and σ -convergence alike and, according to our estimates, convergence was much quicker within these groups of countries than convergence in the world. Moreover, although the 12 East- and South-European countries which joined the EU in 2004 and 2007 are relatively underdeveloped compared to the other 15 EU members, so their admission slowed down the convergence process a bit, the last two rounds of enlargement do not seem to have any major impact on HDI convergence among EU member states.

Finally, we readily acknowledge that the conventional methods we have used to detect cross-country convergence have several shortcomings. They had been criticised in the literature by many and other concepts of and approaches to convergence based on time-series and panel data are nowadays available. However, we could not apply them because of the limitations of the current HDI data set. Nevertheless, as soon as reliable and comparable annual HDI become available, this subject certainly deserves further research.

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