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Absolute Convergence, Its Speed and Economic Growth for Selected Countries for 1961-2001*

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We use cross sectional data of GDP per capita levels and growth rates of European countries EU16 (EU15 + UK), South Asian Countries (5), some East Asian (8) and CIS Countries (15) to test for 'absolute convergence' hypothesis for four different periods 1961-2001,1970-2001,1980-2001,1990-2001. Only EU and East Asian countries together have shown uniform evidence of absolute convergence in all periods. While EU as a region has shown significant evidence of absolute convergence in two periods, 1961-2001 and 1970-2001, there is no convincing statistical evidence in favor of absolute convergence in the last two periods: 1980-2001 and 1990-2001. This latter evidence with declining rate of economic growth for EU since 1961 points to a challenge for designing EUs regional policies which also have to cope up with many East European and Baltic nations who joined EU recently. The speed of absolute convergence in the four periods range between 0.99-2.56% p.a. (2% for the EU was worked out by Barro and Xavier Sala-i-Martin(1995) for European regions) for EU while it ranges between 0.57-1.16% p.a. for the countries in East Asia and EU regions together. However, there is no evidence of convergence among the South Asian countries in all periods and some major CIS republics since 1966. There is however tendency for absolute convergence among countries of South Asia, East Asia and European Union together particularly after the 1980s.

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1. INTRODUCTION

There has been considerable research inquiry into the causes and nature of differences in growth rates across countries and regions over time. Even small differences in these growth rates, if cumulated over a long period of time, may have substantial impact on the standards of living of people. Despite considerable research on the subject, cross-country and cross-regional income disparities are on rise over time. Understanding the causes behind such inequalities is essential to formulate appropriate policies and bring about required institutional changes in order to spread the benefits of growth processes across regions.

Convergence refers to the process by which relatively poorer regions or countries grow faster than their rich counterparts. Few subjects in applied economic research have been studied as extensively as the convergence hypothesis advanced by Solow (1956) and documented by Baumol (1986) and Barro and Xavier-Sala-i-Martin (1995). In its strongest version (known as absolute convergence), an implication of this hypothesis is that, in the long run, countries or regions should not only grow at the same rate, but also reach the same income per capita. The present study tests the 'convergence' of GDP per capita within and across four regions-South & East Asian, European Union (15) and the United Kingdom from 1961-2001, some countries from the Commonwealth of Independent States (CIS) since 1966 till 2001 and other CIS nations from mid 1980s[1)] to 2001. Convergence can be conditional (conditional beta convergence) or unconditional (absolute beta convergence). Conditional convergence implies that a country or a region is converging to its own steady state while the unconditional convergence implies that all countries or regions are converging to a common steady state.

One of the stylized facts of economic growth today is that the levels of GDP per capita and growth rates have differed across countries and regions of the world. This is indeed the case for some of the regions included in our study (see table 1). While EU region (industrialized economies) has

[1)] Please see table 1 for the list of countries included in the four regions included in our study.

Table 1 Per capita Income Levels and Growth Rates Across Regions

	Average GDP Per Capita (in Current US$) in 2001	Average Annual Per capita GDP Growth Rate			
		1961-2001	1970-2001	1980-2001	1990-2001
South Asia (5)	447.72	2.16	2.23	2.82	2.81
East Asia (8)	3348.70	4.34	4.31	3.90	3.51
European Union (16)	21050.75	2.88	2.49	2.28	2.27
CIS (15)	1523.83	1.46 (Latvia, Russia and Georgia) 1966-2001		-1.05 (Estonia & Moldova) 1981-2001	-0.22 (1986-2001) 10 CIS countries excluding Latvia, Russia, Georgia, Estonia and Moldova

Note: The second column shows weighted average with population as weights. The growth rates are for GDP Per capita (in constant 1995 US $).

Sources: Author's calculations using data on GDP Per capita (constant 1995 US $), GDP (current US $) and Population from World Bank, World Development Indicators on CD-ROM, 2003.

relatively the highest GDP per capita income levels in 2001, East Asian region has shown relatively higher growth rates in all periods from 1961 to 2001. Decadal growth rates, however, do show that the performance of EU and East Asian region show a declining trend in economic growth rates while South Asian region show an upward trend.

As is evident from the above data, economic growth varies tremendously across different regions. With the new era of free market philosophy, countries are competing with each other for resources. How are the countries doing relative to one another? Have they been diverging away from one

another? These are critical questions for three reasons: (i) Central planning in Soviet Union (Now Russian federation and CIS countries), China & India has explicitly sought to reduce regional disparities. Also, with 10 new East European and Baltic states joining the EU on May 1 2004,[2)] reducing regional inequalities within the EU would be the explicit goal of the EU enlargement policies (ii) Rising regional disparities cause regional tensions & (iii) poor regions should not remain poor for generations to come?

The absolute convergence hypothesis has been tested by many researchers using different methodologies and data sets and appears to be strongly rejected by some data sets and accepted by others. In view of these results, this study tests for absolute convergence across and within regions, work out speed of absolute convergence & identify policies which may reduce differential levels of per capita income levels and growth rates of regions. Neoclassical growth models (Cass, 1965; Koopmans, 1965; Solow, 1956, Swan, 1957) have been used as a framework to study convergence across regions within countries. The main variable in use will be GDP per capita income prevailing in different countries/ regions included in our study.

The paper is organized as follows: section 2 presents a review of the empirical literature on convergence analysis, section 3 gives the objectives, hypotheses, methodology, data and data sources with variable description section 4 gives the growth equation used for testing the absolute convergence and its speed and derived from solving the Solovian model (1956) around the steady state, section 5 discusses the regression results of absolute convergence analysis. Section 6 gives conclusion and policy implications,

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[2)] Poland — along with Hungary, Lithuania, Estonia, Latvia, Slovakia, Slovenia, Cyprus, Malta and the Czech Republic are new entrants to EU. In practice, according to Eurostat figures, average per capita GDP in the 10 new entrant East European countries now stands at around 40 percent of the EU average, indeed, the gap between the average EU income level and that of the new entrant countries has widened considerably since 1989. The EU's real GDP grew by 30 percent between 1989 and 2002, whereas for the 10 East European accession countries the increase amounted to only 8 percent during the same period. Lowering the gap has not diminished appreciably among the East European nations since the mid-1990s, in part because of macroeconomic mismanagement in some countries; slowing structural change in others; and the impact of external shocks, such as the 1998 Russian financial crisis.

points out the limitations of the study and makes some suggestions for future research.

2. REVIEW OF LITERATURE: PREVIOUS STUDIES ON ECONOMIC GROWTH AND CONVERGENCE ACROSS REGIONS

The bulk of their empirical writings, exemplified by Barro (1991) and Mankiw, Romer, and Weil (1992), have found evidence that economies with low initial incomes tend to grow faster than economies with high initial incomes, after controlling for rates of savings and population growth. This finding has been treated as evidence of convergence, and has generally been taken as evidence that the neo-classical growth model pioneered by Solow' (1956) is consistent with observed growth patterns. Barro and Sala–i- Martin (1992) have investigated the question of convergence within regions as well by using 48 states of the United States. Boldrin and Canova (2001) using a similar methodology severely criticized the previous results. Using a different data set, which includes 185 EU regions during the period 1980-1986, they concluded that the results are mixed and not supportive of convergence of regional per capita income. Canova and Marcet (1995) also, basing the analysis on per capita incomes for 144 EU regions, found only limited signals of convergence during the period 1980-1982. Others have studied different regions of now developed countries: Keller (1994) for Austria and Germany, Cashin (1995) for Australia and Coulombe and Lee (1993) for regions in Canada, Kangasharju (1999) for Finland and Sala-i-Martin (1996) for Japanese Prefectures. The evidence seems to be unequivocal: different regions in different countries are converging. Most rates of convergence hover around 2% per annum. However, the same cannot be said about the whole world. With data of the past 30 years for 110 countries, the evidence shows that the world is not converging. They are diverging. Poor countries are getting relatively poorer and the rich countries

getting richer. The argument put forth to reconcile these two facts is that there is no diffusion of technology across different countries. However, within a country, regions are more closely related. There have been very few studies that look at convergence in the developing countries. This paper tries to fulfill such a gap by including countries from CIS federation, South Asia and East Asia.

The cross-country regression literature is enormous: a large number of papers have claimed to have found one or more variables that are partially correlated with the growth rate: from human capital to investment in R&D, to policy variables such as inflation or the fiscal deficit, to the degree of openness, democracy, financial variables or measures of political instability. In fact, the number of variables claimed to be correlated with growth is so large that the question arises as to which of these variables is actually robust in explaining differential growth performance across countries and regions. Edward Leamers (1985) Extreme Bound Tests approach to identify 'robust' empirical relations in the economic growth literature and Xavier Sala-I-Martin (1997) method of looking at the entire distribution of regression coefficients are some methodologies to identify some significant factors affecting growth.

In recent times, cross country analysis has come under criticism from the "Twin-Peaks" literature led by Danny Quah (1996, 1997). The researcher is interested in the evolution of the distribution of the world distribution of income and the variance is only one aspect of this distribution. Quah noticed that, in 1960, the world distribution of income was uni-modal whereas, in the 1990s, the distribution became bi-modal. He then used Markov transitional matrices & non-parametric method to estimate the probabilities that countries improve their position in the world distribution. Using these matrices, he then forecasted the evolution of this distribution overtime. His conclusion was that, in the long run, the distribution would remain bi-modal, although the lower mode will include a lot fewer countries than the upper mode.

Even though Quah's papers triggered a large body of research, his conclusion does not appear to be very robust. Jones (1997) and Kremer,

Onatski and Stock (2001) have recently shown that a lot of these results depend crucially on whether the data set includes oil-producers (for example, the exclusion of Trinidad and Tobago or Venezuela from the sample changes the prediction of a bi-modal steady state distribution to a uni-modal distribution; the reason is that these are two examples of countries that were relatively rich but have become poor so if they are excluded from the sample, the probability of "failure" — that is, the probability of a country moving down in the distribution- lowers substantially).

The present study uses cross country regression approach and not the time series approach to the study of convergence. The appropriateness of the cross-country regression approach is challenged by, for example, Quah (1993), Bernard and Durlauf (1996) and Evans (1996). Quah (1993) shows that negative correlation between output growth and initial output is consistent with a stable variance in cross country output. Bernard and Durlauf (1996) argue that the initial output regression approach tends to reject the null hypothesis of no convergence too often in the presence of multiple output equilibria as countries converge to their own steady state levels of per capita income. Evans (1996) points out that the cross sectional approach may generate inconsistent convergence rate estimates, which may lead to incorrect inferences. Under the time series framework, output convergence requires real per capita cross country output differentials to be stationarity; that is, the levels of per capita national output are not diverging over time. Quah (1992) examines the unit root property of per capita output of the US. Using a panel unit root test, Evans (1998) shows that convergence occurs within a group of developed countries and different growth patterns are observed among countries with different literacy rates.

Compared with cross country analysis, the time series approach yields less convincing findings for the convergence hypothesis (Cheung and Pascual, 2004) One possible reason for the non convergence outcome is related to the empirical procedures used in these studies. The typical time series test has no convergence (presence of unit root) under the null hypothesis. Since it is commonly known that unit root tests tend to have low power against

persistent but stationarity alternatives, the inability of these studies to reveal evidence of convergence is not surprising. Cheung and Pascual (2004), however, use panel time series procedures for cross sectionally correlated panels because their ability to reject a false null hypothesis is higher than the corresponding univariate procedures. The results from procedures with different specifications of the null hypothesis help determine the usefulness of the data in terms of their ability to identify the convergence property. Nahar and Inder (2002) illustrate that there is an inconsistency in the convergence definitions proposed by Bernard and Durlauf (1995). The notion of convergence is linked to stationarity of output differences, but Nahar and Inder provide counter-examples to show that certain non-stationarity differences can satisfy this definition of stochastic convergence. Consequently, Nahar and Inder propose a new procedure for testing for convergence, either towards a single "leading" economy, or towards the mean of a group of economies.

3. OBJECTIVES OF THE STUDY, METHODOLOGY, HYPOTHESES, DATA SOURCES AND VARIABLE DESCRIPTION

3.1. The Objectives of the Present Study Are

(i) Provide theoretical foundation to the per capita growth equation. Identify some common and major determinants of economic growth rates across regions.

(ii) To know whether the selected 8East Asian, 5 South Asian, Commonwealth of Independent States (15) and 16 European Union countries EU16 (EU15+UK) are converging in absolute beta sense independently and jointly.

(iii) To measure the speed of absolute convergence.

3.2. Methodology

We shall test for the absolute convergence hypothesis using the data from the East Asian, South Asian, CIS and European Union countries. Bangladesh, India, Nepal, Pakistan and Sri Lanka from South Asian region. China, Hong Kong, Japan, Malaysia, Singapore, Thailand, Phillipines, Indonesia, from East Asian region and 16 European Union countries (Austria, Belgium Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, Norway and United Kingdom) and fifteen CIS nations (Azerbaijan, Belarus, Estonia, Latvia, Lithunia, Moldova, Russia, Tajakistan, Turkmenistan, Ukraine, Uzbekistan, Kazakistan, Krygistan, Armenia and Georgia) are considered. Test will be done jointly as well as independently, that is, first on 5 South Asian countries then on 8 East Asian countries, then on 16 European Union countries, 15 CIS nations and then on total 44 countries.

Linear and Non linear Regression between per capita average annual growth rate and initial level of per capita GDP is estimated to test and estimate the speed of absolute beta convergence respectively.

The following regression equation will be used to test the absolute convergence

$$Y_{it,t+T} = a + b \log y_{it} + e_{it}, \tag{1}$$

where $Y_{it,t+T}$ be economy i's average of yearly annual growth rates of GDP between t and $t+T$ (dependent variable) and $\log y_{it}$ is the natural log of economy i's GDP per capita at time t (independent variable).

If $b < 0$ and is significantly different from 0, then, we say that data set exhibits absolute beta convergence and we would reject the null hypothesis (H_0) of b=0. If the null hypothesis (b=0) were rejected, we would conclude that not only do poor countries grow faster than rich countries, but also that they all converge to the same level of GDP per capita. Left tailed test has

been used to work out the critical point beyond which the value of beta coefficient will imply rejection of the null hypothesis of non convergence.

To measure the speed of absolute convergence (in terms of percentage per year), non-linear least squares is used to estimate equation (2)

$$r_{it,t+T} = a - (1 - e^{-\lambda}) \log y_{it} + U_t, \tag{2}$$

where $r_{it,t+T}$ is the average annual growth rate of gross domestic product per capita between time period t and $t+T$. $\log y_{it}$ is the log (*natural*) of per capita gross domestic product at time period t. U_t is the error term. λ is the speed of convergence implying the speed at the which actual income is reaching its common steady state level of income (potential level of income) in an year.[3] In particular, if the production function is Cobb-Douglas with a capital share given by α the, the parameter λ is given by $(1-\alpha)(n+g+\delta)$ where g is the growth rate of technology, δ is the depreciation rate and n is the rate of population growth.

3.3. Data & Data Sources with Variable Description

Data set comprises 13 Asian (8 East and 5 South) countries, 15 Commonwealth of Independent States and 15 European Union countries and UK. Log of initial level of GDP per- capita (independent variable), initial per capita GDP and GDP per capita average annual growth rates (dependent variable), for the four time periods 1961-2001, 1970-2001, 1980-2001 are

[3] Strictly, one must use the exponential or continuous compound growth rate $(1/T)\log(Y_{it+T}/Y_{it})$ since equation (1) is obtained from solovian growth model (with its standard assumptions) for the exponential growth rates. However, as the exponential growth rates are determined only by the end-points and would be influenced for example, by the global recession of 2001 we have in stand proxied (indeed approximated) the same by the average of yearly growth rates. Of course, if one is finding the growth rate for every year and averaging it for the sample period, it will be affected by all events in the sample period, including events taking place at the end years. Equations (1) and (2) are derived from solving the Solovian model (1956) in its transitional dynamics phase. Please refer to Barro and Xavier-Sala-I-Martin (1995) and our subsequent sections for further clarification. In this phase, the model assumes that all economies have not reached their potential level of income (steady state level).

used for empirical analyses. This data set is from the data sample as described in-World Development Indicators on CDROM, various years. Different number of countries is included in CIS in different sub-periods because most of the CIS nations were formed at different intervals after the disintegration of the erstwhile Soviet Union in the late 1980s. For Latvia, Russia and Georgia the data is available from 1966-2001,while for Estonia and Moldova data is available from 1981-2001.

4. GROWTH EQUATIONS: ABSOLUTE CONVERGENCE AND ITS SPEED

It is possible to utilize a more general framework that examines the predictions of the Solow model for behaviour of per capita income out of steady state. Such a framework allows estimation of the effect of various explanatory variables on per capita growth rates as well as the speed at which actual income per capita reaches the steady state level of income per capita. We get the following differential equation if the model is solved around the steady state

$$\frac{\dot{y}}{y} = \lambda(\log y^* - \log y), \tag{3}$$

where $\lambda = (1-\alpha)(n+g+\delta)$ is the speed of convergence. Barro and Xavier-Sala-i-Martin (1995) define speed of convergence (rate at which the level of income per effective worker approaches its steady state)

$$-d(\frac{\dot{y}}{y}) / d(\log y) = \lambda, \tag{4}$$

i.e., speed of convergence coefficient λ is the proportionate change in growth rate caused by change in initial income per effective labour.

Equation (3) says that growth rate of income per effective labour is equal to the speed of convergence multiplied by the gap between steady state and actual level of incomes. Higher the gap, higher would be the growth rates. If the countries or regions have the same steady state growth & level of incomes, country or regions which are far away from its steady state will grow at faster rate and catch up with the relatively rich partner (absolute convergence).

Solving the differential equation (3) we get

$$\log \hat{y}_t = \log \hat{y}_0 e^{-\lambda t} + (1 - e^{-\lambda t}) \log \hat{y}^*, \tag{5}$$

where $\log \hat{y}_0$ is log of initial level of income per effective labour.

$$\log \hat{y}_t - \log \hat{y}_0 = -(1 - e^{-\lambda t}) \log \hat{y}_0 + (1 - e^{-\lambda t}) \log \hat{y}^*, \tag{6}$$

solving for income per labour

$$\log y_t - \log y_0 = -(1 - e^{-\lambda t}) \log y_0 + constant_i, \tag{7}$$

In equation (7) average per capita growth is found by dividing by time period t on both sides. Non linear least squares can be used to estimate equation (7) using cross sectional data. It is to be noted that if we assume that all economies here have the same steady state level of per capita income (in turn implying same structural parameters of the economy) and steady state growth, then $Constant_i$ = Constant, equation (7) would then imply absolute convergence, if the coefficient $(1 - e^{-\lambda t}) = \beta$ of $\log y_0$ is > 0 (implying negative relationship between average growth rate and initial level of GDP per capita).

In this study, we would estimate the variant of equation (7) by the below given linear equation by OLS assuming $Constant_i$ = Constant (a in the below given equation)

$$Y_{it,t+T} = a + b \log y_{it} + e_{it}, \quad (1)$$

where $Y_{it,t+T}$ be economy i's average annual growth rate of GDP between t and $t+T$, $\log y_{it}$ be the log of economy i's GDP per capita at time t.

If $b < 0$ and is significantly different from zero, it would imply absolute convergence.

λ measures speed at which the per capita income approaches the common steady state (potential level) of income Speed of convergence (λ) in an year is found by estimating equation (7) directly by using Non Linear Least Squares taking average annual GDP per capita growth as dependent variable and log of initial level of GDP per capita as independent variable.

In the present study, we would test for absolute convergence and work out the speed for absolute convergence using equations (1) and (7), respectively**.**

5. DISCUSSION OF THE RESULTS: ABSOLUTE CONVERGENCE

The Regression results (using 1961-2001 data) show that coefficient of initial level of GDP per capita b is < 0 (negative) and significant for countries in the EU and the EU and EA (East Asia) together (see all results of absolute convergence in table 2). Such results seem to suggest that absolute convergence hypothesis tends to hold for the EU region (all industrialized countries) and for the countries in the EU and East Asian regions together only. The EU countries including UK seem to have same steady state level of incomes implying that convergence hypothesis holds. For the industrialized countries of EU, the assumption that their economies have similar technology levels, investment rates and population growth may not be a bad one. The neoclassical model then would predict convergence, the same as the results confirm.

The rapid growth rates observed from 1960 onwards by most of the countries in East Asian region including China has led such countries to

Table 2 Absolute Convergence Results

Regions	1961-2001						
	Log of initial level**	*T*-value	R^2	*F*-value	Implied speed#	Obs.	Half life of convergence23 (years)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EU16	-0.92*	-4.28	0.57	18.33	2.56	16	26.9
SA(5)	1.29	1.14	0.30	1.3	-0.83	5	
EA(8)	0.01	0.03	0.01	0.001	-0.01	8	
CIS*	2.27	3.51	0.92	12.34	-1.18	3	
SA+EU+EA	-0.07	-0.5	0.01	0.25	0.06	29	
SA+EU+EA+CIS3	-0.01	-0.07	0.01	0.005	0.0096	32	
SA(5)+EU(16)	0.12	1.31	0.08	1.72	-0.11	21	
SA(5)+EA(8)	0.44	1.38	0.15	1.91	-0.36	13	
SA(5)+CIS(3)	-0.13	-0.36	0.021	0.13	0.14	8	
EU(16)+EA(8)	-0.44*	-2.9	0.28	8.46	0.57	24	121
SA(5)+EU(16)+CIS(3)	0.19	1.88	0.14	3.51	-0.17	24	
EU(16)+EA(8)+CIS(3)	-0.25	-1.39	0.072	1.94	0.28	27	
EU(16)+CIS(3)	0.3	1.41	0.11	1.98	-0.26	19	
EA(8)+CIS(3)	0.02	0.04	0.012	0.002	-0.02	11	
Regions	1970-2001						
	Log of initial level**	*T*-value	R^2	*F*-value	Implied speed #	Obs.	Half life of convergence23 (years)
(1)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
EU16	-0.82*	-2.24	0.26	0.78	1.72	16	40.1
SA(5)	1.16	1.39	0.39	1.93	-0.77	5	
EA(8)	-0.37	-0.88	0.12	0.78	0.46	8	
CIS*							
SA+EU+EA	-0.2	-1.41	0.07	2.01	0.22	29	
SA+EU+EA+CIS3							
SA(5)+EU(16)	0.004	0.45	0.01	0.21	-0.04	21	
SA(5)+EA(8)	0.14	0.43	0.02	0.19	-0.13	13	
SA(5)+CIS(3)							
EU(16)+EA(8)	-0.63*	-3.85	0.4	14.81	0.99	24	69.6

Regions	1980-2001						
	Log of initial level**	*T*-value	R^2	*F*-value	Implied speed #	Obs.	Half life of convergence23 (years)
(1)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
EU16	-0.63	-1.03	0.07	1.07	0.99	16	
SA(5)	0.34	0.94	0.23	0.88	-0.29	5	
EA(8)	-0.55	-1.14	0.18	1.31	0.8	8	
CIS*							
SA+EU+EA	-0.32*	-2.17	0.15	4.72	0.38	29	181.6
SA+EU+EA+CIS3	-0.24	-1.33	0.06	1.77	0.28	31	
SA(5)+EU(16)	-0.66	-1.41	0.10	2.00	1.07	21	
SA(5)+EA(8)	-0.11	-0.34	0.01	0.12	0.11	13	
SA(5)+CIS(3)	-1.18	-1.76	0.38	2.10	23.17	7	
EU(16)+EA(8)	-0.69*	-3.31	0.33	10.94	1.16	24	59.5
SA(5)+EU(16)+CIS(3)	-0.03	-0.18	0.002	0.033	0.03	23	
EU(16)+EA(8)+CIS(3)	-0.41	-1.46	0.08	2.13	0.52	26	
EU(16)+CIS(3)	1.25	3.1	0.38	9.64	-0.81	18	
EA(8)+CIS(3)	-0.47	-0.7	0.06	0.48	0.63	10	
Regions	1990-2001						
	Log of initial level**	*T*-value	R^2	*F*-value	Implied speed #	Obs.	Half life of convergence23 (years)
(1)	(23)	(24)	(25)	(26)	(27)	(28)	(29)
EU16	-0.72	-0.84	0.05	0.70	1.27	16	
SA(5)	0.06	0.06	0.001	0.003	-0.062	5	
EA(8)	-0.64	-1.33	0.23	1.76	1.02	8	
CIS*	-0.54	-0.57	0.04	0.33	0.77	10	
SA+EU+EA	-0.31	-1.90	0.12	3.61	0.36	29	
SA+EU+EA+CIS3	0.24	0.94	0.023	0.88	-0.22	39	
SA(5)+EU(16)	-0.15	-0.99	0.05	0.99	0.15	21	
SA(5)+EA(8)	-0.21	-0.68	0.04	0.47	0.24	13	
SA(5)+CIS(3)	-2.36*	-3.67	0.51	13.51	18.14	15	3.8
EU(16)+EA(8)	-0.66*	-2.72	0.25	7.39	1.08	24	63.8
SA(5)+EU(16)+CIS(3)	0.48	1.84	0.11	3.40	-0.39	31	
EU(16)+EA(8)+CIS(3)	0.62	1.97	0.11	3.89	-0.48	34	
EU(16)+CIS(3)	1.40	5.74	0.58	32.9	-0.87	26	
EA(8)+CIS(3)	0.34	0.50	0.02	0.25	-0.29	18	

Notes: * CIS=3 countries in 1996-2001, * CIS=2 countries in 1996-2001, * CIS=1 countries in 1996-2001. ** log of initial level of GDP per capita negative and significant value (*) imply absolute convergence. # Implied speed of convergence (+) / Divergence (-) in a year (%).

catch up with their richer and industrialized counterparts. Sachs *et al*. (1997) spell out three major reasons why these countries did better than others (at least from 1960-1997 till they faced currency and banking crisis in 1997). Such countries tend to have relatively higher share of investment to GDP ratio, greater trade openness and better quality of public institutions. However, more than that is that their labor force participation rates have increased from 1960s and along with relatively high economic growth rates tend to imply higher labor productivity for the whole region (see table 3). The first column of the table 3 shows that Japan has the highest income per capita among all the South Asian and East Asian countries. It is followed by Singapore and Hong Kong. Sri Lanka has the highest per capita income among all the countries in the South Asian region. The second column of table 3 reports a related measure, income per worker in 1997. The difference between the two columns lies in the denominator; the first column divides total GNP by a country's entire population, while the second column divides GNP by only the labor force. The third column reports the 1997 labor force participation rate – the ratio of the labor force to the population. Thailand has the highest labor force participation rate followed by China and then Japan. Nepal has the highest labor force participation rate among the South Asian countries included in our study. The labor participation rate for Bangladesh, India and Nepal has come down in 1997 from what in was in 1960. For example, India's labor participation rate has come down from 0.45 in 1960 to 0.44 in 1997. While Pakistan and Sri-lanka's labor participation rate have increased.

For all the East Asian countries included in our study the labor participation rates have increased substantially. For example, one may find from the table that China's labor force participation rates have increased from 0.53 in 1960 to 0.59 and so have the economic growth (5.94 from 1960-1997) implying higher labor productivity. Hong-Kong's labor participation rate has increased from 0.39 in 1960 to 0.52 in 1997, while for Thailand it has increased from 0.51 to 0.60. It is quite revealing from the table 3 that despite substantial increase in labor force rates for all the East Asian

Table 3 Growth and Development among Selected South and East Asian Economies

	GNPPC (Constant 1995 us $) in 1997 & GDPPC (Constant 1995 US$) in 2002	GNPPW (Constant 1995 us $) in 1997 (1960) & GDPPW(Constant 1995 US$) IN 2002	Labor force participation rate in 1997 (2002)	Labor force participation rate in 1960	years to double[a]	Population/ world population in 1997 (1960) (2002)	GNPCC/ GNPPC Of Japan In 1997 & GDPPC/ GDPPC of Japan (2002)	GNPPC/ GNPCC of Japan in 1960	Average annual growth rates of PCGNP (1960-1997) & PCGDP (1960-2002)
Bangladesh	351.622 396.20	689.456 (396.58) 742.51	0.51 (0.533)	0.54	47.803	0.022 (.017) 0.0219	0.008 0.008	0.026	1.45 (1.300)
China	667.858 944.12	1113.097 (172.84) 1571.4	0.59 0.600	0.53	11.669	0.217 (.221) 0.2071	0.015 0.020	0.011	5.94 (5.932)
Hong Kong	23646.947 25455	45474.174 (7747.34) 48120.	0.52 0.529	0.39	11.950	0.001 (.001) 0.0010	0.543 0.565	0.368	5.8 (5.256)
India	391.7436 493.27	890.337 (399.87) 1100	0.44 0.448	0.450	27.615	0.170 (.144) 0.1696	0.009 0.010	0.022	2.51 (2.469)
Indonesia	1095.591 1059.8	2331.089 (641.50) 2154.1	0.47 0.492	0.39	16.823	0.035 (.031) 0.0342	0.025 0.023	0.030	4.12 (3.592)
Japan	43574.383 45029	80692.75 (17097.94 84182	0.539 0.534	0.48	14.810	0.022 (.031) 0.0205	1 1	1	4.68 (4.147)

Korea, Rep.	11027.925 14279	22056.05 (3713.90) 27684	0.5 0.515	0.33	11.215	0.008 (.008) 0.0077	0.254 0.317	0.149	6.18 (5.889)
Malaysia	4468.503 4806.4	11171.251 (2741.08) 11368	0.4 0.422	0.35	16.195	0.004 (.003) 0.00393	0.103 0.106	0.117	4.28 (3.932)
Nepal	215.851 240.67	469.2467 (277.57) 515.03	0.460 0.467	0.54	67.295	0.004 (.003) 0.0039	0.005 0.005	0.0183	1.03 (1.350)
Pakistan	501.99 518.40	1356.724 (500.94) 1358.8	0.369 0.381	0.36	24.406	0.023 (.015) 0.0234	0.012 0.011	0.022	2.84 (2.567)
Philippines	1170.460 1208.9	2786.796 (1845.16) 2826.6	0.42 0.427	0.38	47.803	0.0130 (.009) 0.0129	0.027 0.026	0.085	1.45 (1.272)
Singapore	32486.066 27254	64971.806 (10038.18 55383	0.5 0.492	0.33	10.779	0.001 (.0004) 0.0006	0.746 0.605	0.404	6.43 (5.709)
Sri Lanka	770.176 898.81	1791.069 (772.60) 2027.1	0.43 0.443	0.36	24.667	0.003 (.003) 0.0030	0.018 0.019	0.034	2.81 (2.793)
Thailand	2821.170 3000.3	4701.990 (883.98) 4934.	0.6 0.6081	0.51	13.538	0.011 (.009) 0.0099	0.065 0.066	0.055	5.12 (4.607)

Source: Authors calculations from the World Bank, World Development Indicators, 1999 and 2004.

economies included in our study GNP per worker has also increased substantially in the period 1960-1997. This may also indicate the higher efficiency levels of the East Asian economies labor force. We also see from table 3 (column 6) that the bulk of the world's population lives in only two countries: China and India. China with 21.7% of world population had a GNP per capita of 1.5% of that of Japan (column 7) in 1997 and Indian with 17% of the world population had a GNP per capita of 0.9% of that of Japan. Together, these countries account for nearly 38.7% of the world population. In contrast, the 12 countries that make up the rest of the South Asian and East Asian countries account for 14.3% of the total population. Table 3 also shows how the distribution has changed from 1960. In 1960, China and India's share in the world population was 22.1% and 14.4% respectively, while in 1997, China's share has gone down marginally from 22.1% in 1960 to 21.7% in 1997,India share has gone up to 17 % in 1997. While China's GNP per capita constituted 1.1% of that of Japan in 1960, it is 1.5% in 1997. The corresponding figure for India was 2.2% in 1960, it is only 0.9% in 1997. Such figures for population and GNP per capita indicates that the increase in share of population for India since 1960 has led to its fall in its relative position in terms of GNP per capita vis-à-vis Japan.

Surprisingly, the empirical results (using data from 1960-2001) show that countries within East Asia do not show absolute convergence (column 4 in table 2). The beta coefficient of initial level of GDP per capita is positive though insignificant.

The regression coefficient for initial level of GDP per capita is negative but insignificant for regions SA+CIS, SA+EU+EA, EU+EA+CIS and SA+EU+EA+CIS implying that no conclusive evidence can be found in favor of absolute convergence of GDP per capita levels across most of the regions. For other regions within and across regions one finds no evidence of convergence of per capita income levels. For example, the countries within South Asian (SA) region show no evidence of convergence (positive beta though insignificant). Divergence is certainly present in case of the three CIS countries Russia, Latvia and Georgia. The lack of absolute convergence

within and across most of the regions except in EU and EU and EA together may be due to the fact that steady state level of income are not same across such regions. This may be due to the fact that all countries do not have the same investment rates, population growth rates, or technology levels, they are not generally expected to grow towards the same steady state target. Conditional beta convergence would be a better empirical exercise because it reflects the convergence of countries after we control for differences in steady states. It may be not out of place to confirm that conditional convergence is simply a confirmation of a result predicted by the neoclassical growth model: that countries with similar steady states exhibit convergence. It does not mean that all countries in the world are converging to the same steady state, only that they are converging to their own steady states.

The speed of convergence (the rate at which actual GDP per capita reaches common steady state levels) for EU region works out to be 2.56% in an year.[4] These results are in conformity with Barro and Xavier Sala- Martin (1995) who found speed of convergence to be approximately 2% across EU regions. Kaitila (2004) using panel regression finds speed of convergence of 2.6%for EU 15 countries using data from 1961-2001 (although without differentiating between speed of convergence and beta regression coefficient of the initial level of GDP per capita).[5] The speed of convergence for EU and EA region together works out to be only 0.57% in an year only. Depending on the speed of convergence, the half life of convergence[6] for the

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[4] Non-linear least squares have been used to estimate the speed of convergence. SPSS software has been used for some of the regression results. Starting values of zero are given to the parameters involved.

[5] Solving the simple Solovian model (1956) around the steady state under the factor accumulation assumptions of the model gives us the growth equation which relates per capita growth rates nonlinearly to log of initial level of GDP per capita. Equation (2) above is the final derived result. It is clear from this equation that speed of convergence parameter λ is different from the beta coefficient of initial level of GDP per capita of equation (1) above. It seems that Kaitila (2004) has missed the point.

[6] Half life of convergence is the time that it takes for half the initial gap between steady state (potential level of GDP per capita) and actual GDP per capita to be eliminated. In the equation $\log y_t = \log y_0 e^{-\lambda t} + (1 - e^{-\lambda t}) \log y^*$ the time t for which $\log y_t$ (actual income) is half way between $\log y_0$ (initial income)and $\log y^*$ (potential level or steady state level of

EU region worked out to be 26.9 years while for all countries in the EU and the East Asian region worked out to be 121 years. Mankiw, Romer and Weil (1992) argue that in the textbook Solow growth model, convergence takes place at a rate of 4%, which would imply that the economy moves half way to its steady state in 17 years. On the other hand, if the textbook model is augmented by human capital, the convergence rate declines to 2% and the economy moves to its steady state in 35 years.[7] Higher education makes it easier to adopt new technology.

A useful way to interpret growth rates of different regions from 1961-2001 was provided by Lucas (1988). A convenient rule of thumb used by Lucas is that country growing at g percent per year will double its per capita income every 70/g years.[8] According to this rule, GDP per capita in East Asian region will double approximately in 16 years (70/4.34=16.12), GDP per capita in South Asian region will double in 32 years (70/2.16),GDP per capita in EU region will double in 24 years(70/2.88) and GDP per capita in CIS (3) will double in 48 years (70/1.46).

Using data from 1970-2001, beta coefficient for log of initial level of GDP per capita is negative and significant for two regions, the EU and EU and East Asia (EA) together implying absolute convergence exist for such regions (see table 2). The speed of convergence works out to be is 1.72% (the speed at which the actual GDP per capita approaches the steady state

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income)satisfies the condition $e^{-\lambda t} = 0.5$. The half life is therefore $\log(2)/\lambda = 0.69/\lambda$ (fraction), where λ denotes speed of convergence. The above equation is derived by solving the Solovian model (1956) around the steady state.

7) The speed of convergence works out to be $(1-\alpha-\beta)(n+g+\delta)$ in an extended Solovian model (Cobb-Douglas production function with human capital - as in Mankiw, Romer and Weil, 1992). If α is interpreted to be the elasticity of output with respect to capital and β as elasticity of output with respect to human capital, assuming $\alpha+\beta=0.7$, n=0.01 per year (1%), $g=0.02$ (2%) and $\delta=0.05$ (5%) speed of convergence works out to be (0.3*8=2.4% which is approximately similar to the speed of convergence results we have got for EU.

8) Let y be per capita income at time t and let y_0 be some initial value of per capita income. Then $y = y_0 e^{gt}$. The time it takes per capita income to double is given by the time t^* at which $y = 2y_0$. Therefore, $2y_0 = y_0 e^{gt}$ implies $t^* = \log 2/g$.

level of GDP per capita) for countries in the EU while it is 0.99% for countries of the EU and EA regions together. Depending on the speed of convergence, the half life of convergence for the EU region worked out to be 40.1 years while for all countries in the EU and the East Asian region worked out to be 69.6 years. The speed of convergence figures are lower for EU and higher for EU+EA together as compared to the corresponding figures for the period 1961-2001. Beta coefficient for the initial level of GDP per capita is negative but insignificant for EA only and SA, EU and EA together. There is no evidence of absolute convergence among countries in the South Asian region, South Asian and East Asian region together and South Asian and EU region together.

Using data from 1980-2001 we find negative and significant beta coefficient for initial level of GDP per capita for the countries in the EU and East Asian (EA) regions together and also for the countries in the South Asian (SA), EU and EA regions together implying absolute convergence for such regions (see table 2). This phenomenon may be due to faster growth of SA region since 1980s.There is no evidence of convergence of GDP per capita levels of the nations in the EU and two CIS republics of Moldova and Estonia together. The beta coefficients for all other regions except South Asian region show negative but insignificant beat coefficient for initial level of GDP per capita implying tendency for convergence of the regions from 1980 onwards. South Asian region show no evidence of convergence in the periods 1961-2001 and 1970-2001. The speed of convergence in the EU and EA region together worked out to be 1.16% showing increasing trend from earlier periods 1961-2001 and 1970-2001. This feature shows that the East Asian economies are quickly (relatively) catching up with the European nations. The speed of convergence for all countries in the SA, EU and EA worked out to be 0.385% in an year. Depending on the speed of convergence, the half life of convergence for all the countries in the EU and EA region together worked out to be 59.5 years while for all countries in the SA, EU and the East Asian region together worked out to be 181.6 years.

Using data from 1990-2001, we find negative and significant coefficients for initial level of GDP per capita for the countries in the EU and East Asian regions together (speed of convergence of more than 1% with half life of convergence to be 63.8 years) and also for the countries in the South Asian and CIS regions together implying absolute convergence (with half life of convergence to be 3.8 years) for such regions (see table 2). The South Asian countries it seems are catching up in terms of GDP per capita with the newly formed republics of erstwhile Soviet Union since 1990s.The South Asian regions have shown relatively higher growth rates in 1990s while the newly formed CIS nations had difficult period of negative growth rates. However, there is no evidence of absolute convergence in terms of reaching the common GDP per capita levels for countries in the South Asian regions (as in earlier periods), the EU, EA and CIS together, the SA, EU, EA and CIS together, EA and CIS together and SA,EU and CIS together. For all other groups (which do no have CIS) we see negative but insignificant beta coefficient implying tendency towards convergence.

In summary, only countries in the EU and East Asian regions together have shown uniform evidence of absolute convergence in all periods 1961-2001, 1970-2001, 1980-2001 and 1990-2001. The speed of absolute convergence for such region had shown an increasing trend till 1990. While countries in the EU has shown significant evidence of absolute convergence in two periods, 1961-2001 and 1970-2001, there is no convincing case for absolute convergence in the last two periods of 1980-2001 and 1990-2001. This later evidence with declining rate of economic growth for the EU since 1961 (see table 1) may be a worrying sign for designing EU's regional policies which also have to cope up with many East European and Baltic nations who joined the EU on May 1, 2004. The South Asian regions in all periods have shown no evidence of convergence in their GDP per capita levels. Since 1980s, however, we do see some evidence of absolute convergence for all countries in South Asia, EU and East Asia.

6. CONCLUSION: POLICY IMPLICATIONS AND LIMITATIONS OF THE STUDY

The study is an attempt to understand and re-examine the convergence process (relatively poorer states catching up with richer counterparts) in the four regions included in our study from 1961 to 2001. Only EU and East Asian countries together have shown uniform evidence of absolute convergence in all periods 1961-2001,1970-2001,1980-2001 and 1990-2001. East Asian nations are catching up with their richer counterparts despite the setback in their economic growth performance in the late 1990s due to the currency and banking crises in the region. This (resilience) of the most of the East Asian economies like South Korea, Thailand, Indonesia, among others may be due to their higher labor productivity, quality of institutions, higher trade openness and relatively higher savings rate. While EU as a region has shown significant evidence of absolute convergence in two periods, 1961-2001 and 1970-2001, there is no convincing statistical evidence in favor of absolute convergence in the last two periods: 1980-2001 and 1990-2001. This latter evidence with declining rate of economic growth for EU since 1961 (see table 1) points to a challenge for designing EU's regional policies which also have to cope up new entrants - East European and Baltic nations (ten in all at this stage) who joined EU on May 1, 2004. Low growth is linked to high unemployment and the failure of the labor market as well to the unsolved problems in the systems of social security. This may require good governance and institutional changes.

Under current EU rules, regions with a per capita GDP of less than 75 percent of the EU average automatically qualify for EU regional aid under the so-called Objective 1 facility. With the accession of the East Europeans, average EU GDP will drop by about 10 percentage points. This means that many of the regions that currently have GDP per head less than 75 percent of the EU average, and so qualify for regional support, will no longer do so. As a result, all Germany's new states, all but two Spanish legions, and all but one region in Italy will no longer qualify for

Objective I funding. In addition, GDP pet head in Spain will move above 90 percent of the EU average, which means that it will no longer qualify for cohesion fund money.

The speed of absolute convergence in the four periods range between 0.99-2.56% in an year (2% for the EU as worked out by Barro and Xavier Sala-i-Martin, 1995 for European regions) for EU while it ranges between 0.57-1.16% in an year for the countries in East Asia and EU regions together. There is no evidence of convergence of GDP per capita incomes among the South Asian countries in all periods and some major CIS republics since 1966.Divergence in GDP per capita incomes among the South Asian nations over a period of time will be challenge for the policy makers who are keen on forming the South Asian Free Trade Association. Unless efforts are made to legalize trade channels and promote trade based on comparative advantage, there may not be much gain in regional liberalization efforts. However, statistical evidence shows that there is tendency for absolute convergence between countries of South Asia, East Asia and European Union particularly after the 1980s. The relatively inferior economic growth performances of some of the CIS republics particularly Russia have shown why socialism did not prosper in such countries. Most of the Eastern block nations and Russian federation are now keen to join the EU as they are eager to raise their living standards and catch up with their richer counterparts.

It seems that there are more important factors particularly in South Asian Region, besides the one taken in the study namely the initial level of GDP per capita, which can have deeper impact on convergence of incomes. These may be policies directed towards higher infrastructure spending, making bureaucracy efficient, reducing corruption, more open economies, less restrictive labor regulations, achieving political stability, implementing rule of law, understanding institutions, among others. It is up to future research to quantify such factors and generate time series data on such factors over long time period. The Global Competitive Report (2003-2004) is one such attempt.

Conditional beta convergence seems to be a better empirical exercise (as

evident from our theoretical model) because it reflects the convergence of countries after we control for differences in steady states. Conditional convergence is simply a confirmation of a result predicted by the neoclassical growth model: that countries with similar steady states exhibit convergence. It does not mean that all countries in the world are converging to the same steady state, only that they are converging to their own steady states

For research in future, conditional convergence can be tested using cross sectional average data on pertinent growth factors like corruption perception indices, rule of law index, social capital and trust variables, formal and informal rules governing the society, among others. It will be interesting to find out the speed of conditional convergence by including such variables in the per capita growth equation.

This study does not test for cluster convergence (Giles, 2001; Stroomer and Giles, 2003). This methodology uses 'fuzzy sets' to cluster the data (for one series) for the different countries in the sample, with the purpose of measuring the distance between the centers of these clusters at each point in time. If the centers of the fuzzy clusters move towards each other over time, this represents a particular type of convergence in the variable in question (e.g., in output, or in life expectancy, gini coefficient, among other indicators of quality of life). However, we have not attempted this approach in the present paper. The fuzzy regression could be used, for example, if the objective was to see whether countries which have had higher trade openness have a higher speed of convergence - countries could then be clustered in to open, partially open and other possibilities, by using fuzzy logic. The future research can take up this type of study for gaining insights into the growth process.

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