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WORLDWIDE GROWTH CONVERGENCE IN THE NEW MILLENNIUM: AN EMPIRICAL INVESTIGATION†

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Abstract

Economic growth is an important ingredient for reducing poverty and achieving the Millennium Development Goals proposed by United Nations in 2000. Meeting these goals by the proposed 2015 target data depends on the ability of poor nations to grow their economies and improve their standards of living. Neoclassical and new growth theory suggests that there should be a negative relationship between a nation's initial income and subsequent growth giving rise to either absolute convergence (income levels of all nations converge over time) or conditional convergence (each nation converges to its unique steady-state income level). Using the most recent (2000-2013) World Bank data and cross-country regression techniques, I evaluated whether convergence has been occurring in the world in the last decade. My results showed a robust negative relationship between starting income level and subsequent growth. Savings and education were also associated with growth whereas trade was not. Overall, these results support the notion of convergence which is an encouraging finding as the world approaches the 2015 post-development agenda.

Keywords: Economic Growth, Convergence, Millennium Development Goals

1. Introduction

In 2000, the United Nations proposed 8 global challenges, or Millenium Development Goals (MDGs), to be met by 2015. The primary MDG, "eradicate poverty and hunger" from underdeveloped countries, is accompanied by 7 other MDGs: universal primary education, gender equality, reduction in child mortality, improvement in maternal health, progress against human immunodeficiency virus (HIV) and malaria, environmental sustainability, and a global partnership for development (United Nations General Assembly, 2000). Achievement of these MDGs, or lack thereof, will influence the next round of 15-year development priorities that the United Nations plans to select in September 2015 (Higgins, 2013).

It is generally understood that the driving force in realizing the MDGs is the economic growth of less developed countries. It has been argued that economic growth is an important way for these nations to achieve substantial and sustainable reductions in poverty (Bhagwati and Panagariya, 2013; Dollar *et al.* 2013).The recent economic growth of China and other large emerging markets also provides an unprecedented roadmap for economic development for low income countries in Africa, Asia, and South America (Lin, 2012).The ability of less developed

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nations to capture the "low-hanging fruit" of technology, knowledge, and institutions may facilitate the convergence of their income levels to those of developed nations.

A key question in the development community is if current rates of economic growth will help the world realize the primary MDG, "eradicate extreme poverty and improve the standard of living". Since higher economic growth facilitates improvements in standard of living, it is important to know if growth rates in developing countries are decreasing, stagnating, or increasing. Is the economic gap between less developed and developed countries narrowing fast enough to accomplish economic convergence in the world?

The focus of this paper is to assess whether or not economic convergence has been a characteristic of economic growth in less developed countries during 2000-2013.This paper will analyze the economic growth data of countries at multiple income levels and explore answers to these questions. The rest of the paper is divided as follows. In section 2, a brief overview of the conceptual framework of the convergence hypothesis is presented. Section 3 presents the methodology to be used to make an assessment if less developed countries are growing fast enough to catch up with developed countries and are on track to eliminate extreme poverty. Estimation results are analyzed in section4. Section 5 provides conclusion of this paper.

2. An Overview of the Convergence Theory

Convergence between countries or regions is defined as "the tendency for the levels of per capita income, or levels of per worker product (productivity) to equalize over time which will happen only if a catch-up process takes place" (Soukiazis, 2000, p.2). In the context of neoclassical growth theory, spurred by the pioneering work of Solow (1956) and others, the concept of convergence (catch-up effect) emerges because a poor nation will have a higher marginal productivity of capital compared with a rich one (assuming identical technologies, see Rodrik, 2013). As Mankiw notes:

> "The diminishing returns to capital [implied by Solow model] have another implication: Other things being equal, it is easier for a country to grow fast if it starts out relatively poor. This effect of initial conditions on subsequent growth is sometimes called the catch-up effect. In poor countries, workers lack even the most rudimentary tools and, as a result, have low productivity. Small amount of capital investment would substantially raise these workers' productivity. By contrast, workers in rich countries have large amounts of capital with which to work, and this partly explains their high productivity. Yet with the amount of capital per worker already so high, additional capital investment has a relatively small effect on productivity" (Mankiw, 2012, p.245).

A key empirical question is whether the growth and standard of living within underdeveloped nations is actually converging to those of developed notions, as predicted by neoclassical growth theory. As Islam put it, "whether income levels of poor countries of the world are converging to those of richer countries is by itself a question of paramount importance for human welfare" (2003, p.309). Islam's view certainly underscores the importance that the United Nations have placed on MDGs in general and eradication of extreme poverty and hunger in particular. The theory of convergence has evolved into different concepts that have shaped the way convergence has been studied theoretically and empirically. Islam identifies the following dimensions of the convergence concept that has become popular as research on convergence continued to advance (Islam, 2003):

a. Convergence within an economy vs. convergence across economies;
b. Convergence in terms of growth rates vs. convergence in terms of income levels;
c. β (Beta) – convergence vs. σ (Sigma) – convergence;
d. Unconditional (Absolute) convergence vs. conditional convergence;
e. Global convergence vs. local of club convergence;
f. Income convergence vs. TFP (total factor productivity) convergence;

Of greatest importance for my paper is the β (Beta) – convergence involving absolute and conditional convergence. A brief review of Beta vs. Sigma convergence and absolute vs. conditional convergence and their implications in the convergence of less developed countries are given below.

2.1. β- Convergence vs. σ- Convergence

β- Convergence implies that the real gross domestic product (GDP) in poor countries is growing at a faster rate compared with developed ones. This performance differential is due to diminishing returns to capital in capital-rich developed countries and higher marginal productivity of capital in capital-poor less developed countries (Rodrik, 2013; Soukiazis, 2000).Taken to its limit, β – convergence suggests that countries should have the same growth and GDP per capita in the long run (Mathur, 2005). Based on this setting, we would expect a negative correlation between the initial income level and income growth across a group of countries or regions, with the initial income level of countries/regions reflecting the starting economic conditions of the respective countries/regions.

σ- convergence refers to a tendency for the standard deviation (or other related measure of dispersion) of per capita income across a group of countries to converge over time(Young *et al.* 2008). Researchers have stressed β- convergence over σ- convergence because it is a necessary, though not sufficient, condition for σ- convergence (Young *et al.* 2008).

2.2. Unconditional (Absolute) β- Convergence and Conditional β- Convergence

Unconditional convergence is the epitome of neoclassical growth theory. Identical technologies implies convergence to a common level of income (Rodrik, 2013). At the empirical level, unconditional convergence indicates a negative relationship between the growth rate of per capita GDP over a given period of time and initial level of per capita GDP across different regions and countries. This negative relationship is considered as evidence of unconditional convergence to the same long-run per capita GDP for all regions and countries, regardless of initial GDP per capital levels (Barro and Sala-i-Martin, 1992).

The factors driving economic growth may be more complex than those depicted in the model of absolute convergence. If there are multiple codependent factors that drive economic growth, then each country may have its own long-run growth path. As described by Islam, “In the case of unconditional convergence, there is only one equilibrium level to which all economies approach. In the case of conditional convergence, equilibrium path differs by the economy, and each particular economy approaches its own but unique equilibrium” (Islam, 2003, p.315). In new growth or endogenous growth theory, factors such as research and development expenditures (Romer, 1986), human capital formation (Becker *et al.* 1994), and economic liberalization (Billmeier and Nannicini, 2013) modulate the path of convergence. Regions or countries with more qualified human capital, innovation activities, and trade openness have a tendency to grow faster. Therefore the process of convergence, although still within the neoclassical framework, is conditional (i.e. conditional convergence) on these variables, among others.

3. Growth and Convergence: An Empirical Approach and Methodology

The objective of this paper is to evaluate the convergence hypothesis within the context of the UN’s MDGs, 2000-2015. More specifically, using a growth-initial economic condition regression technique pioneered by Baumol (1986) and Barro and Sala-i-Martin (1992), I estimate if developing countries are on track to eradicate extreme poverty and hunger and eventually catch-up with the standard of living of developed countries. A large number of empirical studies have used cross section (Barro and Sala-i-Martin, 1992; Baumol, 1986) or time series (Bernard and Durlauf, 1995) data to analyze whether different countries have converged or not. The novel contribution of this paper is that I use the most recent 2000-2013 World Bank data on GDP per capita growth (a popular measure of economic growth in the convergence literature)to gauge whether convergence has occurred and therefore if there is a realistic prospect to meet the primary UN MDG (eradication of extreme poverty and hunger) by 2015.

The estimate of unconditional convergence (β- Convergence) is estimated using a cross country regression of the exponential growth rate of per capita GDP growth between 2000 and 2013 on the initial level of per capita GDP (constant 2005 U.S. $). The per capita GDP circa 2000 was taken as a measure of a country's initial economic position which plays a role in terms of the growth path of a country. To test the convergence hypothesis in general and to make an assessment of MDGs trajectory in particular, I used the World Bank's country classification table. The World Bank country classifications based on per capita income as of July 2013 are as follows:

- Low Income Countries (LICs): $1,035 or less
- Lower Middle Income Countries (LMICs): $1,036 to $4,085
- Upper Middle Income Countries (UMICs): $4,086 to $12,615
- High Income Countries (HICs): $12,616 or more

The following growth-income regression model, based on the seminal work of Baumol (1986) and Barro and Salai-i-Martin (1992), is estimated for each income group of countries.

$$\boldsymbol{ln}\left(\frac{\boldsymbol{G(T)}}{\boldsymbol{G(0)}}\right) = \boldsymbol{\alpha} + \boldsymbol{\beta ln}(\boldsymbol{G(0)}) + \boldsymbol{\varepsilon}$$

Where *ln* is the natural logarithm, *G* (*T*) is the average GDP per capita over 2011-2013, *G* (*0*) is the average GDP per capita over 1999-2001, α is a constant, β is the coefficient on initial(1999-2001) per capita GDP, and ε denotes an error term.

Averages of per capital GDP were taken over 3 year intervals to minimize the effect of year-to-year variations. A negative sign of the β coefficient indicates unconditional β convergence. This implies that less developed countries are approaching the standard of living of developed countries. In unconditional convergence, β is obtained without including other structural (conditioning variables) in the model. It is assumed that the countries in each income group do not differ significantly in their level of technology, trade openness, human capital, and economic infrastructure.

The methodology for the estimate of conditional convergence is similar to the one for absolute convergence except that we now introduce structural variables. Researchers have used identified several significant structural variables in empirical convergence studies; the set of significant variables varies from study to study and the choice of what variables to include in the model is not standardized. In this paper I have used the following structural (conditioning) variables, averaged over the 2000-2013 time period, based on their natural relationship with economic growth:

Domestic Saving Rate[1]: Gross domestic saving as a percentage of gross national income (GNI) is a proxy for investment. A higher savings rate implies more resources for growth. Investment increases the productivity of labor by giving workers more capital to work with, allowing them to produce an increased volume of high-quality goods and services.

Trade Openness[2]: High trade openness entails high levels of foreign investment, new ideas, new managerial skill, new technologies which in turn facilitate the growth process of a country. In this study, trade openness is the sum of exports and imports of goods and services measured as a percentage of GDP.

Human Capital[3]: Human capital denotes the skills and knowledge that accumulate over time in the labor force. In this study human capital is measured by estimating the average number of years of formal education among the working age population, 15+ years of age. The following equation is estimated for unconditional convergence.

[1]Data source: World Bank (last updated 9/16/2014).
[2]Data source: World Bank (last updated 9/16/2014).
[3]Data source: Barro and Lee (2013) and World Bank (last updated 8/21/2014).

$$ln\left(\frac{G(T)}{G(0)}\right) = \alpha + \beta ln(G(0)) + cln(EDU) + dln(SAVE) + fln(TRADE) + \varepsilon$$

Where EDU is the average years of total schooling for 15+ age groups, SAVE is the savings as a percentage of GNI, TRADE is exports plus imports as a percentage of GDP measuring trade openness, and ε is an error term.

4. Estimation Results and Analysis

Data for a total of 214 countries were obtained from the World Bank databases. In the model for absolute convergence, countries were excluded from the analysis if there was no GDP per capita data available for the years 1999-2001 and 2011-2013. In addition, in the model for conditional convergence, countries were also excluded if the data for any one of the conditional variables (including the logarithm) did not exist. Table 1 below presents the number of countries in each income level that were concluded in each analysis as well as summary statistics for the predictor variables in the regression models. Although LICs had markedly lower mean initial (2000) levels of per capital GDP compared with HICs (335.67 vs. 25076.87), they had a higher mean growth rate than HICs from 2000-2013 (0.23 vs. 0.20 or AGR (2% vs. 1.74%), respectively). HICs tended to have greater savings, trade, and education than LICs and MICs which is consistent with what has been generally reported previously.

Table 1. Descriptive Statistics of the Predictor Variables Included in the Cross-Country Regression Analysis by Country Income Level

	LIC	LMIC	UMIC	MIC	HIC	All countries
Countries in absolute convergence model, n	30	48	52	100	56	186
Countries in conditional convergence model, n	16	32	52	64	43	123
Variables, mean (std)						
AGR, %	2.00 (2.57)	2.94 (2.01)	3.19 (2.32)	3.07 (2.17)	1.74 (2.28)	2.50 (2.35)
PGDP growth rate	0.23 (0.30)	0.35 (0.23)	0.37 (0.27)	0.36 (0.25)	0.20 (0.27)	0.29 (0.27)
PGDP2000, constant 2005$	335.67 (134.63)	1067.19 (538.15)	3774.40 (2128.69)	2474.94 (2078.36)	25076.87 (16468.84)	8934.78 (14013.21)
Savings, % of GNI	8.17 (14.28)	12.83 (11.76)	9.81 (13.29)	11.25 (12.60)	12.03 (13.15)	11.01 (13.03)
Trade, % of GDP	62.02 (22.31)	89.95 (34.88)	92.50 (34.86)	91.26 (34.71)	110.20 (70.28)	92.17 (49.42)
Education[a], yrs	4.26 (1.97)	6.36 (2.32)	8.37 (1.61)	7.39 (2.21)	10.22 (1.52)	7.90 (2.82)

Notes: [a]Average number of years of formal education among the working age population, 15+ years of age. AGR, annualized growth rate; GDP, gross domestic product; GNI, gross national income; LIC, low income countries; LMIC, lower middle income countries; MIC, middle income countries (LMIC+UMIC); PGDP2000, 2000 per capita GDP; Average Growth Rate (AGR) in per capital real GDP (2000-2013); standard deviation (in parenthesis); UMIC, upper middle income countries.

Table 2 shows the results for the absolute convergence regression models. The β coefficient for the initial (2000) per capital GDP was negative and statistically significant regardless of country income grouping. Values for β ranged from −0.05 (full sample) to −0.36 (LICs, UMICs) corresponding to estimated convergence rates of 0.3% and 3% per year respectively. These results from the absolute convergence model suggest that there is a

negative relationship between starting GDP per capita and subsequent growth (i.e. convergence). It is especially important that this trend is observed in LICs, since the existence of a catch-up effect would help these countries reduce poverty and meet the UN's MDGs.

Table 2. Regression Results for the Absolute Convergence Model

Regression	LIC	LMIC	UMIC	MIC	HIC	Full Sample
Number of Observations	30	48	52	100	56	186
Coefficient (SE)						
Constant	0.19*** (0.06)	0.14*** (0.04)	0.27*** (0.034)	0.09*** (0.02)	0.20*** (0.03)	0.06*** (0.008)
Ln (PGDP2000)	−0.03** (0.01)	−0.017*** (0.005)	−0.03*** (0.004)	−0.008*** (0.002)	−0.02*** (0.003)	−0.004*** (0.001)
R^2	0.22	0.17	0.50	0.10	0.38	0.08

Notes: *P<0.1; **P<0.05; ***P<0.01.

GDP, gross domestic product; LIC, low income countries; LMIC, lower middle income countries; Ln, natural logarithm; MIC, middle income countries (LMIC+UMIC); PGDP2000, 2000 per capita GDP; SE, standard error; UMIC, upper middle income countries.

Building on the results shown in Table 2, a conditional convergence model was then fit to the World Bank data. In previous studies, tests for conditional convergence have been usually performed after the test for absolute convergence has failed to reject the null hypothesis that there is no relationship between starting income and subsequent growth. In these cases, the test for conditional convergence is used to show evidence for the existence of convergence, conditional on including other important growth variables in the model. Since the results in Table 2 give evidence for the existence of absolute convergence, I instead use the conditional convergence model to show the robustness of the finding of a negative relationship between starting income and growth from 2000 to 2013. Table 3 demonstrates that even after incorporating education, savings, and trade, the β coefficient was still negative with P<0.1 for all income levels. Values for β were generally similar between the absolute and conditional convergence models.

Table 3. Regression Results for the Conditional Convergence Model

Regression	LIC	LMIC	UMIC	MIC	HIC	Full Sample
Number of Observations	16	32	32	64	43	123
Coefficient (SE)						
Constant	0.14 (.11)	0.087* (0.045)	0.22*** (0.06)	0.06** (0.03)	0.12** (0.05)	0.024* (0.014)
Ln (PGDP2000)	−0.03* (0.015)	−0.015*** (0.005)	−0.027*** (0.006)	−0.01*** (0.003)	−0.02*** (0.003)	−0.01*** (0.001)
Ln (Savings)	0.001 (0.005)	0.006 (0.004)	0.001 (0.004)	0.005* (0.003)	0.006* (0.003)	0.004** (0.002)
Ln (Education)	0.015 (0.014)	0.03*** (0.007)	0.013 (0.016)	0.03*** (0.007)	0.02 (0.02)	0.028*** (0.005)
Ln (Trade)	0.004 (0.02)	−0.004 (0.006)	0.0007 (0.006)	−0.003 (0.005)	0.007* (0.004)	0.003 (0.003)
R^2	0.29	0.53	0.40	0.34	0.56	0.33

Notes: *P<0.1; **P<0.05; ***P<0.01.

GDP, gross domestic product; LIC, low income countries; LMIC, lower middle income countries; Ln, natural logarithm; MIC, middle income countries (LMIC+UMIC); PGDP2000, 2000 per capita GDP; SE, standard error; UMIC, upper middle income countries.

At least one conditioning variable was significant or nearly significant (P<0.1) for all countries, HICs, and LMICs. Focusing on all countries, increased savings and education were also associated with a higher growth rate, consistent with previous research (Barro, 2001; Loayza *et al.* 2000). Trade, however, was not found to be associated with growth. This finding may be consistent with the findings of a previous report showing that the latest wave of globalization in the 1990s did not significantly affect economic growth (Billmeier and Nannicini, 2013).

Although my results are encouraging in that they provide evidence that a catch-up effect may help less developed nations increase their standard of living, there are several important limitations of our study that need to be addressed. The first limitation is that data from the World Bank database is incomplete and not all countries could be included in the analyses; there may be a selection bias in that important characteristics (e.g. GDP, standard of living, quality of government) may be correlated with the likelihood of a country having adequate data. Another limitation of this study is that I have used a simple regression technique that has methodological shortcomings. In previous reports, the finding of absolute convergence, conditional convergence, or even divergence was sensitive to the statistical technique used (e.g. Barro regressions, panel estimations, distributional dynamics) (Battisti *et al.* 2013). Therefore, in future work, I will test the robustness of the technique used in this paper by applying other methods to the same World Bank dataset.

5. Conclusions

Using the most recent World Bank data and cross-country regression techniques, I have shown that countries that were initially poorer in 2000 had subsequently higher growth rates from 2000-2013. This finding provides evidence for the occurrence of a catch-up effect within the last decade, an effect that would help poor nations meet the UN's MDGs. Furthermore, this catch-up effect appears to be modulated by education and savings. Future work will incorporate updated data, sophistical statistical techniques, and case studies to confirm the findings reported herein.

References

Barro, R.J. and Lee, J.W., 2013. A new data set of educational attainment in the world, 1950-2010. *Journal of Development Economics*, 104, pp.184-198. http://dx.doi.org/10.1016/j.jdeveco.2012.10.001

Barro, R.J. and Sala-i-Martin, X., 1992. Convergence. *Journal of Political Economy*, 100(2), pp.223-251. http://dx.doi.org/10.1086/261816

Barro, R.J., 2001. Education and economic growth. In: J. Helliwell, ed. *The Contribution of Human and Social Capital to Sustained Economic Growth and Well-Being*. Ottawa and Paris: Government of Canada and OECD, pp.13-41.

Battisti, M., Di Vaio, G., and Zeira, J., 2013. Global divergence in growth regressions. *CEPR Discussion Paper*, No.DP9687.

Baumol, W.J., 1986. Productivity growth, convergence, and welfare: What the long-run data show. *The American Economic Review*, 76(5), pp.1072-85.

Becker, G.S., Murphy, K.M., and Tamura, R., 1994. Human Capital, Fertility, and Economic Growth. In: G.S. Becker, ed. *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*. Third Edition, Chiago: The University of Chicago Press. pp.323-350.

Bernard, A.B. and Steven, N.D., 1995. Convergence in international output. *Journal of Applied Econometrics*, 10(2), pp.97-108. http://dx.doi.org/10.1002/jae.3950100202

Bhagwati, J. and Panagariya, A., 2013. *Why growth matters: How economic growth in India reduced poverty and the lessons for other developing countries*. New York: PublicAffairs.

Billmeier, A. and Nannicini, T., 2013. Assessing economic liberalization episodes: A synthetic control approach. *Review of Economics and Statistics*, 95(3), pp.983-1001. http://dx.doi.org/10.1162/REST_a_00324

Dollar, D., Kleineberg, T., and Kraay, A., 2013. Growth still is good for the poor. *Policy Research Working Paper*, No.6568. Washington, D.C.: The World Bank.

Higgins, K., 2013. Reflecting on the MDGS and making sense of the post-2015 development agenda. *North-South Institute Paper*, [online] Available at: <www.nsi-ins.ca> [Accessed 14 June 2014].

Islam, N., 2003. What have we learnt from the convergence debate?. *Journal of Economic Surveys*, 17(3), pp.309-362. http://dx.doi.org/10.1111/1467-6419.00197

Lin, J.Y., 2012. *The quest for prosperity: How developing economies can take off*. Princeton, NJ: Princeton University Press.

Loayza, N., Schmidt-Hebbel, K., and Servén, L., 2000. Saving in developing countries: An overview. *The World Bank Economic Review*, 14(3), pp.393-414. http://dx.doi.org/10.1093/wber/14.3.393

Mankiw, N.G., 2012. *Principles of macroeconomics*. Boston, MA, South-Westrn Cengage Learning.

Mathur, S.K., 2005. Absolute and conditional convergence: Its speed for selected countries for 1961-2001. *Econ WPA Paper*, [pdf] Available at: <http://econwpa.repec.org/eps/mac/papers/0510/0510023.pdf> [Accessed 4 February 2014].

Rodrik, D., 2013. Unconditional convergence in manufacturing. *The Quarterly Journal of Economics*, 128(1), pp.165-204. http://dx.doi.org/10.1093/qje/qjs047

Romer, P.M., 1986. Increasing returns and long-run growth. *The Journal of Political Economy,*94(5), pp.1002-1037. http://dx.doi.org/10.1086/261420

Solow, R.M., 1956. A contribution to the theory of economic growth. *The Quarterly Journal of Economics,* 70(1), pp.65-94. http://dx.doi.org/10.2307/1884513

Soukiazis, E., 2000. What have we learnt about convergence in Europe? Some theoretical and empirical considerations. *Discussion Paper*, No.12. [pdf] Available at: <http://www4.fe.uc.pt/ceue/working_papers/iconv.pdf> [Accessed 4 June 2014].

United Nations General Assembly, 2000. *United Nations Millennium Declaration*. General Assembly, No.18.

Young, A.T., Higgins, M.J., and Levy, D., 2008. Sigma convergence versus beta convergence: Evidence from U.S. county-level data. *Journal of Money, Credit and Banking*, 40(5), pp.1083-1093. http://dx.doi.org/10.1111/j.1538-4616.2008.00148.x