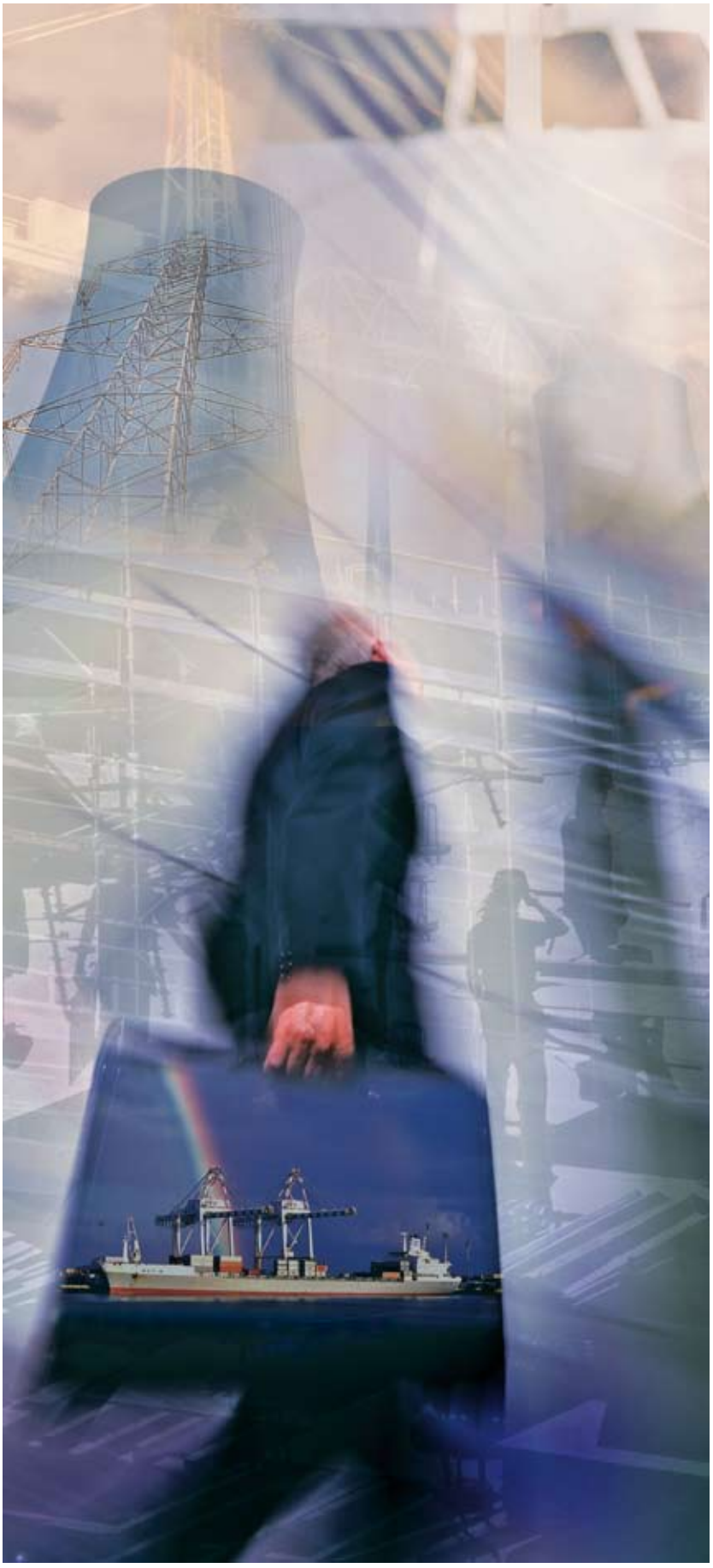

Queensland

The Economic Society of Australia Inc.

Proceedings of the 37th Australian Conference of Economists

Papers delivered at ACE 08

30th September to 4th October 2008

Gold Coast Queensland Australia

ISBN 978-0-9591806-4-0

Welcome

The Economic Society of Australia warmly welcomes you to the Gold Coast, Queensland, Australia for the 37th Australian Conference of Economists.

The Society was formed 83 years ago in 1925. At the time, the Society was opposed to declarations of policy and instead focused on open discussions and encouraging economic debate. Nothing has changed today, with the Society and the conference being at the forefront of encouraging debate.

This year we have a large number of papers dealing with Infrastructure, Central Banking and Trade.

Matters of the greatest global importance invariably boil down to be economic problems. Recent times have seen an explosion of infrastructure spending, after world-wide population growth has seen demand outpace aging supply. The world has become more globalised than at any time since World War I but the benefits of this (and the impact on our climate) has been questioned by some.

At the time of preparing for this conference we could not have known that it would have been held during the largest credit crisis since the Great Depression. The general public and politicians both look to central banks for the answers.

We are also very pleased to see a wide selection of papers ranging from applied economics to welfare economics. An A – Z of economics (well, almost).

Another feature of this conference is that we have gone out of our way to bring together economists from all walks of life, in particular from academia, government and the private sector. We are grateful to all of our sponsors, who are as diverse as the speakers.

The Organising Committee

James Dick
Khorshed Alam (Programme Chair)
Michael Knox
Greg Hall
Allan Layton
Rimu Nelson
Gudrun Meyer-Boehm
Jay Bandaralage
Paula Knight

Published November 2008
© Economic Society of Australia (Queensland) Inc
GPO Box 1170
Brisbane Queensland Australia
ecosocqld@optushome.com.au

Our Gold Sponsors

QIC

Queensland Treasury Corporation

Reserve Bank of Australia

Queensland Government
Department of Infrastructure and Planning

Keynote Sponsors

Australian Government
Productivity Commission

Australian Government
The Treasury

Queensland University of Technology
Faculty of Business
School of Economics and Finance

The University Of Queensland
AUSTRALIA

Goldman Sachs JBWere

The University Of Queensland
AUSTRALIA

NCER National Centre for Econometric Research

Central Council

Special Session Sponsors

Griffith UNIVERSITY

The Higher Education Academy Economics Network

Unless we have specifically been requested to do otherwise, all the papers presented at the conference are published in the proceedings in full. A small number of papers will have versions that have also been made available for special editions of Journals, Economic Analysis and Policy, and the Economic Record. Authors will retain the right to seek additional publication for papers presented at the conference so long as it differs in some meaningful way from those published here.

The opinions expressed in the papers included in the proceedings are those of the author(s) and no responsibility can be accepted by the Economic Society of Australia Inc, Economic Society of Australia (Queensland) Inc, the publisher for any damages resulting from usage or dissemination of this work.

The Paper following forms part of - *Proceedings of the 37th Australian Conference of Economists*
ISBN 978-0-9591806-4-0

Panel Data Evidence of Human Development Convergence from 1975 to 2005

László Kónya

La Trobe University, Department of Economics and Finance

May 2008

Abstract:

This paper studies the possibility of human development convergence in the world from 1975 through 2005. Human development is measured by the Human Development Index (HDI) trend and convergence across countries is tested for by the panel data approach of Ben-David (1993) and bootstrap critical values. Similar analysis is performed on the members of the Organisation for Economic Co-operation and Development (OECD) and on the European Union (EU) countries too. Moreover, it is also tested whether low human development countries had been converging to high human development countries, less rich OECD countries to rich OECD countries, and whether those countries that joined the EU in 2004 and 2007 had been converging to those member states that joined the EU earlier. The results suggest that in each case, the general rise of HDI was accompanied by convergence.

JEL Classification: B23, E13, I31, O47
Key Words: Convergence, Human Development

Acknowledgement:
I started this work in the second half of 2007 during my sabbatical at the University of Santiago de Compostela and at the Central European University, Budapest. I am extremely grateful to both Institutions and highly appreciate the hospitality and help of my hosts, Maria-Carmen Guisan and László Mátyás. The usual disclaimer applies for responsibility.

Correspondence:
Dr László Kónya, Department of Economics and Finance, La Trobe University, Bundoora, VIC 3086, Australia; *l.konya@latrobe.edu.au*.

1. Introduction

Although the notion that poor countries might gradually catch up with rich countries can be traced back in the economic literature to at least as far as the mid 19th century (DeLong, 1988), the real surge of interest in the issue of income convergence across countries stemmed from the emergence of the modern study of economic growth in the mid 1950s and was further enhanced after the late 1980s by the controversy between the neoclassical and endogenous growth theories.

According to the Solow-Swan model (Solow, 1956, 1957; Swan, 1956), if some countries differ at most only in their initial capital per effective labour ratios, then countries with relatively low initial capital-effective labour ratio tend to grow faster than countries with higher capital-effective labour ratio, and poor countries are expected to converge to rich ones. If these countries 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. Accordingly, the empirical growth literature distinguishes absolute convergence from conditional convergence; the former meaning that the per capita incomes of countries tend to converge to each other independently of their initial conditions, while the latter referring to per capita income 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 its labour force growth, technological progress, and capital depreciation, and according to Solow (1957), exogenous technological progress was the single most important factor behind the output per capita growth in the US during the first half of the 20^{th} century. Its contribution to growth was estimated to be close to 88%, implying that the overwhelming majority of economic growth was determined by variables not included in the Solow-Swan model itself.

In response to this shortcoming of the Solow-Swan model, the late 1980s and early 1990s saw the appearance of the first generational endogenous growth models (Romer, 1986, 1990; Lucas, 1988; Rebelo, 1991), which assume that technological change is induced by previous economic conditions and that returns are non-diminishing so that economies can grow without limits and without ever converging to each other.

This contrast between the neoclassical and the early endogenous growth models gave rise to a rich empirical literature, which primarily intended to test the convergence hypothesis in order to settle the debate between the neoclassical and endogenous growth models. Although this question is undoubtedly of great theoretical significance, the possibility of cross-country convergence in per capita income is an important issue on its own right too. Moreover, convergence in the qualitative aspects of human life and standard of living, like health, education, working conditions, leisure time, environment, and social justice etc. become increasingly crucial for developing nations.

Convergence in this wider sense lacks the thorough theoretical support that income convergence enjoys in neoclassical economics, but the methods used to test for income convergence are readily applicable for convergence in human development. Yet, till the early 2000s empirical research in this field was hampered by the lack of internationally comparable data on human development. Since then, however, the publication of reasonably long time series of the Human Development Index (HDI) for a large number of countries by the United Nations Development Programme has made possible to study convergence among countries in terms of a somewhat wider sense of development.

To my best knowledge, four published studies have focused on HDI convergence so far, namely Mazumdar (2002), Sutcliffe (2004), Noorbakhsh (2006), and Kónya and Guisan (2008). Each of them tested for β- and/or σ-convergence in various groups of countries within cross-sectional regression frameworks and, with the exception of Mazumdar (2002), they found evidence of HDI convergence. The current paper belongs to this line of the empirical literature. It aims at testing for convergence in HDI trend between 1975 and 2005 among 144 countries of the world, within the OECD, and within the EU. Moreover, it is also studied whether during this period low human development countries had been converging to high human development countries, less rich OECD countries to rich OECD countries, and whether those countries that joined the EU in its 2004 and 2007 expansions had been converging to those member states that joined the EU earlier.

Unlike the previous studies, this study is based on the panel unit-root test approach of Ben-David (1993). This procedure is neither new nor the most sophisticated of its kind but, given the small time dimension of comparable HDI values, the more recent and powerful panel unit-root tests are impractical this time. Moreover, although the latest edition of the *Human Development Report* publishes seven equidistant HDI trend values for a large number of countries for the first time, the number of observations for any country is still far too small making the application of group specific bootstrap critical values an attractive option.

In spite of the different methodologies, the results of the current study are qualitatively similar to those of Kónya and Guisan (2008). Namely, as far as human development is concerned, the world experienced convergence between 1975 and 2005. There was also human development convergence within the OECD and also within the EU, between the groups of high and low HDI countries, between the rich and less rich OECD countries, and finally between the countries that joined the EU before and in the 2004, 2007 enlargement rounds. The speed of convergence varies greatly across the groups of countries, but in general it is larger than in Kónya and Guisan (2008).

The rest of this paper is structured as follows. Section 2 summarizes the conventional tests for β- and σ-convergence and the panel-data method of Ben-David (1993). Section 3 is about the previous studies on HDI convergence. The empirical analyses are detailed in Section 4. Finally, a summary in Section 5 concludes this paper.

2. Methodology

There are several different concepts of and approaches to test for convergence in the literature. Traditionally the two most frequently applied concepts in cross-sectional analysis are β-convergence and σ-convergence, respectively. The first is concerned with the mobility of different countries within a static distribution of income or human development, while the second relates to whether the cross-country distribution of income or human development shrinks over time.

We say that there is β-convergence over a given time period if poor countries tend to grow faster than rich ones and hence in a cross-section of countries there is a negative correlation between the average growth rate and the initial value of some variable of interest. In particular, denote GDP per capita or HDI of country i in year t as $y_{i,t}$ and its annualised growth rate between periods t and $t+T$ ($T>0$) as

$$\gamma_{i,t,t+T} = \frac{1}{T}\ln\frac{y_{i,t+T}}{y_{i,t}} = \frac{\ln y_{i,t+T} - \ln y_{i,t}}{T} \tag{1}$$

Absolute β-convergence is said to occur (Sala-i-Martin, 1996) if the

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

cross-sectional regression has a negative slope parameter. Convergence may be conditional on steady state, in which case regression (2) must be augmented by a set of conditioning independent variables.

As regards the second notion of convergence, σ-convergence occurs in a group of countries if the standard deviation (or the coefficient of variation) of the variable of interest tends to decrease over time, that is the

$$\sigma_t = \alpha + \beta t + \varepsilon_t \tag{3}$$

regression has a negative slope parameter. These two concepts of convergence are related to each other, and in general β-convergence is a necessary but insufficient condition for σ-convergence (Sala-i-Martin, 1996).

Since the mid 1980s there has been a long list of cross-sectional studies on convergence in income or labour productivity, both without and with some conditioning variables, within different groups of countries and over various time periods, like for example Abramowitz (1986), Baumol (1986), Dowrick and Nguyen (1989), Barro (1991), Barro and Sala-i-Martin (1992), and Mankiw et al. (1992), and most of them rejected the no-convergence null hypothesis.

The cross-country regressions of observed growth rates on initial levels, similar to equation (1), however, were criticised by several authors. Quah (1993), for example, warned that the traditional test for β-convergence is subject to 'regression toward the mean'. Given that (x,z) are normal random variables with μ_z, μ_x expected values, σ_z, σ_x standard deviations, and ρ correlation, the conditional expected value of z is $E(z \mid x) = \mu_z + \rho\sigma_z / \sigma_x (x - \mu_x)$. Therefore,

if $\sigma_z = \sigma_x$ and $|\rho| \neq 1$, then the absolute difference between the conditional and unconditional expected values of z is smaller than the deviation of x from its expected value. Equation (2), however, is equivalent to

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

so if the variance of y does not increase between periods t and $t + T$ ($\sigma_{t+T} \leq \sigma_t$) and y is not perfectly autocorrelated ($|\rho| < 1$), then $\beta T + 1$ is smaller than one, and β is negative. As a result, in regression (2) the t-test on the null hypothesis of $\beta = 0$ (no-convergence) against the alternative of $\beta < 0$ (convergence) is biased in favour of the alternative hypothesis.

In order to avoid this problem, in this paper I do not rely on cross-country regression at all. Instead, I test for convergence in HDI adopting the panel unit-root test approach of Ben-David (1993), which is based on a simple first-order autoregressive model of the deviations from the mean. Formally, for a given group of countries let

$$\ln h_{i,t+1} - \overline{\ln h_{t+1}} = \phi\left(\ln h_{i,t} - \overline{\ln h_t}\right) + \varepsilon_{i,t} \qquad (4)$$

where $\overline{\ln h_t}$ is the sample mean of the log HDI values in year t. Given this model, $\phi < 1$ implies HDI convergence while $\phi > 1$ implies HDI divergence, and the smaller $0 \leq \phi < 1$ is, the faster the convergence process is. In particular, by dropping the error term, model (4) implies

$$\ln h_{i,t+T} - \overline{\ln h_{t+T}} = \phi^T \left(\ln h_{i,t} - \overline{\ln h_t}\right)$$

so assuming that the gap reduces by half in T years, $0.5 = \phi^T$ and the half-life of the convergence process is

$$T = \frac{\ln 0.5}{\ln \phi} \qquad (5)$$

For a given group of countries, model (4) is to be estimated from the panel of HDI data and the test for convergence is essentially a test for a unit root in the deviations ($\phi = 1 \rightarrow$ no convergence) against stationarity ($\phi < 1 \rightarrow$ convergence).[1]

[1] Since the model is defined in terms of the deviations around the sample mean, there is no need to augment model (4) with a constant term. For a formal explanation, see Ben-David (1996, p. 283, fn. 5). Moreover,

$$y_{it} - \overline{y}_t = y_{it} - \frac{1}{n}\sum_{j=1}^{n} y_{jt} = y_{it} - \frac{1}{n} y_{it} - \frac{1}{n}\sum_{j \neq i} y_{jt} = \frac{n-1}{n} y_{it} - \frac{n-1}{n}\frac{1}{n-1}\sum_{j \neq i} y_{jt} = \frac{n-1}{n}(y_{it} - \hat{y}_t)$$

so it does not matter whether the deviations are calculated from the group mean ($\overline{y}$) or from the mean of the other group members ($\hat{y}$).

3. Previous Studies on Convergence in HDI

The Human Development Index has been published each year since 1990 by the United Nations Development Programme in its annual Human Development Report (HDR). The aim of this index is 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 US dollar (UNDP, 2007, p. 356).

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

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

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 calculated as a simple average of the dimension indices.

Although the HDI has attracted many criticism, both for its complexity and simplicity, so far it has proven to be the most enduring and useful composite index for measuring the multifaceted relationship between income and well-being. It is published annually but, due to ongoing data revisions 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 not to perform trend analysis on data from different editions (UNDP, 2007, p. 227). 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 1975-2005 (UNDP, 2007, pp. 229-232).

This paper follows the footsteps of four earlier papers in the literature, Mazumdar (2002), Sutcliffe (2004), Noorbakhsh (2006), and Kónya and Guisan (2008). They all used the HDI to measure standard of living and tested for β- and σ-convergence in different groups of countries over different time periods.[2]

In particular, Mazumdar (2002) tested for β-convergence over 1960-1995 in a sample of 91 countries, and also in three groups of countries classified by their levels of human development, and in each case the results indicated divergence. This study, however, must be taken with some grain of salt because the referred data source, the 1998 issue of the Human Development Report, does not publish HDI data for 1960. In fact, as it is mentioned on the HDRs' website[3], "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."

For Sutcliffe (2004) convergence in HDI was of secondary importance, his interest was primarily in globalization and inequality. Although he rebuffed the whole idea of HDI convergence, he studied the HDI trends of 99 countries in five-year intervals from 1975

[2] The first three studies had been reviewed in Kónya and Guisan (2008).
[3] http://hdr.undp.org/en/statistics/faq/question,78,en.html.

through 1995 and then in 2001, and concluded that the given countries converged to each other.

Noorbakhsh (2006) used HDI trend data from 1975 to 2002 at intervals of five years up to 2000 and then 2002, and found evidence of β- and σ-convergence in a sample of 93 medium and low human development countries. By excluding the high human development countries from the sample, Noorbakhsh's analysis could not shed light on whether underdeveloped countries were getting closer to the developed countries. Apart from absolute convergence, Noorbakhsh also tested for conditional HDI convergence. Conditional HDI convergence, however, is far less appealing than absolute convergence since it is not really comforting to know that countries converge to their steady states if the goal posts themselves are potentially diverging from each other.

Finally, Kónya and Guisan (2008) tested for β- and σ-convergence in HDI trends of 101 countries in 1975, 1980, …, 2000, and 2004. Similar analyses were performed on those countries which joined the EU before the last two rounds of enlargement, and then on all current EU members over 1995-2004. In all three cases there was ample evidence of β- and σ-convergence alike.

4. Empirical Analysis

The data used in this study are from *Table* 2 of UNDP (2007, pp. 234-237), which provides at most seven five-yearly HDI trend values between 1975 and 2005 for 177 countries. For almost half of these countries the samples are incomplete, but in the subsequent tests I consider all countries under consideration for which at least two consecutive HDI trend values are available.

The obvious disadvantage of the approach adapted in this paper is that in a given group all countries are supposed to be characterised by the same autocorrelation coefficient, so either all of them experience convergence or none of them. There are less restrictive panel unit-root tests which allow ϕ in equation (4) to vary across cross-sections[4], but given the limited time dimension of the panel of comparable HDI data, they are unsuitable this time.

I consider three groups of countries: the World, the OECD, and the EU. Further, in each group I distinguish two sub-groups, such as high HDI and low HDI countries of the World, rich (high) OECD countries and other (low) OECD countries, and EU member countries that joined the alliance before 2004 (old) and those countries that joined the EU in 2004 or 2007 (new). Given these (sub-) groups of countries, I intend to answer two questions about HDI convergence. Firstly, has there been convergence to each other within any given (sub-) group? Secondly, have low HDI countries converged to high HDI countries, low OECD countries to high OECD countries, and new EU countries to old EU countries?

As regards the implementation of Ben-David's (1993) approach, there is an important difference between these two questions. Namely, in the first case we are interested in the deviations from the group's own mean, while in the second case we consider the deviations from the mean of a reference group. Consequently, in the second case model (4) is replaced with

[4] See, for example, the tests advocated by Im et al. (2003) and Maddala and Wu (1999).

$$\ln h_{i,t+1} - \widetilde{\ln h_{t+1}} = \alpha + \phi\left(\ln h_{i,t} - \widetilde{\ln h_t}\right) + \varepsilon_{i,t} \qquad (4^*)$$

where $\widetilde{\ln h_t}$ is the sample mean of the year t log HDI values in the reference group.[5]

In analysing income convergence among major trading partners, Ben-David (1996) used model (4) and tested for convergence with augmented Dickey-Fuller tests. In lieu of an intercept and trend, he used t critical values and selected the common lag structure by allowing for maximum four lags and then eliminating them one-by-one when the last lag proved to be insignificant at the 10% level. Because of the intercept term, however, the t critical values are not appropriate for model (4*). Moreover, since there are only at most seven HDI trend values for each country, I experiment with zero and one lags only, and generate bootstrap critical values for each country group and model separately.

The bootstrap procedure consists of the following five steps.[6]

i) Estimate model (4) or (4*), calculate the t-statistic for the no-convergence null hypothesis ($\phi = 1$), and obtain the residuals.
ii) Resample the unrestricted residuals for each country one-by-one.
iii) Generate a bootstrap sample for the deviations under the no-convergence null hypothesis.
iv) Replace the actual deviations with the bootstrap deviations, estimate model (4) or (4*), and calculate the bootstrap t-statistic for the no-convergence null hypothesis.
v) Develop the bootstrap distribution of the t-statistic by repeating steps ii-iv 10,000 times.

The results are reported in *Tables* 1-3.[7] The most important outcome is that for each country group the data indicates convergence to each other or to a more developed group even at the 1 percent level, except for the EU where the within group convergence process is significant at the 2 percent level 'only'. Despite this common feature though, there are large differences in terms of the speed of convergence measured by the estimated half-life, which is also sensitive to the lag structure in about half of the cases.

Table 1 shows the point estimates and standard errors of the ϕ autocorrelation coefficient, the t-statistics for the $\phi = 1$ null hypothesis, the bootstrap critical values, and the estimated half-lives of the convergence processes for 144 countries of the World, for high and low HDI countries, respectively. I consider both the 2005 and the 1975 HDI classifications. As regards the first one, UNDAP (2007, p. 222) defines high human development in 2005 with HDI of 0.800 or above, and low human development with HDI of less than 0.500. As for the second, I consider a country to be of high human development in 1975 if its HDI was at least 0.673, and low development if its HDI was below 0.420.[8] I denote these groups as HHDI05, LHDI05, HHDI75, and LHDI75, respectively.

[5] In the second case the deviations do not necessarily add up to zero, so the constant term might be different from zero.
[6] About bootstrapping unit root tests in general, see Maddala and Kim (1998, §10.4). In terms of their notations, my procedure is based on re-sampling scheme S_2 and test statistic T_2.
[7] All calculations were performed with EViews 6.0.
[8] I adopt the classification used by Kónya and Guisan (2008).

Table 1: HDI Trend Convergence in the World

Group	*Number of*			*Convergence to*	ϕ *estimate (se)*	*t-stat.* (ϕ*=1)*	*Bootstrap critical values*			*Half -life*
	Cntrs.	*Obs.*	*Lag*				*1%*	*5%*	*10%*	
All	144	759	0	*Each other*	0.955 (0.004)	-11.273	-1.523	-0.881	-0.522	15.1
		613	1		0.970 (0.004)	-6.848	-1.454	-0.767	-0.414	22.8
HHDI05	58	313	0	*Each other*	0.883 (0.011)	-10.951	-1.578	-1.006	-0.679	5.6
		254	1		0.926 (0.012)	-6.428	-1.984	-1.360	-1.017	9.0
HHDI75	40	236	0	*Each other*	0.966 (0.010)	-3.579	-1.892	-1.188	-0.802	20.0
		195	1		0.983 (0.009)	-1.796	-1.520	-0.891	-0.542	40.4
LHDI05	19	104	0	*Each other*	0.850 (0.031)	-4.878	-1.614	-1.123	-0.799	4.3
		85	1		0.823 (0.035)	-5.065	-1.257	-0.763	-0.478	3.6
LHDI75	22	128	0	*Each other*	0.947 (0.026)	-2.041	-0.851	-0.348	-0.091	12.7
		106	1		0.931 (0.029)	-2.418	-1.353	-0.749	-0.463	9.7
LHDI05	19	104	0	*HHDI05*	0.852 (0.031)	-4.781	-1.505	-1.039	-0.738	4.3
		85	1		0.833 (0.036)	-4.655	-1.581	-1.066	-0.767	3.8
LHDI75	22	128	0	*HHDI75*	0.942 (0.025)	-2.317	-0.644	-0.198	0.048	11.6
		106	1		0.938 (0.029)	-2.184	-1.532	-0.947	-0.654	10.8

Note: a) *All* – Countries for which at least two consecutive HDI trend values are available;
HHDI05 – High HDI countries in 2005; *HHDI75* – high HDI countries in 1975;
LHDI05 – Low HDI countries in 2005; *LHDI75* – low HDI countries in 1975;
b) ϕ: autocorrelation coefficient in equation (4) or (4*);
Cntrs.: Number of countries;
Obs.: Number of observations;
Lag: Number of lagged first-differences;
se: Standard error;
Half-life: Number of years it takes to half the HDI gap.

There is HDI convergence among the 144 countries of the World and on average it takes about 15 years (with one lag 23 years) to half the gap between the world average HDI and a given country's HDI.[9] The convergence process is much faster among the countries which are classified as high development countries in 2005 (HHDI05). This outcome, however, might be due to the end of period (*ex post*) classification of the countries since convergence is much slower within the HHDI75 group than in the World in general. Similarly, convergence is faster within LHDI05 than within LHDI75, but the difference between the speed of convergence estimates based on the *ex post* and *ex ante* classifications is not as large for the low human development countries as for the high human development countries. Finally, it is interesting to observe that the low human development countries converge to each other at

[9] These half-life estimates are much smaller than the one obtained by Kónya and Guisan (2008), but cross-sectional studies on β-convergence typically estimate rather slow convergence.

about the same rate than to the high development countries, no matter which classification is considered.

Table 2 presents the results for the OECD countries. As one would expect, convergence is much faster within this more homogeneous group than in the World in general. Probably for the same reason, convergence appears to be even faster within the low OECD subgroup (comprising the Czech Republic, Hungary, Poland, Korea Rep., Mexico, and Turkey[10]) and high OECD subgroup, respectively. There is not much difference though, at least not in the models without lag, between the speed of convergence of LOECD countries to each other and to the HOECD countries.

Table 2: HDI Trend Convergence in the OECD

Group	*Number of*			*Convergence to*	ϕ *estimate (se)*	*t-stat.* (ϕ=1)	*Bootstrap critical values*			*Half -life*
	Cntrs.	*Obs.*	*Lag*				*1%*	*5%*	*10%*	
All	29	167	0	*Each other*	0.903 (0.010)	-10.042	-2.251	-1.571	-1.187	6.8
		138	1		0.919 (0.013)	-6.350	-1.231	-0.665	-0.363	8.2
HOECD	23	137	0	*Each other*	0.875 (0.029)	-4.305	-1.838	-1.040	-0.590	5.2
		114	1		0.843 (0.034)	-4.675	-1.578	-0.859	-0.459	4.1
LOECD	6	30	0	*Each other*	0.899 (0.036)	-2.793	-1.658	-1.204	-0.930	6.5
		24	1		0.906 (0.043)	-2.177	-1.522	-1.018	-0.762	7.0
LOECD	6	30	0	*HOECD*	0.895 (0.031)	-3.381	-1.643	-1.236	-0.978	6.2
		24	1		0.933 (0.036)	-1.867	-1.485	-1.027	-0.766	10.0

Note: a) *All* – OECD countries for which at least two consecutive HDI trend values are available;
HOECD – High OECD countries; *LOECD* – Low OECD countries;
b) See Table 1, Note b.

The convergence test results for the EU countries can be seen in *Table* 3. Apparently, HDI convergence is far slower among all current EU members than either among the countries which joined the alliance before 2004 (OEU) or among those countries which joined it in 2004 or 2007 (NEU)[10]. It is even more enlightening to observe that since 1975 the NEU countries have been converging to the OEU countries about twice as fast than to each other. This latter finding suggests that the arrival of the new member countries is unlikely to hinder human development convergence within the enlarged EU.

[10] Due to lack of data, Slovakia is omitted from the analysis.

Table 3: HDI Trend Convergence in the EU

Group	*Number of*			*Convergence to*	ϕ *estimate (se)*	*t-stat.* (ϕ=1)	*Bootstrap critical values*			*Half -life*
	Cntrs.	*Obs.*	*Lag*				*1%*	*5%*	*10%*	
All	26	138	0	*Each other*	0.966 (0.025)	-1.326	-1.448	-0.768	-0.388	20.0
		112	1		0.950 (0.027)	-1.836	-1.991	-1.109	-0.670	13.5
OEU	15	89	0	*Each other*	0.864 (0.036)	-3.743	-2.008	-1.271	-0.854	4.7
		74	1		0.846 (0.044)	-3.481	-1.621	-1.002	-0.620	4.1
NEU	11	49	0	*Each other*	0.923 (0.074)	-1.048	-0.789	-0.222	0.094	8.7
		38	1		0.848 (0.089)	-1.712	-0.956	-0.346	-0.026	4.2
NEU	11	49	0	*OEU*	0.802 (0.096)	-2.061	-1.196	-0.569	-0.252	3.1
		38	1		0.730 (0.117)	-2.309	-1.507	-0.868	-0.527	2.2

Note: a) *All* – EU countries for which at least two consecutive HDI trend values are available;
OEU – Old EU countries (joined to EU before 2004); *NEU* – New EU countries (joined the EU in 2004 or 2007).
b) See Table 1, Note b.

5. Summary

This paper is a follow up to Kónya and Guisan (2008) which studied human development convergence in the world and in the EU between 1975 and 2004 by testing for β- and σ-convergence in the HDI trend and concluded that relatively backward countries managed to increase their HDI relatively faster than more developed countries. Although the cross-sectional approach adopted in that study, and in particular the test for β-convergence has well-known shortcomings, due to the lack of comparable annual HDI data, this was probably the only workable option at the time.

Since then, however, the 2007/2008 edition of the *Human Development Report* has become available. This updated data set does not contain comparable annual HDI data either, but at least provides five-yearly HDI trend values from 1975 to 2005 for 177 countries. In spite of the fact that seven observations are not available for each of these countries, it seemed to me reasonable to experiment with the panel data approach of Ben-David (1993) and perform panel unit-root tests with bootstrap critical values on the deviations of log HDI trend values from the mean log HDI trend.

It was comforting to find that these tests led to similar overall conclusions than the cross-sectional approach in Kónya and Guisan (2008). Namely, between 1975 and 2005 there was HDI convergence in the world, as well as within the OECD and the EU, between the groups of high and low HDI countries, between the rich and less rich OECD countries, and between the countries that joined the EU before and in the 2004, 2007 enlargement rounds. The

estimates of speed of convergence are very much different across the groups of countries, but in general they are much larger than in Kónya and Guisan (2008).

References

Abramowitz, M. (1986): Catching Up, Forging Ahead, and Falling Behind, *Journal of Economic History*, vol. 46, pp. 385-406.

Barro, R.J. (1991): Economic Growth in a Cross Section of Countries, *Quarterly Journal of Economics*, vol. 106, pp. 407-443.

Barro, R.J. and Sala-i-Martin, X. (1992): Convergence, *Journal of Political Economy*, vol.100, pp. 223-251.

Baumol, W.J. (1986): Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show, *American Economic Review*, vol. 76, pp. 1072-1085.

Ben-David, D. (1993): Equalizing Exchange: Trade Liberalization and Income Convergence, *Quarterly Journal of Economics*, vol. 108, pp. 653-679.

Ben-David, D. (1996): Trade and Convergence among Countries, *Journal of International Economics*, vol. 40, pp. 279-298.

DeLong, J.B. (1988): Have Productivity Levels Converged? - Productivity Growth, Convergence, and Welfare in the Very Long Run, *NBER Working Papers*, No. 2419.

Dowrick, S. and Nguyen, D.-T. (1989): OECD Comparative Economic Growth 1950-1985: Catch Up and Convergence, *American Economic Review*, vol. 79, pp. 1010-1030.

Im, K.S., Pesaran, M.H., and Shin, Y. (2003): Testing for Unit Roots in Heterogeneous Panels, *Journal of Econometrics*, vol. 115, pp. 53-74.

Kónya, L. and Guisan, M-C. (2008): What Does the Human Development Index Tell Us about Convergence? *Applied Econometrics and International Development,* vol. 8-1, *forthcoming*.

Lucas, R.E. Jr. (1988): On the Mechanics of Economic Development, *Journal of Monetary Economics*, vol. 22, pp. 3-42.

Maddala, G.S. and I-M. Kim (1998): *Unit Roots, Cointegration, and Structural Change*, Cambridge University Press.

Maddala, G.S. and Wu, S. (1999): A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test, *Oxford Bulletin of Economics and Statistics*, vol. 61, pp. 631-652.

Mankiw, N.G., Romer, D. and Weil, D.N. (1992): A Contribution to the Empirics of Economic Growth, *Quarterly Journal of Economics*, vol. 107, pp. 407-437.

Mazumdar, K. (2002): A Note on Cross-Country Divergence in Standard of Living, *Applied Economics Letters*, vol. 9, pp. 87-90.

Noorbakhsh, F. (2006): International Convergence or Higher Inequality in Human Development? Evidence from 1975 to 2002, *Research Paper*, No. 2006/15, United Nations University, World Institute of Development Economics Research.

Quah, D. (1993): Galton's Fallacy and Tests of the Convergence Hypothesis, *Scandinavian Journal of Economics*, vol. 95, pp. 427-443.

Rebelo, S. (1991): Long Run Policy Analysis and Long Run Growth, *Journal of Political Economy*, vol. 99, pp. 500-521.

Romer, P.M. (1986): Increasing Returns and Long-Run Growth, *Journal of Political Economy*, vol. 94, pp. 1002-1027.

Romer, P.M. (1990): Endogenous Technological Change, *Journal of Political Economy*, vol. 98, pp. S71-102.

Sala-i-Martin, X. (1996): The Classical Approach to Convergence Analysis, *Economic Journal*, vol. 106, pp. 1019-1036.

Solow, R. (1956): A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, vol. 70, pp. 65-94.

Solow, R. (1957): Technical Change and the Aggregate Production Function, *Review of Economics and Statistics*, vol. 39, pp. 312-320.

Sutcliffe, B. (2004): World Inequality and Globalization, *Oxford Review of Economic Policy*, vol. 20, pp. 15-37.

Swan, T.W. (1956): Economic Growth and Capital Accumulation, *Economic Record*, vol. 32, pp. 334-61.

UNDP (2007): *Human Development Report 2007/2008*, Published for the United Nations Development Programme (UNDP) by Palgrave Macmillan, New York.