Measuring Income per capita Disparities across Countries Using a Panel Data Approach

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Abstract

This paper empirically looks at the conditional convergence debate by focussing on the impact of the debt crisis on disparities in income per capita across countries and over time. Using the recent Penn World Table's database, version 6.1 (PWT 6.1), the results seem to suggest that countries have experienced conditional convergence in income per capita, hence poorer countries growing faster than richer ones, controlling for the long-run determinants of growth. The results also suggest that once we control for decade-specific and country-specific factors and the traditional variables that always appear in the augmented Solow growth framework, the regressions generate more plausible and robust results. Moreover, the regression results seem to suggest that there is a conditional convergence across heavily indebted poor countries (HIPCs), which may mean convergence towards a poverty trap rather than a standard steady state.

Key words: *econometric models, debt crisis, income per capita, determinants of growth, convergence*

JEL Classification: B23, C31, C33, E64, O47

Introduction

Although economists have always been interested in investigating whether poor economies remain poor for generations, while their richer counterparts remain richer for years, this desire has been hampered by the absence of long-period time series data that may encompass large number of countries.

In the growth literature, there are several reasons (of which I mention at least two) why the study of convergence has become important (Sala-i-Martin, 1996b, p. 1019):

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First, the empirical evidence for convergence, hence the situation where poor countries are growing faster than rich ones, has been considered as a test for the validity of modern theories of economic growth.

Second, in the mid-1980s, a data set on GDP per capita for a large number of countries was available and this allows growth researchers to compare GDP per capita levels across countries and time.

In general, convergence is said to take place across countries if there is an inverse relationship between GDP per capita and its initial level (Sala-i-Martin and Barro, 1995; Sala-i-Martin, 1996a and 1996b). In other words, convergence occurs in a cross-section of economies, if relatively poor countries grow faster than their relatively richer counterparts do Like wise, Baumol (1994) defines convergence as a tantamount diminishing in the degree of economic inequality among countries. In the convergence debate, there are two concepts: one is the so-called absolute convergence, convergence across countries regardless of their differences in initial conditions.

The second concept is the so-called conditional convergence, hence convergence across countries after controlling for policy and other variables that will keep the steady state constant.[1]

The absence of empirical evidence for absolute convergence gives rise to a different way of looking at the growth debate. In this regard, it appears that the conditional convergence version seems to be the more widely used framework on which most recent empirical researches are based.

The objective of this paper is to empirically test whether the income gap between poor and rich countries of the world has narrowed or rather widened in the past four decades. Particular attention will be given to the position of the heavily indebted poor countries (HIPCs) in the process of convergence (divergence) in the past four decades, with especial emphasis on the last two decades, which capture the periods of debt and financial crises and other spill-over effects of the process of globalisation. For this purpose, I used the conditional convergence hypothesis and a fresh international data set (The Pen World Tables (PWT 6.1)) by A. Heston, R. Summers, and B. Aten covering the period 1960 to 2000.

The remainder of the paper is organised as follows: part two presents the summary of the augmented Solow model and its empirical specification. Part three briefly summarizes the advantages of the panel data approach in measuring convergence of income per capita. Part four presents some of the previous empirical researches in the conditional convergence debate. Part five presents data and samples, and part six presents regression results and the policy implication of this paper.

[1] See, Sala-i- Martin and Barro (1995) for the detailed distinction between the two concepts.

2. The Augmented Solow Model and the Conditional Convergence Debate: *Revisiting Mankiw, Romer and Weil (1992)*

2.1. The Textbook Solow Model

$$Y = K(t)^{\alpha}\left(A(t)L(t)\right)^{1-\alpha} \qquad (1)$$

$$0 \prec \alpha \prec 1$$

Where, *Y, K, A, L,* and α stand for output, capital, the level of technology, labour, and the share of capital in the production function, respectively. The model assumes that both the growth rates of population and technology are exogenously determined. Therefore, the level of technology and labour are expected to grow in the following ways:

$$A(t) = A(0)e^{gt} \qquad (1.1a)$$

$$L(t) = L(0)e^{nt} \qquad (1.1b)$$

$$\ln(A0) = a + \varepsilon \qquad (1.1c)$$

The model also assumes that the number of effective units of labour, $A(t)L(t)$, grows at rate $n + g$.

Now, defining

$$y = \frac{Y}{AL} \quad \text{is output per effective labour}$$

$$k = \frac{K}{AL} \quad \text{is capital per effective labour}$$

The evolution of k is determined by:

$$k^{\bullet}(t) = sy - (n + g + \delta) \qquad (1.1.1)$$

$$= sk(t)^{\alpha} - (n + g + \delta)k(t) \qquad (1.1.2)$$

The steady state value of capital per effective labour

$$k^{*} = \left[\frac{s}{(n + g + \delta)}\right]^{\frac{1}{1-\alpha}} \qquad (1.1.3)$$

Substituting equation (1.15) into the production function and taking logs, they arrived at the steady state income per capita:

$$\ln\left(\frac{Y(t)}{L(t)}\right) = \ln A(0) + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}(n+g+\delta) \quad (1.1.4)$$

$g + \delta$ = assumed as constant across countries,

$A(0)$ = resource endowments, climate, institutions, etc.,

$\ln A(0)$ = $\alpha + \varepsilon$, where α and ε are a constant and country specific shocks respectively.

2.2. The Augmented Solow Model and its Empirical Specification

The augmented Solow model considers a Cobb-Douglas production function, where output (Y) is a function of both physical and human capital.

$$Y = K^{\alpha} H^{\beta} (AL)^{1-\alpha-\beta} \quad (1.2)$$

Defining $h = \frac{H}{AL}$, and leaving y and k as defined above, the production function in intensive form can be written as:

$$y = k^{\alpha} h^{\beta} \quad (1.2')$$

The evolution of k and h, therefore, take the following form:

$$\dot{k} = s_k y - (n+g+\delta)k \quad (1.2a)$$

$$\dot{h} = s_h y - (n+g+\delta)h \quad (1.2b)$$

In the steady state, the levels of physical and human capital per effective labour are constant. Thus, setting (1.2a) and (1.2b) to zero and solving the resulting equation gives the following steady state values:

$$k^* = \left(\frac{(s_k)^{1-\beta}(s_h)^{\beta}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \quad (1.2c)$$

$$h^* = \left(\frac{(s_k)^{\alpha}(s_h)^{1-\alpha}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \quad (1.2d)$$

Substituting (1.2c and 1.2d) into the production function (1.2) and taking logs produces:

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \ln A(0) + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) \quad (1.3)$$

Measuring the Speed of Convergence

Following Mankiw, Romer, and Weil (1992), the Solow model makes quantitative predictions about the speed of convergence to the steady state. Taking y^* as the steady-state level of income per effective worker given by equations (1.2c and 1.2d), and let $y(t)$ be the actual value at time t. Approximating around the steady state, the speed of convergence is given by the following relationship:

$$\frac{\partial \ln(y(t))}{\partial t} = \lambda\left[\ln(y^*) - \ln(y(t))\right] \tag{1.4}$$

$$\lambda = (n + g + \delta)(1 - \alpha - \beta) \tag{1.5}$$

From equation (1.4), they move to a regression. equation that measures the speed of convergence.

$$\ln(y(t)) = (1 - e^{-\lambda t})\ln(y^*) + e^{-\lambda t}\ln(y(0)) \tag{1.6}$$

Subtracting $y(0)$ from both sides

$$\ln(y(t)) - \ln(y(0)) = (1 - e^{-\lambda t})\ln(y^*) - (1 - e^{-\lambda t})\ln(y(0)) \tag{1.7}$$

Substituting for y^*:

$$\begin{aligned}\ln(y(t)) - \ln(y(0)) = {} & (1 - e^{-\lambda t})\frac{\alpha}{1-\alpha-\beta}\ln(s_k) + (1 - e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln(s_h) - \\ & -(1 - e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln(n + g + \delta) - (1 - e^{-\lambda t})\ln(y(0))\end{aligned} \tag{1.8}$$

An empirical counterpart to (1.8) is given as:

$$\ln(y(t)) - \ln(y(0)) = \beta 1 + \varphi.\beta 2\ln(s_k) + \varphi.\beta 3\ln(s_h) - \varphi.\beta 4\ln(n + g + \delta) - \varphi.\ln(y(0)) \tag{1.11}$$

Where $\varphi = 1 - e^{-\lambda t}$

$$\left(\ln(y(t)) - \ln(y(0)) = \beta 1 + \gamma 1\ln(s_k\right) + \gamma 2\ln(s_n) + \gamma 3\ln(g + n + \delta) + \gamma 4\ln(y(0)) + \varepsilon \tag{1.12}$$

Where $\beta 1 = \ln\left[A(0)\right] * \varphi$

3. The Advantage of a Panel Data Approach in Measuring Convergence

It has become almost a tradition to use a cross-country framework to discuss the factors that account for growth-rate differences across countries. Though this strategy has produced quite useful initial results, it suffers from several drawbacks, which may distort the outcomes of any empirical analysis. Studies identify at least three problems for a single cross-section regression (Islam, 1995; Hoeffler, 2000; Pattillo, et al. 2001):

The first problem is linked to the so-called omitted variable bias. The single cross-country regression assumes that countries have identical production function, hence this strategy does not allow for heterogeneity, for example, in the initial level of technology across countries. Following Islam (1995, p. 1128), the country-specific aspect of the production function that is ignored could, however, be correlated with some of the covariates and this may lead to omitted variable bias. The second problem, as Hoeffler, (2000) argues, is that limiting the time series to a single cross-section regression would mean that not all available information is utilised. The third problem is linked to a single cross-section regression is the problem of reverse causality (endogeneity), where one or more of the explanatory variables may happen to be correlated with each other.

In this respect, the panel data approach is thought to be a remedy. Following Islam (1995), the panel data approach is a compromise that solves the conflict between endogenous growth theorists and neoclassical growth economists who advocate the Solow-Cass-Koopmans model. In this constant conflict regarding the determinants of long-run growth, while the empirical finding of convergence has been associated with the Solow-Cass-Koopmans model, its absence has been interpreted as a proof for the validity of the endogenous growth model. This ongoing controversy gave rise to the concept of a conditional convergence. The panel data approach allows for differences in the production function in the form of unobservable individual „country effects“, which, to a great extent, helps to minimize the omitted variable bias that would otherwise generate distorted results.[2] Furthermore, one of the advantages of a panel data approach is that it allows to control for time-specific effects as the worldwide conditions for growth may not be equally advantageous for all countries over time (Chowdhury, 2001, p. 6).[3] In addition, a panel data approach allows one to increase the number of observations and by doing so increases the degrees of freedom, which may generate results that are more plausible.

There is, however, an ongoing debate about whether it is the random effects model or the fixed effects one that is more appropriate to employ in international growth comparison. Some argue that a random effects model may be more

[2] For a broad discussion of the panel data approach, see Greene (2000), Tsangarides (2000), Islam (1995), Hoeffler (2001); Caselli, et al. (1996), among others.

[3] A similar argument has been advanced by Pattillo et al. (2001), who pointed out that the time series dimension of the data is important, as an understanding of how debt affects economic growth over time (the within country variability of panel data) is at least as important as understanding how countries with different levels of debt experienced different growth patterns (the between-country variability of panel data).

advantageous relative to a fixed effects one on the grounds that the fixed effects model destroys all variations across countries once country-specific effects are incorporated (Quah, 1996). Similarly, Elbadawi, et al. (1997) argue that one advantage of a random effects model is that it enables one to estimate variables that are constant over time, and hence no information is lost. In other words, the random effects model captures all the information on all the individual units and all the variables, even those that do not vary over time (p. 56).

3.2. A Formal Specification of the Empirical Model

The fixed effects model may be expressed as follows (see, Greene, 2003, among others):

$$Y_{i,t} = \chi'_{i,t}\,\underline{\beta} + \mu_{i,t} \tag{2}$$

$$= \chi'_{i,t}\,\underline{\beta} + \alpha_i + \varepsilon_{i.t} \tag{2a}$$

$$= \alpha_i + \chi'_{i,t}\,\underline{\beta} + \varepsilon_{i.t} \tag{2b}$$

Where

individuals: $i = 1,\dots, n,$

time $t = 1,\dots, T,$ and

$\chi'_{it} = (\chi_{it1}\ \chi_{it2} \dots \chi_{itk})$

- i – indicates that a variable may vary over individuals,
- t – indicates that it may vary over time,
- Y_{it} – endogenous variable of individual i in period t,
- χ'_{it} – is a vector of K regressors of individual i in time period t,
- μ_{it} – is the error term of individual i in time period t and is made up by two terms: a random component that varies over individuals and time (ε_{it}), which is *iid* (identically and independently distributed) and unknown individual-specific constant referred to as fixed effect (α_i), which does not change over time,
- $\underline{\beta}$ – is the unknown parameter vector of the regressors.

Assumptions about the error terms and the fixed effects

$$E(\varepsilon_{i,t}) = 0$$

$$V(\varepsilon_{i,t}) = \sigma^2$$

$$Cov(\varepsilon_{i,t}, \varepsilon_{j,t}) = 0$$

$$Cov\left(\varepsilon_{i,t}, \varepsilon_{i,s}\right) = 0$$

$$Cov\left(\varepsilon_{i,t}, \underline{\chi}_{i,t}\right) = 0$$

Though there are seeds of truth in the previous analyses, there are some caveats that need to be addressed to check the robustness of the results and the subsequent conclusion. The first shortcoming of the previously discussed analyses is linked to selection biasedness where countries are apriori chosen and put into groups based on similarities in their economic, political and institutional parameters. The second caveat has something to do with the empirical strategy that is employed in the convergence debate, which is based on either a cross-section analysis, which does not allow to control for country-specific events or time--specific factors that may affect countries' growth performance and the subsequent rate of convergence.[4]

To find a modest remedy to this issue, I have run several regressions, which include the following:

The first attempt is to check conditional convergence in the spirit of the augmented Solow model during the period 1960 – 2000, the longest period for which data is available for the larger number of countries.

Second, like in other similar studies, instead of apriori classifying countries into groups, I incorporated initial life expectancy and education, alternatively, and investment to GDP ratio to control both for human and physical capital accumulations and for initial GDP per capita to capture the conditional convergence effect.

Third, in the context of the above point, to check how the growth rate of economies behaved during different decades, I decomposed the entire period into decade averages. This has been done for the entire sample, developing countries, and for HIPCs alone. The reason is that factors that affect developing countries growth performance might differ from those that affect developed ones.

Fourth, switching to a panel data approach, I run both pooled cross-section time series and random and fixed effects models. The main reason is that endogeneity and omitted variable problems cannot be solved in the cross-section framework. The fixed effects model allows researchers on growth to control for time--specific factors (decade-specific factors in this case) and country-specific factors that are peculiar to the sample countries. Moreover, since the HIPCs dummy has always been negative and significant in the cross-section approach, the model did not explain the factors that account for HIPCs poor growth performance.

[4] Islam (1995), Hoeffler (2000), among others, have broadly discussed such issues.

As one of the reasons for this to happen may be linked to the missing variables that may determine the growth rate of this group but are not included, the fixed effects model is used to take care of this problem.

4. A Summary of Some Previous Empirical Studies

Despite the disputes among economists, there is a bulk of empirical evidence on conditional convergence across countries once the variables that affect the steady state are controlled for Barro (1991) is one of the first in this regard, where using data for 98 countries in the period 1960 – 1985, he shows that initial capital is negatively correlated with the growth rate of GDP per capita, controlling for both human and physical capital accumulation, and other policy variables. Human capital is believed to play a key role in achieving accelerated economic growth from various fronts (Barro, 1991, p. 409).[5]

Mankiw, Romer and Weil (1992) tested the absolute convergence hypothesis using a sample of 98 non-oil exporting countries, 75 intermediated countries and 22 OECD countries in the period 1960 – 1985. Their results indicate that the log of GDP per working-age population is positively correlated with the investment and negatively with population growth. Next, adding human capital accumulation to their model, while population continues to have a negative impact on GDP per working-age person in 1985, education and investment are positively correlated with GDP.

Here it is important to note two points: First, after controlling for education, the impact of investment is now in line with the predictions. Second, once education is incorporated into the regression, the explanation power of the model has jumped from 59 % to 78 % for non-oil exporting countries. The jump in the R^2 is quite high for the other groups as well. Turning to the log difference in GDP per

[5] Following Romer (1980, in Barro, 1991), it is a fundamental input into the research sector, which is indispensable for technological progress. The empirical evidence also seems to suggest that countries with higher stock of human capital have a greater tendency to grow faster. As argued by Nelson and Phelps (in Barro, 1991, p. 409), a larger stock of human capital also makes it easier for nations to imitate new ideas developed elsewhere. This gives the country that is a follower an enormous advantage to catch up relatively quickly towards those that are advanced. However, it appears that it is not only total education that matters for log-run economic growth. The quantity-quality trade offs and the distribution of education among men and women are issues that are on the agenda in recent empirical studies on economic growth and development. It seems that high total education if accompanied by gender inequality may not be extremely helpful for long-run economic growth. Klasen (2002) empirically shows that lower gender inequality may enhance economic growth through its direct externality effects (by feeding the economy with more educated labour force), and through its indirect externality effects, operating through demographic effects, lower gender inequality means higher education for women increasing the opportunity cost of women not to work and this leads to lower rate of fertility, which ultimately downsizes the population growth rate and increases capital deepening and growth, among other things.

working-age (1960 – 1985) as a dependent variable, while they find an evidence for unconditional convergence across OECD, the remaining groups have not demonstrated unconditional convergence. Finally, turning to the augmented Solow framework, where schooling (a proxy for human capital accumulation) was added, all groups have demonstrated conditional convergence and the overall explanatory power of the model has improved substantially. Tsangarides (2000) using a sample of 22 OECD and 42 African countries in the period 1960 – 1990, indicates that while there was an empirical evidence for unconditional convergence across OECD countries, he finds unconditional convergence for Africa only in the fixed effects model.[6]

5. Data Description, Results and Discussion

Table 2 presents definitions of variables in the regressions and their sources. Tables (3 – 6) present cross-section regression for each decade during 1960 – 2000. Table (7) presents the results for random and fixed effects models, respectively for the entire sample of observations. Table (8) presents regression results for pooled time series and random and fixed effects, respectively, for HIPCs alone in the period (1960 – 2000) with decade dummies.

Table (1)

Economic Growth, Capital Accumulation, and Population Growth (1960 – 2000)

	Heavily indebted poor countries[6]				Non-Heavily Indebted countries			
Variables	1960 – – 1969	1970 – – 1979	1980 – – 1989	1990 – – 2000	1960 – – 1969	1970 – – 1979	1980 – – 1989	1990 – – 2000
GDPG[1]	1.5	0.56	–0.75	–0.45	3.08	3.02	1.42	2.13
Log (INV)[2]	2	2.3	2.54	2.73	2.17	2.77	3.2	3.13
Log (SCHL)[3]	0.38	0.46	0.57	0.81	0.75	0.92	1.27	1.38
Log (LIFE)[4]	3.56	3.65	3.73	3.77	3.68	3.76	3.83	4.03
Log (POPG)[5]	2.5	2.65	2.74	2.66	2.34	2.09	2.1	1.82

[1] The growth rate of log of real GDP per capita.
[2] The log of average investment to GDP ratio.
[3] The log of education (initial period value for each decade).
[4] The log of total life expectancy at birth (the initial period of each decade).
[5] The log of the growth rate of the population +0.05.
[6] Heavily indebted countries are those with total external debt to exports of 150 percent or more (in NPV terms).

Source: Own calculations based data from the PWT 6.1, and the World Development Indicators, 2001 CD-ROM.

[6] Hoeffler (2000) using the augmented Solow growth framework and taking a sample of 85 countries (in most cases) during the period from 1960 – 1989, with the panel data of four-year non--overlapping averages indicates several problems linked to both the OLS approach and the African dummy. Hoeffler (2000) concludes that using the first difference GMM model is appropriate for in international growth comparison.

Table 1 below shows the differences in growth, investment, schooling, life expectancy, and the growth rate of the population between HIPCs and non--HIPCs. The differences are strikingly significant: The growth rate for HIPCs in the 1960s was about 1.5 % compared to around 3 % for non-HIPCs counterparts. During this decade, HIPCs had quite comparable figures in all the indicators in Table 1. Although the growth rate failed to 0.56 % in the 1970s, it seems that the worst was about to come. In fact, HIPCs, on average, had negative growth rates throughout the 1980s and 1990s. What is even more puzzling is that the deterioration in growth occurred despite improvements in investment ratios, which puts both the quality of the data and investment under serious suspicion.

Table 2

Definitions of Variables and Sources

Variables	Definitions	Sources
GDPG	Growth rate of the logarithm of GDP per capita (PPP-adjusted)	The Penn World Tables (6.1)
LGDP	The logarithm of GDP per capita (PPP-adjusted) (initial period value)	The Penn World Tables (6.1)
INV	The logarithm of the average level of investment to GDP ratio	The Penn World Table (PWT, 6.1)
LLIFE	The logarithm of the index of life expectancy (initial period value)	The World Development Indicators, 2001, The World Bank
LSCHOOL	Percentage of the total population aged 15 and above who have at least some secondary school education (which is the sum of „secondary school attained, secondary school complete, higher school attained, and higher school complete“)	Barro-Lee education data set (2000)
Ln $(n + g + \delta)$	The average growth rate of the population and the rate of depreciation	The World Development Indicators, 2001, The World Bank

Now, turning to the results themselves, in regressions (3 – 6), while the average investment to GDP ratio and initial education and initial life expectancy at birth, boost income per capita growth; in contrast, the average growth rate of population, in most cases, punishes it. The initial GDP per capita is inversely correlated with that of the growth of GDP per capita, an indication of conditional convergence, holding investment, education (life expectancy) and population growth rate constant. The results here are generally consistent with the findings of most previous empirical studies.

My attempt in the framework of a cross-section regression was to figure out the extent to which heavily indebted poor countries' (HIPCs) growth performance had been deviating from the other group of countries in the sample. In the first decade (1960 – 1969, see Table 3), the HIPCs dummy was negative and significant perhaps indicating that this group of countries had a relatively poorer growth performance during the decade while there was a widespread growth across the world.

Table 3

Dependent Variable is Growth Rate of Log of Real GDP per capita (1960 – 1969)

Variable	1	2	3	4
CONSTANT	3.489 (1.32)	4.971^{*} (1.84)	-6.534^{*} (–1.71)	–4.884 (–1.14)
LGDP60	–0.429 (–1.18)	–0.569 (–1.56)	-0.647^{*} (–1.91)	-0.670^{**} (–1.97)
LINV6069	1.084^{***} (5.0)	0.994^{***} (4.56)	0.927^{***} (3.9)	0.903^{***} (3.77)
LSCHL60	0.332 (1.37)	0.336 (1.42)		
LLIFE60			3.219^{**} (2.39)	2.894^{**} (2.06)
Log $(n+g+\delta)$	-0.537^{***} (–2.57)	-0.515^{**} (–2.50)	-0.393^{*} (–1.84)	-0.398^{*} (–1.86)
HIPCs		-1.001^{*} (–1.97)		–0.433 (–0.85)
No. of Observation	88	88	107	107
Implied β	0.004	0.006	0.006	0.007
R^2	0.37	0.40	0.33	0.34

For all regression results, the asterisks *, **, and *** indicate significance levels at 10 %, 5 % and 1 %, respectively.

Table 4

Dependent Variable is Growth Rate of Log of Real GDP per capita (1970 – 1979)

Variable	1	2	3	4
CONSTANT	4.725 (1.35)	8.105^{**} (2.34)	-20.018^{***} (–3.57)	-16.261^{***} (–2.72)
LGDP70	-1.301^{***} (–2.77)	-1.55^{***} (–3.44)	-1.374^{***} (–3.89)	-1.414^{***} (–4.03)
LINV7079	1.901^{***} (5.42)	1.623^{***} (4.74)	1.555^{***} (4.67)	1.448^{***} (4.31)
LSCHL70	0.824^{**} (2.46)	0.792^{**} (2.5)		
LLIFE70			6.918^{***} (3.93)	6.192^{***} (3.45)
Log $(n+g+\delta)$	0.053 (0.17)	0.038 (0.13)	0.392^{*} (1.73)	0.414^{*} (1.84)
HIPCs		–2.144 (0.13)		-0.998^{*} (–1.68)
No. of Observation	88	88	105	105
Implied β	0.013	0.016	0.015	0.015
R^2	0.33	0.41	0.44	0.46

Table 5

Dependent Variable is Growth Rate of Log of Real GDP per capita (1980 – 1989)

Variable	1	2	3	4
CONSTANT	4.339 (1.52)	6.625** (2.14)	–0.871 (–0.14)	3.522 (0.53)
LGDP80	–0.972** (–2.51)	–1.097*** (–2.82)	–0.980*** (–3.23)	–1.128*** (–3.66)
LINV8089	1.956*** (4.65)	1.705*** (3.88)	1.958*** (4.57)	1.735*** (3.97)
LSCHL80	0.175 (0.56)	0.107 (0.35)		
LLIFE80			1.44 (0.77)	0.915 (0.49)
Log $(n+g+\delta)$	–0.843*** (–3.01)	–0.863*** (–3.11)	–0.857*** (–3.38)	–0.90*** (–3.58)
HIPCs		–1.149* (–1.78)		–1.218** (–2.03)
No. of Observation	95	95	108	108
Implied β	0.010	0.011	0.010	0.012
R^2	0.30	0.32	0.37	0.40

Table 6

Dependent Variable is Growth Rate of Log of Real GDP per capita (1990 – 2000)

Variable	1	2	3	4
CONSTANT	4.706 (1.58)	8.587*** (2.84)	–13.762* (–1.8)	–4.593 (–0.57)
LGDP90	–0.908** (–2.23)	–1.131*** (–2.9)	–0.980*** (–2.69)	–1.061*** (–3.0)
LINV902000	1.273*** (3.12)	0.987** (2.51)	1.215*** (2.87)	0.973** (2.32)
LSCHL90	0.683* (1.88)	0.448 (1.28)		
LLIFE90			5.071 (2.26)	3.285 (1.45)
Log $(n+g+\delta)$	–0.876 (–2.57)	–0.794** (–2.46)	–0.547* (–1.71)	–0.531* (–1.71)
HIPCs		–2.304*** (–3.48)		–1.897*** (–2.78)
No. of Observation	97	97	110	110
Implied β	0.009	0.012	0.010	0.011
R^2	0.24	0.33	0.23	0.29

Moving to the 1970s and 1980s (Tables 4 and 5), now HIPCs' dummy became negative and relatively significant. In the 1990s, the coefficient for this dummy was the highest in all the preceding decades and highly statistically significant, reflecting among other things, the impact of the debt crisis to this group during this decade. To capture the turbulence period of the 1980s and 1990s, I ran the (1980 – 2000) log of GDP per capita growth against the 1980 log of real

GDP per capita, controlling for investment and education. The results indicate that this period was in particular unfavourable to this group of countries. The coefficient on the initial log of GDP per capita is also the lowest among all the other regressions (the results are not reported here).

HIPCs' dummy did not change substantially even when I run separate regressions for developing countries alone.[7] In the first decade (1960 – 1969), for instance, HIPCs did not deviate too much from the rest of the developing world. While the 1970s and 1980s were quite unfavourable for this group, the 1990s seem to be even worse for HIPCs as a whole, where there is an indication of a dramatic lag in terms of economic growth. The longest period regression (1960 – – 2000) also indicates that this group of countries, on average, has the lowest economic growth relative to the rest of the world during the entire past 40 years.

Switching to the panel data analysis, the first attempt was to run a cross-section pooled time series regression for all observations. The result now indicates that while all the variables remain as in the previously discussed cross-section regressions, HIPCs continues to have experienced a more sluggish economic growth as opposed to the rest of the countries under investigation in this study. It is also interesting to note the coefficients on the decade dummies included to capture decade-specific factors that may hinder economic growth. The results seem to suggest that while the 1960s is the most favourable decade, followed by the 1970s, the remaining two decades, the 1980s and 1990s were very poor ones for growth performance. It is also equally important to note that the whole explanatory power of the regression has now increased after the inclusion of the HIPCs' and decade dummies relative to the simple cross-section regression that was discussed earlier. The R^2 in every regression where HIPCs dummy is included is higher than when it has been dropped. The results have not been reported for space economizing reasons.

Similarly, staying further in the spirit of the panel data approach, while the random effects model generates almost similar results as that of the cross-section pooled time series regression, the fixed effects model results confirm that the 1980s were harsh for HIPCs (see Table 7).[8]

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[7] The results have not been reported for space economising reasons.

[8] The theoretical justification for using a fixed effects model to study the convergence hypothesis is linked to several explanations. First, it is not possible to control for all variations across countries in the cross-section framework, which gives rise to the omitted variable problem, among other things. Secondly, since the HIPCs dummy has always carried a negative coefficient, this may imply the failure of the augmented model to explain the factors that account for the growth-rate differences of this group. This may be due to missing important factors that affect the growth rate of this group, but are not included in the regression. Thirdly, endogeneity problem (the possibility that some of the covariates may be correlated to each other and leads to biased estimators). The fixed effects model should help to control for country-specific factors that affect the determinants of long-run growth.

Table 7

Regression Results for Panel Data (1960 – 2000) Random Effects Model Fixed Effects Model

Variable	1	2	3	4	5	6	7	8
Const.	6.372*** (3.64)	9.329*** (5.32)	8.065*** (4.74)	–5.301 (–1.61)	19.03*** (6.28)	19.03*** (6.28)	16.701*** (4.56)	9.487 (1.17)
LGDPI	–1.246*** (–5.34)	–1.427*** (–6.36)	–1.337*** (–6.21)	–1.063*** (–6.12)	–2.662*** (–7.57)	–2.662*** (–7.57)	–2.416*** (–6.00)	–1.738*** (–5.69)
LINV	2.089*** (10.31)	1.743*** (8.68)	1.542*** (7.58)	1.492*** (7.71)	1.537*** (5.09)	1.537*** (5.09)	1.701*** (5.56)	1.906*** (6.4)
LSCHL	0.226 (1.38)	0.209 (1.34)	0.487*** (2.99)		0.187 (0.97)	0.187 (0.97)	0.232 (0.99)	
LLIFE				2.935*** (3.17)				0.279 (0.16)
Log $(n+g+\delta)$	–0.563*** (–3.31)	–0.547*** (–3.45)	–0.551*** (–3.62)	–0.236* (–1.84)	–0.226 (–0.87)	–0.226 (–0.87)	–0.22 (–0.84)	–0.046 (–0.25)
HIPCs		–2.053*** (–5.17)	–1.717*** (–4.44)	–1.123*** (–3.34)				
Dummy for 1960s			1.068*** (3.54)	1.397*** (4.42)			–0.062 (–0.14)	0.386 (0.79)
Dummy for 1970s			0.521* (1.8)	0.504* (1.69)			–0.203 (–0.57)	–0.159 (–0.43)
Dummy for 1980s			–0.666*** (–4.44)	–0.593** (–2.16)			–0.956*** (–3.57)	–0.903*** (–3.12)
No. of obser.	372	372	372	430	372	372	372	430
Implied β	0.017	0.021	0.019	0.013				
R^2	0.20	0.23	0.30	0.29	0.29	0.29	0.33	0.31
Prob(Chi2)	0.000	0.000	0.055	0.031				

Nevertheless, the fact that the HIPCs dummy was always significant and negative does indicate the problem of the augmented Solow model in explaining why some countries remain poor while others remain rich. Other empirical researchers have often encountered similar problems in empirical studies based on cross-section or panel of a large sample of countries. As Hoeffler (2000, p. 32) puts it, „the coefficient on the Africa dummy is significant and negative. This confirms the commonly found result in the literature when unobserved country specific effects and endogeneity are not accounted for, i. e., the Solow growth model appears to be unable to account for the growth experience of African economies“.[9]

My final attempt was to run a separate cross-section pooled time series and random and fixed effects models for HIPCs alone. The objective here is to empirically explore the extent to which the growth rate of these economies were converging towards themselves or rather diverging from each other. The results for cross-section pooled time series regressions have not been reported.[10] The first

[9] See, Englebert (2000) for the discussion of the „mystery“ of the African dummy.

[10] Since data on education for those HIPCs that are included in the regression is missing, cross-section analysis was unlikely, though it may have been helpful.

attempt was to check if there is an empirical evidence for absolute convergence. The results indicate that there is, in fact, a per capita income convergence across these countries, controlling for investment and population growth rate. This may seem to suggest that these countries have all moved towards poor growth path, which may be in line with what Quah called „polarization" in his „twin peaks" analysis. Then, moving to the conditional convergence hypothesis, I added the log of initial life expectancy index, now the coefficient on the initial GDP per capita decreases and the explanatory power of the model improves, though very marginally. The last attempt was to control for decade dummies as the global macroeconomic fluctuations during different decades did not benefit or hurt all developing countries equally. This time, while the coefficient on log of initial per capita income increases, the life expectancy index, which was negative previously, now turned into positive, though remain insignificant.[11] The signs on decade dummies are as one would expect: While HIPCs on average enjoyed economic growth during the 1960s (also called the „Golden age"), and, to a great extent, also in the 1970s, things dramatically changed for worse in the 1980s and 1990s.

Table 8

Regression Results Using a Panel Data (1960 – 2000) Decade Averages-HIPCs alone Random Effects Model Fixed Effects Model

Variable	1	2	3	4
CONST	12.552* (1.92)	–1.614 (–0.23)	63.85*** (6.23)	56.542** (2.43)
LGDPI	–1.375*** (–2.61)	–1.789*** (–3.56)	–5.441*** (–5.27)	–5.297*** (–4.84)
INV	2.272*** (4.25)	2.369*** (4.73)	1.334* (1.89)	1.239* (1.72)
LLIFE	–2.581 (–1.35)	1.601 (0.78)	–8.022*** (–3.39)	–6.385 (–1.19)
POPG	0.208 (0.56)	0.148 (0.44)	0.68 (1.29)	0.673 (1.21)
Dummy for 1960s		2.636*** (3.7)		0.296 (0.22)
Dummy for 1970s		1.282** (1.98)		0.228 (0.26)
Dummy for 1980s		0.078 (0.13)		–0.276 (–0.45)
No. observations	90	90	90	90
Implied β	0.027	0.019		
R^2	0.23	0.37	0.49	0.50
Prob (Chi2)	0.000	0.04		

[11] The negative sign on life expectancy does not mean that human capital hurts economic growth. Hoeffler (2000), using Barro-Lee data set for education also found a negative coefficient on education. Tsangarides (2000) who also found an insignificant coefficient on education variable argues that this does not mean human capital accumulation does not help African economies but it might be rather due largely to multicollinearity or simply measurement error.

Since country-specific factors that may affect economic growth are not incorporated, I finally shifted to the fixed effects model, that allows to overcome the problem of omitted variable, and other bottlenecks that the cross-section framework is suffering from (the results are in Table 8). The results for the random effects model are similar to that of the cross-section pooled time series one that was discussed. The results in the fixed effects model, which allows to control for country-specific effects, in addition to the traditional covariates suggest that there is a significant indication of conditional convergence across HIPCs, which may again imply convergence towards a poverty trap rather than to a standard steady state. The decade dummies also indicate the worst period for the 1980s, though larger coefficients for the constant term, which also capture the decade dummy for the 1990s that was left out, is a bit puzzling. One possible explanation for such a high constant term in the fixed effects model may be that countries had a very high growth at the beginning of the 1960s, which was turned down as the result of the debt crisis in the 1980s and 1990s.

6. Conclusion and the Policy Implication of this Paper

The objective of this paper was to figure out the extent to which the growth-rate difference in real income per capita across countries has improved in the past four decades. The availability of the fresh international data set (the Penn World Table 6.1) makes it possible to carry out the empirical analysis across countries and over time. The first attempt was to quantify the growth-rate differences of countries in the past four decades. The results seem to suggest that the gap between poor and rich countries increased over time, perhaps reaching its climax in the 1980s and 1990s. From the analysis, it also implies that SSA, on average, comes out to be the most affected region in terms of its degree of divergence from the rest of the world. In fact, this region, on average, has virtually been outrun by all developing regions in all essential economic and social indicators in the 1980s in particular. Since 33 of the 41 countries characterized by the World Bank, as heavily indebted poor countries (HIPCs) are located in this region, the primary legitimate suspect in this regard is the debt crisis of the 1980s that drove many of the poor nations into a deeper vicious circle of poverty.

Turning to the formal analysis of the conditional convergence debate, the results are quite consistent with the predictions of the augmented Solow model. First, the results suggest that while investments in human and physical capital enhance growth of per capita income, the growth rate of the population, in most cases, harms it. Second, controlling for human and physical capital accumulations, and population growth rate, there is an evidence for conditional convergence across countries in the past four decades. The HIPCs dummy that was included to control for the impact of indebtedness, indicates that HIPCs growth performance had indeed been terribly worse relative to non-HIPCs. The decade dummies incorporated to control for decade-specific effects suggest that the 1980s and 1990s were indeed the worst decades in terms of income per capita convergence. Finally, the fact that there was an evidence for conditional convergence across HIPCs seems to suggest that this group of countries has been converging towards a common poor growth path.

The Policy Implications of this Paper

The policy implication from this study is quite apparent. The first policy implication is that poor countries should invest scarce resources into education and capital formation if long-run growth that could lead to accelerated convergence is to be achieved. Second, the fact that heavily indebted poor countries did not grow despite huge foreign debt build up and substantial foreign aid transfers may imply that either these resources had been virtually eaten up, deposited in foreign banks in the form of capital flight, or invested in projects that were very ineffective. In fact, the past-inherited external debt of poor nations has become a chronic development bottleneck and a factor of instability rather than a growth acelerator.

This calls for a radical policy change that encompasses governments' accountability, the role of the international financial institutions, donor governments and the broader international community. The situations in many poor countries indicate that they are converging to such unbearable phase of poverty that many of them are on the verge of collapse as nations, which may have fatal spill over effects in terms of both regional and global peace and security in the decades ahead. An ancient wisdom „you can't sleep in peace unless your neighbour does so" is a case in point here.

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