Economic Growth and Convergence in India

Kshamanidhi Adabar*

Abstract

In the recent years there has been considerable emphasis on understanding regional dimensions of economic growth in India within the convergence implications of neoclassical growth paradigm. The most important issue emerges from this literature is that how to control for differences in the steady state. This paper attempts to re-examine the issue of convergence and economic growth by focusing on the differences in the steady state of 14 major states of India from 1976-77 to 2000-01 by employing dynamic fixed effects panel growth regression. Once per capita investment, population growth rate and human capital along with state-specific effects are controlled for, then there has been evidence of conditional convergence at the rate around 12 % per five-year span. These variables alone could explain around 93 per cent variation in the growth rate of per capita real income across 14 major states from 1976-2000. This highlights the importance of policy activism to achieve balanced growth and regional convergence.

1. Introduction

In the recent years considerable attempts have been made to understand the regional dimensions of economic growth in India. Understanding the causes and nature of differences in levels and growth of income across the regions (countries) is very important because even small differences in the growth rates, if cumulated over a long period of time, may have substantial impact on the standards of living of people [Barro and Sala-i-Martin, 1995]. Further, inequality in any respect gives rise to unequivocal negative effects on subsequent growth and development, and worsens economic, social, and political tension among regions leading to misallocation of resources (Chowdhury, 2003). Therefore, it is important to identify the sources of changes in productivity and growth in order to recommend appropriate policies for accelerating growth and achieving equity by raising the standards of living of people in different states. Despite five and half decades of development planning in India aiming to reduce the income disparities among

* Ph.D Fellow in Institute for Social and Economic Change, Nagarbhavi, V.K.R.V Rao Avenue, Bangalore-560072. The author is grateful to Prof. M.R Narayana for his useful comments. email:kshama@isec.ac.in. Usual disclaimer applies.

regions, inequality in income and growth between the regions has been rising over the time. Since it may lead to disparities and divide among rural-urban regions and between specific groups of population in different states, explaining the differences in standards of living (measured in per capita income) across states in India has been a matter of serious concern among development economists, planners and policy makers, administrators, and social scientists. In spite of considerable research made on the subject, much more remains to be understood to explore the nature and causes of differences in growth rates in order to calibrate appropriate policies and institutions to achieve balanced regional growth and hence, regional convergence in terms of per capita income, and to combat poverty by spreading the benefits of growth processes in different regions of India.

Although the literature on regional growth and productivity in Indian economy is huge [Dholakia, 1985; Mathur, 1983; Datta Roy Choudhury, 1993; Cashin and Sahay, 1996; Marjit and Mitra, 1996; Rao et al., 1999; Ahluwalia, 2001; Sachs et al., 2002; Shetty, 2003 among others], neoclassical growth paradigm has been extensively used in the recent years due to its theoretical underpinning to understand the inter-regional and inter-country growth and level differences in standard of livings [Solow-Swan, 1956; Cass-Koopmans, 1965; Ramsay, 1928]. One of the basic predictions of the neoclassical growth theory is that economies with lower capital-labour ratio tend to grow faster than the economies with higher capita-labour ratio. It predicts that if the economies are similar with respect to their tastes and preferences, and technology, then there is an inverse relationship between the initial level of per capita income and its growth rate due to implications of diminishing returns to reproducible capital. The lower the initial level of per capita income, the higher is the growth rate of per capita income. Within this neoclassical growth framework a number of studies have attempted to examine the differences in growth rates and convergence across regions and countries [Baumol, 1986; Delong, 1988; Lucas, 1988,1990; Barro and Sala-i-Martin, 1995; Mankiw, Romer and Weil, 1992; Shioji, 1993; Cashin, 1995; Coulombe and Lee, 1993; Persson, 1994; Keller, 1994; De la Fuente, 1996; Koo et al., 1998].

There are a few studies in India that have focused on the issue of regional growth and convergence in per capita real income across the states, which are debated in nature. These studies have tried to show the tendency of convergence or divergence in per capita income among the states of India, and determine the responsible factors [Aiyer, 2001]. While some of these studies reveal that the growth pattern of per capita income has followed a divergent tendency in absolute terms [Marjit and Mitra, 1996; Rao et al. 1999; Dasgupta et al., 2000]; after controlling internal migration, center-state grants, and different indexes of physical, social and economic infrastructure, evidence is found in favour of unconditional and conditional convergence in per capita real income across the States [Cashin and Sahay, 1996; and Nagaraj et al., 1997; Aiyer, 2001]. Moreover, even if there has been evidence of either absolute or conditional convergence, the speed of convergence differs per se from low, 1.5 per cent [Cashin and Sahay, 1996] to high, 20 per cent [Aiyer, 1999] and 34 per cent [Nagaraj et al. 1997]. The Indian studies on growth and convergence have used different samples of states over different time periods and arrived at times conflicting conclusions. But, the most important issue arising from this literature is how to control for the differences in the determinants of steady state in general and differences in saving rates and technology (the determinants of steady state) in particular across Indian states (economies) due to lack of saving (investment) and capital stock data at the state levels.

The present study makes an attempt to account for differences in the steady state and re-examine the issue of convergence across 14 major states[1] from 1976-77 to 2000-01 using dynamic panel growth framework. The data set used in the study differ from earlier studies to account for differences in the steady state across the states. It uses relatively better data set of investment (saving) rate, population growth rate, human

[1] 14 major states are Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. These 14 major states account for 93 per cent of population and 91.5 per cent of Net Domestic Product (NDP) in the country and may, therefore, be taken as representative for this analytical purpose. Although the differences in technology, preferences, and institutions do exist across the states, it is assumed that these differences are likely to be smaller than those across countries. Furthermore, the states share a common central government and similar institutional and legal set up. The mountainous States of the north and northeastern parts of India, which are considered special category States by the Planning Commission and the small State like Goa, have been excluded from the analysis due to the significant differences in the structure of these economies from the rest of the States (Rao et al., 1999).

capital and initial level of per capita income in the theoretical line of neoclassical growth model to observe convergence without regressing the growth rate of income on a broad set of explanatory variables in the model.

The following section discusses the theoretical underpinning of analysis of convergence within the neoclassical growth paradigm. The third section gives the methodology of dynamic panel growth framework derived from neoclassical growth model while the fourth section deals with the sample and database. Section fifth discusses the empirical results. A concluding remark is provided in the end.

2. Neoclassical Growth Model

The basic prediction of convergence is derived from neoclassical growth theory due to diminishing returns to reproducible capital. In the Solow-Swan growth model [1956] output per effective worker depends on the initial level of output per effective worker, y^(0), the initial level of technology, A(0), the rate of technical progress, g, the saving rate, s, the growth rate of labour force, n, the depreciation rate of capital, δ, the share of physical and human capital in output, α and λ, and the rate of convergence to the steady state, β during the transitional dynamics. Thus, the model predicts that a high saving rate is positively related to the growth in output per worker and the growth of labour force is negatively related to the growth in output per worker after corrected for the rate of technological progress and the rate of depreciation of capital. The basic testable model is

$$(\ln \hat{y}_t - \ln(\hat{y}_0) = (1-e^{-b\,t})\ln(A_0) + gt + (1-e^{-b\,t})\frac{a}{1-a}\ln(s) -$$

$$(1-e^{-b\,t})\frac{a}{1-a}\ln(n+g+d) - (1-e^{-b\,t})\ln(\hat{y}_0) \qquad (1)$$

Equation (1) predicts that states with low initial output per effective worker possess faster transitional growth rates than the states with higher initial output per effective worker, conditioned upon the values (s, n, g, and ä). The transitional equation for the Solow-Swan model augmented with human capital is given by

$$
\begin{aligned}
(\ln \hat{y}_t - \ln(\hat{y}_0) = {} & (1-e^{-\beta t})\ln(A_0) + gt + (1-e^{-\beta t})\frac{\alpha}{1-\alpha}\ln(s) - \\
& (1-e^{-\beta t})\frac{\alpha}{1-\alpha}\ln(n+g+\delta) + (1-e^{-\beta t})\frac{\lambda}{1-\alpha}\ln(\hat{h}*) \\
& -(1-e^{-\beta t})\ln(\hat{y}_0) \qquad (2)
\end{aligned}
$$

where $\beta = (1-\alpha-\lambda)(n+g+\delta)$ = speed of convergence,

ln = the natural logarithm.

Further equation (2) implies that human capital is also positively related to the growth in output (income) per effective worker.

In the single cross-section analysis the above testable equations (1) and (2) are estimated under the assumption that the production structure is common to all countries (states). This assumption is necessary because it is difficult to observe the efficiency function of ln (A_t) and $(1-e^{-\beta t})\ln(A_0) + gt$ is assumed to be constant across the States[2]. Based on this assumption a number of studies have analysed the growth and convergence across countries and regions as mentioned earlier (e.g., Baumol, 1986; Levine and Renelt, 1992; Barro and Sala-Martin, 1995; MRW, 1992; Cashin and Sahay, 1996 among others].

Using the single-cross-section equation of types (1) and (2), however poses a number of problems. First, reducing the time series to a single (average) observation means that not all available information is used. Second, it is likely that single cross-section regression suffer from omitted variable bias. Third, one or more of the regressors may be endogenous (see Hoeffler, 2002).

Caselli, Esquivel and Lefort (CEL) [1996] argue that almost all existing cross-country regressions, either based on cross-section, or panel data techniques, have been estimated inconsistently. Without accounting for the omitted variable bias and endogeneity, the speed of convergence is potentially bias and inconsistent. How omitted variable bias and endogeneity of explanatory variables can be addressed through the

[2] For details about this assumption see Mankiw et al. (1992) and Garofalo and Yamarik (2002).

implications of dynamics panel growth framework in the neoclassical growth paradigm can be seen from Islam, (1995); Caselli et al. (1996); Easterly and Levine, (2001); Aiyer, (1999); Yao and Zhang (2001); Hoeffler, (2002).

3. Methodology

Dynamics Panel Growth Framework

We follow the dynamics panel growth framework of Islam [1995]. Islam [1995] reformulated the above testable empirical equation (1) and (2) derived from basic neoclassical growth model by converting the output (income) per effective worker to per worker output (income), and represented a dynamic panel data model with $(1-e^{-b\,t})\ln$ A (0) as the time-invariant individual state-specific effect term using conventional notation of the panel data literature.

$$y_{i\,t} = g\, y_{i,\,t-1} + \sum_{1}^{3} q_j\, x^{j}{}_{i\,t} + h_t + m_i + v_{it} \qquad (3)$$

where, y is the per capita output (income)

$$y_{i\,t} = \ln y_t$$
$$y_{i,\,t-1} = \ln y_0$$
$$g = e^{-b\,t}$$
$$q_1 = \left(1-e^{-b\,t}\right)\frac{a}{1-a}$$
$$q_2 = \left(1-e^{-b\,t}\right)\frac{a}{1-a}$$
$$q_3 = \left(1-e^{-b\,t}\right)\frac{l}{1-a}$$
$$x^{1}{}_{i\,t} = \ln(s)$$
$$x^{2}{}_{it} = \ln(n+g+d)$$
$$x^{3}{}_{it} = \ln(\hat{h}*)$$
$$m_i = \left(1-e^{-b\,t}\right)$$
$$h_t = g\left(t-e^{-b\,t}\,0\right),$$
$$n_{i\,t} = idiosyncratic\ \ error$$

τ = time interval of five-year period.

0 refers to the beginning of the period.

Estimating Dynamics Fixed Effects Panel Data Model

The single cross-section estimator (OLS) is only consistent as long as the individual effects is captured by random disturbance term, and assumed to be uncorrelated with explanatory variables. Since the unobserved individual effects are positively correlated with initial level of per capita income, omitting the individual effects lead to upward bias in the coefficient of lagged per capita income causing a downward bias in the estimate of convergence coefficient, β i.e., the rate at which the economy converges to the steady state [CEL, 1996].

The presence of lagged dependent variable in equation (3) makes the dynamics nature of growth regression. This dynamics fixed panel growth model can account for the differences in the individual effects and explain a part in the differences in the initial levels of technology across the states. There are various techniques to control this unobserved technological effects like minimum distance (MD) approach, Least Square and Dummy Variable (LSDV) approach [Islam, 1995] First Difference GMM [Arellano and Bond, 1991], System of GMM [Blundell and Bond, 1998], Hoeffler [2002] and Woodridge (2002) among others.

While controlling for unobserved state-specific effects one common issue is whether this technological effects is 'fixed' or 'random'. If the effects are random, they are assumed to be uncorrelated with the exogenous variables included in the model. Since the effects are considered to be correlated with saving rate and population growth rate and this correlation forms the basis of the argumentation for the panel approach [for example, GLS in Maddala, 1971], the assumption of random effects is considered to be unsuitable. The LSDV estimator, which is based on the fixed effects assumption, is permissible, although that assumption may seem too strong. One possible problem with LSDV arises from the dynamic nature of the panel data model. The presence of a lagged dependent variable makes LSDV inconsistent estimators, when asymptotic are considered in the direction of $N \rightarrow \infty$. However, the asymptotic properties of panel data estimators are in the direction of t, and Amemiya (1967) shows that when considered in that direction, LSDV proves to be consistent and asymptotically equivalent to Maximum Likelihood Estimator (MLE). Many other estimators start by eliminating the individual effects term through first differencing. Therefore, it does not matter whether the effect is fixed or random and whether ε is correlated with the exogenous variables. Yao and Zhang (2001) found that the LSDV estimator generated results that are robust although they are only consistent in the direction of t. Islam (1995) used both the LSDV and MD estimators proposed by Chamberlin (1982), but found that there was no significant difference between the two estimators. Therefore, the use of LSDV is an adequate approach. However, the theoretical properties of most of these estimators are asymptotic, and in terms of these properties they are equivalent.

Estimation of a dynamic panel with fixed effects poses a technical difficulty. Lancaster (1997) describes a method for consistent, likelikhood-based estimates by seeking an orthogonal reparameterisation of the fixed effects in the model, Unfortunately, this estimator is not applicable in the present case since it does not allow for the possibility of heteroskedasticity in the sample. Arellano-Bond (1991) show that first difference GMM estimator can be applied in a panel data regression with fixed effects and a lagged dependent variable. If the data set is 'small T and large N', a standard fixed effects estimator may be subject to a rather considerable bias. In small sample weak instruments can produce biased coefficients since consistency of the GMM estimator depends on the validity of the instruments [Easterly and Levine, 2001].

Aiyer (2001) also used the fixed effects formulation of panel data framework to control for unobserved differences between the steady states of Indian states. The fixed effect may be thought of as representing 'technology' or the efficacy with which inputs are transformed into outputs; it seems inevitable that this is not independent of an explanatory vector of variables important to the growth process. Like Aiyer (2001) we also exclude the use of this estimator in the small sample size of 14 Indian states due to the nearly singular weighting matrix. Therefore, ultimately we employ the LSDV estimator to the equation (3) by treating heterogeneous intercepts to account for individual specific effects ignoring the time effects η_t.

4. Sample and Data Sources

The study is based on secondary data sources to re-examine the issue of convergence in per capita real income across 14 major states from 1976-77 to 2000-01. NSDP (state income) and population are obtained from EPW Research Foundation (2003). Since saving or investment data at the state levels are not available in India federation, this study has used outstanding credits extended by All Scheduled Commercial Banks[3] (SCBs) and assistance given by All Financial Institutions[4], and government capital expenditure[5] as proxy for investment. Outstanding credits extended by all SCBs and assistance given by AFIs along with state government capital expenditure are assumed to be meant for investment purposes (i.e., capacity creating aspect of the economy). However, problems may arise in the overlapping of credits by different financial institutions. Another point is that some part of the credits may be used for consumption purposes. Furthermore, due to high Statutory Liquidity Ratio and Cash Reserve Ratio policies of Reserve Bank India, the amount of credits extended to primary, secondary and tertiary sectors may be less as expected. However, these are the limitations of investment used in the present analysis. The per capita income and per capita investment are measured at 1993-94 constant prices.

Human capital is found to be a positive and significant factor in influencing economic growth across countries and regions [Barro and Sala-i-Martin, 1995; Barro and Lee, 1993; MRW, 1992]. Despite the outcome indicators of human capital like literacy rate, enrolment ratio and life expectancy or infant mortality rate are very useful for analysing their impacts on growth of income, in broad sense human capital index could be a better indicator than these indicators since it includes both educational and health

[3] All Scheduled Commercial Banks compries of State Bank of India and its Associates Banks, Nationalised Banks, Regional Rural banks, and other Scheduled Commercial Banks (see, *Banking Statistics, Basic Statistical Returns, Reserve bank of India*).

[4] AFIs include All India Development Banks (IDBI, IFCI, ICICI, SIDBI, IIBI); Specialised Financial Institutions (RTCT, TFCI, ICICI Venture); Investment Institutions (LIC, UTI, GIC); and State Level Instituions (SFCs, SIDCs) (see, *IDBI Report on Development Banking in India*).

[5] State government capital expenditure includes only capital outlay and gross lending by states to avoid the duplications or overlapping between the capital expenditure and credits extended by SCB by excluding the relevant components from government expenditure; since state government resorts to borrowings that makes the part of the expenditure from internal sources particularly from markets loans provided by different commercial banks (see, *RBI State Finances*, various issues).

attainments. An attempt has been made in the present analysis to construct a human capital index to see its impact on differential growth of income across 14 major states from 1976-77 to 2000-01 (see, Appendix I). Therefore, per capita investment, population growth rate and human capital are used to account for the differences in the steady state to analyse conditional convergence across the states.

The present study covers the time period from 1976-77 to 2000-01 to observe convergence in per capita income across 14 major states of India. Annual time lenths data are very short to study growth convergence. Therefore, we have divided the total time period 1976-2000 into five-year shorter time periods to apply the dynamic fixed effects panel growth framework[6]. The constructed five-year periods are 1976-1980, 1980-85, 1985-90, 1990-95, and 1995-2000. However, the beginning period i.e., 1976-80 is kept as four-year period due to lack of some of the data used in the analysis. It is noted that our panel growth framework is such that the dependent variable is natural log of per capita income in the end point of the each five-year span while independent variable is natural log of per capita income at the beginning of the each five-year period. The independent variables such as per capita investment and population growth rate are averaged over the five-year period for each state. However, human capital index is used as human capital and introduced as state variable at the beginning of the each five-year span. Since our sample is 14 major states and we have 5 shorter time periods, the total number of observations in the fixed effects panel growth framework we have got pooling across individuals and time is 70. White's variance-covariance matrix is used to correct the standard errors of unknown form. We have used LIMDEP Version 7.0 by William Greene [1995] to estimate the dynamic fixed effects panel data model [equation (3)].

5. Empirical Discussion

In pooled regression and random effects panel data model although the structure of data set is comparable with the fixed effects model in the present study, we have not

[6] The formulation of panel data analysis is permissible if poolability test is satisfied after pooling across the cross-section unit and time period (Wooldgridge, 2002). In strict sense, in the present analysis, 14 major states are not pooled over the time period 1976-2000 due to nature of panel growth data structure. However, the F-statistics due to poolability test of the panel growth data set is negative (-3.61), which is unexpected.

used these models since unobserved state-specific effects is added to idiosyncratic error. Our purpose here is to account for the differences in unobserved state-specific effects. Therefore, dynamic fixed effects panel data model given in equation (3) can be employed to explain this unobserved state-specific effects and account for omitted variable bias.

However, assuming all the 14 major states of India are in the common steady state level of income per capita, absolute convergence analysis can be found by regressing ln of y_t on its natural log of initial per capita income, y0. The highly significant coefficient of ln (y_0) is found to be 1.027 from which the rate of convergence derived is –0.54 per cent over a five-year period. Since the structural characteristics differ across the states, they reach different steady state levels of income per capita over time. In order to control for the differences in steady state across the states, we have estimated the equation (3) with and without human capital with dynamic fixed effects panel data model and reported the results in column 2 and column 3 of Table 1.

The equation (3) is estimated without restriction to observe the elasticity of growth rate due to per capita investment and population growth rate. The coefficients of ln y0, ln (s) and ln ($n+g+\delta$) have the expected signs. These are significant at 1 per cent level except the coefficient of ln ($n+g+\delta$), which is significant at 16 per cent level. Every one per cent increase in per capita investment will increase the trend growth rate of per capita real income by 0.27 per cent while one per cent increase in population growth rate will reduce the growth rate of per capita real income by 0.15 per cent. The share of capital and population (labour force) in the state income is found to be 37 and 63 per cent respectively. Therefore, one of the finding of the study is that $\alpha = 0.37$ is quite reasonable within the neoclassical growth model. These three variables ln y0, ln (s) and ln ($n+g+\delta$) could explain 93 per cent variation in the differences in the trend growth rate of per capita real income across 14 states from 1976-2000.

The coefficient of ln y0, 0.5382 has the expected sign and is found to be significant at 1 per cent level. The modified for the differences in the way the equation (3) is specified, our estimate of initial per capita real income variable is –0.4618.

Accordingly the speed of conditional β convergence is found to be 12.39 per cent for every five-year span. It will take around 6 years to close the half way gap between the initial level of per capita real income and its steady state level. This high rate of convergence implies that the states are very close to their steady state values. It can be interpreted as the large differences in observed levels of per capita real income are arising from differences in the steady states levels, rather than from differences in the position of 14 major Indian states along their transitional growth paths. As captured by state-specific effects indicated by significant positive fixed effects coefficients also show some evidence that the differences in initial levels of technology may play an important role in generating dispersion in steady state levels (see, Table 2).

Aiyer (2001) has found the significant state-specific effects, which he has interpreted as conventional TFP measures or technical efficacy that helps to transform inputs into outputs. We have also got the fixed effects coefficients, which are all significant at 5 per cent level, which are relatively smaller, almost half of Aiyer (2001) (see, Table 2).

Comparing the rates of conditional convergence due to single cross-section and dynamic fixed effects panel data analysis is difficult since the structure of data and estimation are different. As mentioned earlier, the correlation with lagged income is positive; the coefficient for this variable would be biased upward in a cross-section study, implying that the convergence coefficient β will be underestimated. This is why absolute convergence differs from conditional convergence. It is because the former will always tend to be smaller than the later due to the bias arising from the omission of appropriate conditioning variables. Thus, dynamic fixed effect growth framework would be expected to yield higher estimates of convergence relative to the cross-section studies based on the conditioned variables that have gone before.

Therefore, the high rate of conditional β convergence in case of dynamic fixed effects panel data analysis in comparision to cross-section one (1.5 % in Cashin and Sahay, 1996) is attributed to the controlling of unobserved state-specific effects across the 14 major states. All the fixed effects estimates are significantly different from zero at 5 per cent level indicating the heterogeneity of intercepts in the 14 major states (see, Table 2). The simple correlation between these fixed effects estimates i.e., unobserved effects and the initial level of per capita income in each five-year span for all the regressions is equal or greater than 0.44. Due to this correlation the coefficient of initial level of per capita income in the single cross-section analysis is biased upward, which underestimates rate of the conditional convergence. Once the unobserved state-specific effects like initial level of technology, resource endowments, climatic conditions and social and economic environments are controlled for in the dynamic fixed effects panel data growth framework, then the rate of conditional convergence jumped up to a high level (i.e., 12.39 %).

Table 1: Conditional Convergence across 14 major States of Indian from 1976-2000

Column 1	Column 2	Column 3
ln y0	0.5382 (3.68)*	0.5302 (3.35)*
ln (s)	0.2707 (3.38)*	0.2634 (3.10)*
ln (n+g+d)	-0.1548 (-1.44)	-0.1530 (-1.44)
ln (h)		0.0360 (0.22)
Implied β	0.1239	0.1269
Implied α	0.3696	0.3592
Implied λ		0.0491
Half Life	5.59	5.46
R-square	0.95	0.95
Adj R-square	0.93	0.93
F-test	59.06	54.57

Note: *Note: Equation (3) is estimated with dynamic fixed effects panel estimation with and without human capital component. y0 is the initial per capita income at the beginning of each five-year span. Investment = [credits extended by all SCBs + assistance given by AFIs + state government capital expenditure]. s = per capita investment; n is the growth rate of population.* **d***+g = 0.07 by assumption.. h is the human capital index (constructed). Half-life is estimated by ln (2)/***b***. t-values are given in the parentheses. *, **, and *** refer to significant at 1, 5, and 10 percent levels.*

Since human capital is positively related to saving (investment) rate and negatively related to the growth of population, omitting this variable in the model (3) causes the omitted variable bias. MRW [1992] show that augmenting the human capital with Solow-Swan [1956] model can explain around 80 per cent variation in cross-country growth in income. However, it is surprising to note that estimating equation (3) with the inclusion of human capital, ln (h) shows that the coefficients of ln y0 and ln (s) are although significant at 1 per cent level, these slightly decline from 0.5382 and 0.27 to 0.53 and 0.26 respectively [see Table 1: column 3]. Neither the coefficient of ln $(n+g+\delta)$ nor the coefficient of ln (h) is statistically different from zero. The speed of convergence retrieved from the coefficient of ln y0 is found to be 12.69 per cent for every five-year period. This is a marginal increase over the rate of convergence (12.39) obtained without inclusion of human capital. The capital share parameter α is reduced to 0.36 from 0.37. In fact inclusion of human capital should accelerate the process of convergence and share of broad view of capital should increase as shown by Barro and Sala-i-Martin (1995) and MRW (1992). Unexpected impact of human capital on growth of income can be seen from (Islam, 1995).

Further, the inclusion of human capital does not influence the explanatory power of the model and Adjusted R-squares value remains to be same at 93 per cent. It is because the correlation between the per capita investment variable and human capita index used in this study is 0.67. The output indicators of human capital like education attainment (in the form of literacy rate and enrolment ratio) and health attainment (life expectancy at age one and infant mortality rate) may be influenced by the private and government investment made in social sectors in the different states. Maybe the positive coefficient of human capital indicates that the better off states could be able to spend more to improve the levels and quality of education and health attainment of social sectors than that of worse off states that resulted in positive relationship between total investment and human capital. However, since this coefficient is insignificant, it does not influence the differential growth of per capita income across 14 major states during the period 1976-2000.

Table 2: Fixed Effects Coefficients

Column 1	Column 2	Ranks	Column 3	Ranks
AP	2.26058 (2.48)	7	2.2487 (2.46)	7
BI	2.22128 (2.4)	10	2.2021 (2.44)	10
GJ	2.27852 (2.36)	5	2.2663 (2.39)	5
HY	2.37696 (2.38)	2	2.3670 (2.4)	2
KN	2.21315 (2.39)	11	2.1997 (2.42)	11
KR	2.19647 2.42)	12	2.1694 (2.47)	12
MP	2.37183 (2.48)	3	2.3576 (2.52)	3
MH	2.22226 (2.28)	9	2.2122 (2.3)	9
OR	2.18602 (2.4)	13	2.1676 (2.44)	13
PJ	2.30187 (2.32)	4	2.2926 (2.34)	4
RJ	2.44198 (2.45)	1	2.4314 (2.47)	1
TN	2.15615 (2.38)	14	2.1428 (2.41)	14
UP	2.23308 (2.39)	8	2.2183 (2.42)	8
WB	2.2758 (2.46)	6	2.2575 (2.50)	6

Note: $m_i = \left(1 - e^{-bt}\right)\ln A(0)_i$ *is the fixed effects coefficients of equation (3) estimated with Least Squares Dummy Variable (LSDV) technique. The estimated fixed effects coefficients are given in the column 2 and 3 due to without and with inclusion of human capital in the equation (3). All the fixed effects coefficients are statistically significant at 5 per cent level. AP = Andhra Pradesh, BI= Bihar, GJ=Gujarat, HY=Haryana, KN=Karnataka, KR=Kerala, MP=Madhya Pradesh, MH=Maharashtra, OR=Orissa, PJ=Punjab, RJ=Rajasthan, TN=Tamil Nadu, UP=Uttar Pradesh, and WB=West Bengal.*

This estimate of conditional convergence is relatively smaller than the high speeds of convergence (34 % and 20 %) found by Nagaraj et al. [1997] and Aiyer [2001] due to the differences in the data set used in this study and theirs, who have employed the panel data analysis. Although the framework and data set used in this study is quite similar to Aiyer's (2001) study (only two explanatory variables: per capita private investment and literacy rate); as mentioned earlier our data set is different from him to control for differences in the steady states across the states of India. Even if the time period, sample size and data set used in this study are not exactly same as that of Aiyer [2001], still we attempt to compare the finding of high speed of convergence (20 %). Our estimate of 12 % speed of convergence is accounted for both observed differences in the total investment due to outstanding credit extended by all SCBs, assistance given by AFIs and state government capital expenditure as well as population growth rate. Despite human capital index is better proxy for human capital and increasing over the period, it might not affect the differential growth of income per capita across the states (perhaps because of the mismatch between the education and the skill needed for activities that generate social returns) (see, Benhabib and Spiegel, 1994; Pritchet, 2001). As a result of this there may be a negative temporal relationship between the human capital variable and growth of income per capita across the Indian states.

6. Conclusion

This paper shows that the differences in the findings of absolute and conditional convergence. Absolute divergence is consistent with conditional convergence in the context of India. Once omitted variable bias along with determinants of steady state such as per capita investment, population growth rate and human capital are accounted for across 14 major states of India from 1976-2000, there has been evidence of conditional convergence at the rate 12 per cent per five-year period. It will take around 6 years for a state to close the half way gap between the initial level of per capita real income and its steady state level. Since omitted variable bias is not accounted for in the single cross-section analysis the speed of convergence tends to be smaller than the finding of conditional convergence due to the omission of appropriate conditioning variables. The unobserved state-specific effects in the form of differences in the aggregate production function could explain the variations in the steady states of Indian states other than per capita investment, population growth rate. However, human capital index variable does not seem to be a significant factor in influencing the steady state.

Although the income elasticity with respect to capital, 0.37 appears to be reasonable in the present context, the relatively high rate of convergence indicates that the Indian states are close to their steady states. Therefore, the large differences in observed levels of per capita real income across the 14 major states are arising from differences in the steady state levels, rather than from differences in the position of states along their similar transitional growth paths. Further, since conditional β convergence is consistent with sigma divergence, the high rate of convergence implies that inequalities of income and growth in Indian states are driven by wide differences in the steady states.

From the policy activism point of view the faster rate of conditional convergence gives the impression to be irrevalent as ascribed by Solow-Swan growth model (Islam, 1995). But then a state can emphasize on the initial level of technology [A (0)] as a determinant of the steady state level of income other than the variables like saving (investment) and population growth rates for policies purposes. Thus, even with similar saving and population growth rates across the states, it may help a state to improve its long-run position of economic growth by bringing about improvements in the components of A (0). Further, improvements in A (0) can have the effects on saving and population growth leading to an indirect increase in the steady state level of income. The fixed effects estimates of panel growth regression shows another dimension of estimation of total factor productivity, or the efficiency with which other factors of production are being transformed into output.

Despite the LSDV estimator of dynamic fixed effects panel growth framework helps us to control the omitted variable bias i.e., unobserved state-specific effects due to differences in the technology etc. across the Indian states to estimate the rate of convergence, it cannot solve the endogeneity problems of regressors due to lack of suitable instruments. A general method of moments (GMM) estimator in a dynamic fixed effects panel model can sort out these problems with suitable instruments of lagged values of explanatory variables to estimate the unbiased and consistent convergence coefficient.

Appendix I: Attempting to Construct Human Capital Index

Human capital is a broad concept capturing the elements of health and education attainments including experience and ideas etc. Usually indicators captured by health attainments such as infant mortality rate and life expectancy rate are relatively more stock in nature as compared to indicators of educational attainments implying less fluctuations over time unlike other macroeconomic variables. Introducing each element of human capital at the state levels between a time points can be used in the convergence analysis and its impact on differential growth of income across states can be examined. But, due to small sample size (i.e., 14 in the present case) it may create the loss of degrees of freedom problems. Due to differences in weights attached to each indicator of human capital, finding out a composite index for human capital is always a debated issue. Nevertheless, an attempt is made here to construct an index for human capital, which can further, be used in the conditional convergence analysis of Indian states.

Literacy rate and age-specific enrolment ratios for educational attainments, and levels of life expectancy at birth and infant mortality rate at age 1 for health attainments are used to construct human capital index in the present analysis. Following the composite indicator on educational and health attainments of National Human Development Report 2001 (Planning Commission, 2002) given as follows, it has been tried to construct the human capital index.

Composite indicator on educational attainment is obtained from equation (1)

$$CEA = [(e_1 * 0.65) + (e_2 * 0.35)] \qquad \ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

where e1 is literacy rate for age group 7 and above and e2 is the weighted age-specific enrolment ratios for age group 6-11 years and 11 to below 14 years by giving one-third weightage to former and two-third to the later.

Composite indicator of health attainment is given in equation (2)

$$CHA = [(h1 * 0.65) + (h2 * 0.35)] \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where h1 is life expectancy at age one, and h2 is reciprocal of infant mortality rate.

Now Human Capital Index is constructed as the simple average of the equations (1) and 2).

$$HC =(1/2)* [CEA + CHA] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(3)$$

In order to obtain a time series of HC, all the variables used for HC have been interpolated from 1976-77- 2000-01, which can be used for panel data analysis for growth and convergence. Since the data for these indicators are available for either at the five years or ten years interval, generating data over time may be useful to give some more insights to help establish the relationship among variables to understand the growth performance of different states. But, assuming the indicators to grow at constant rate between the time points is the obvious limitation.

References

Ahluwalia, Monte S. (2001): "Economic performance of the States in the post Reforms Period", Chapter 28 in *Indian Economy Since Independence* ed. Yuma Kampala, Academic Foundation, New Delhi.

Aiyer, Shepherd (2001): "Growth Theory and Convergence across Indian States: A Panel Study", Chapter 8 in *India at the Crossroads: Sustaining Growth and Reducing Poverty*, ed. Tim Cullen, Patricia Reynolds and Christopher Towel, International Monetary Fund.

Akkina, K. N. (1996): " Convergence and the Role of Infrastructure and Power Shortages on Economic Growth across States in India", mimeo, Kansas State University.

Amemiya, T. (1967): "A Note on the Estimation of Balestra-Norlove Models", Technical Report No.4, *Institute for Mathematical Studies in Social Sciences,* Stanford University.

Arellano, M. and Bond, S. (1991): “Some Tests of Specification for Panel Data: Monte Carlo Eveidence and an Application to Employment Equations”, *Review of Economic Studies*, Vol. 58, pp. 277-97.

Banking Statistics, Basic Statistical Returns, Various Issues. Reserve Bank of India.

Barro, Robert and Xavier Sala-i-Martin (1995): *Economic Growth*, New York: McGraw-Hill.

Barro, Robert J, (1991): “Economic Growth in a Cross-section of Countries”, *Quarterly Journal of Economics,* 106:2, pp.407-43.

Barro, Robert J, (1997): Determinants of Economic Growth: A cross-counties Empirical Study, The MIT Press, Cambridge.

Baumol, William J. (1986): "Productivity Growth, Convergence and Welfare: What the Long-run Data Show", *American Economic Review,* 76:1072-1085.

Bhattacharya, B.B, and S Sakhivel (2004): “ Regional Growth and Disparity in India: Comparision of Pre-and Post-Reform Decades”, Economic and Political Weekly, Vol. 39, No. 10, pp. 1071-1077.

Blundell, R and Bond, S. (1998): “Initial Conditions and Moments Restrictions in Dynamic Panel Data Models, *Journal of Econometrics*, vol. 111, pp. 115-43.

Caselli, D., G. Esquivel, and F. Lefort (1996): “Reopening the Convergence Debate: A New Look at Cross-country Growth Empirics”, *Journal of Economic Growth*, Vol. 1, pp. 363-89.

Cashin, P and R. Sahay (1996): “Internal Migration, Centre State Grants and Economic Growth in the States in India”, *IMF Working Paper*, WP/95/66.

Chamberlain, G., (1982): “Panel Dta” in the *Handbook of Economics*, Vol. II, ed. by Z. Grilliches and M.D Intriligator (Amsterdam:North Holland).

Cass, David (1965),"Optimum Growth in an Aggregate Model of Capital Accumulation", *Review of Economic Studies,* 32:233-40.

Chowdhury, Khorshed (2003) ‘Empirics for World Income Distribution: What does the World Bank Data Reveal?’, *The Journal of Development Areas* 36 (2): 59-83.

Dasgupta, D, P. Maiti, R. Mukherjee, S. Searcher, and S. Chakraverti (2000): Growth and Interstate Disparities in India", Economic and Political Weekly, July 1.

Datta Roy Choudhury, Uma (1993): "Inter-State and Intra-State Variations in Economic Development and Standard of Living", New Delhi: National Institute of Public Finance and Policy.

de la Fuente, A. (2002). "Regional Convergence in Spain, 1965-95," *CEPR Discussion*

De Long, J. B., (1988): "Productivity Growth, Convergence and Welfare: A Comment", *Americam Economic Review*, Vol. 78, p. 1138-1155.

Dholakia, R.H (1985): *Regional Disparities in Economic Growth in India*, Himalaya Publishing House, Bombay.

Dholakia, Ravindra H. (2003): "Regional Disparity in Economic and Human Development in India", Economic and Political Weekly, vol. 38, No. 39, p. 4166-4172.

Easterly, W. and Ross Levine (2001): "It's Not Factor Accumulation: Stylised Facts and Growth Models", The World band Economic Review, Vol. 15, N. 2 pp.177-219.

Galor, Oded (1996): "Convergence? Inferences fom Theoretical Models", *The Economic Journal*, 106:1056-1069.

Hoeffler, Anke E. (2002): The augmented Solow model and the African growth debate", *Oxford Bulletin of Economics and Statistics*, Vol. 64, No.2 pp. 135-58.

Hsiao, Chang (2003): *Panel Data Analysis*, Second Edition, and Cambridge University Press, New York.

IDBI Report on Development Banking in India- various issues.

Islam, Nazrul (1995): "Growth Empirics: A Panel Data Approach", Quarterly Journal of Economics, Vol. 110 (November), pp. 1127-70.

Juan-Ramon, V. H., and L. A. Rivera-Batiz (1996). "Regional Growth in Mexico: 1970-93," *IMF Working Paper*, WP/96/92, (August).

Koopmans, Tjalling C. (1965) *On the Concept of Optimum Economic Growth*, in The Econometric Approach to Development Planning. Amsterdam: North Holland.

Mankiw, N. Gregory, David Romer and David N. Weil (1992): “A Contribution to the Empirics of Economic Growth”, *Quarterly Journal of Economics,* 107(2): 407-437.

Marjit. S. and S. Mitra (1996): “Convergence in Regional Growth Rates: Indian Research Agenda”, *Economic and Political Weekly*, Vol. 31, No-33.

Nagaraj, R. A. Varaudakis and M. A. Veganzore (1997): *Long Run growth Trends and Convergence across Indian States*, Technical Paper, Development Center. No.131.

National Accounts Statistics, EPW Research Foundation, Mumbai, June 2003.

Planning Commission, (2002): *National Human Development Report, (2001)*, Government of India, New Delhi.

Quah, Danny (1996): “Twin Peaks: Growth and Convergence in Models of Distribution Dynamics”, *The Economic Journal*, 106:1045-1055.

Ramsey, F.P (1928), “A mathematical Theory of Saving”, Economic Journal, 38 (December). 543-559.

Rao M.G, and K. Sen (1997): “Internal Migration, Centre- State Grants and Economic Growth in the States of India: A Comment on Cashin and Sahay”, *IMF Working Paper,* Vol. 44, No.2.

Rao, M.G., R.T. Shand and K.P. Kalirajan (1999): “Convergence of Incomes across Indian States”, *Economic and Political Weekly*, Vol.34, No.13.

Sachs, J.D, N. Bajpai, and A. Ramiah, (2002): “Understanding Regional Economic Growth in India”, Harvard University, CID, working Paper No. 88,

Sala-i-Martin, Xavier (1996): “Regional cohesion: Evidence and Theories of Regional Growth and Convergence”, *European Economic Review* Vol.40, pp. 1325-1352

Sala-i-Martin, Xavier (1996): “The Classical Approach to Convergence Analysis", *The Economic Journal*, 106:1019-1036.

Shetty, S L (2003) ‘Growth of SDP and Structural Changes in State Economies: Interstate Comparisons’, *Economic and Political Weekly* 38 (49): 5189-200.

Sinha Tapen and Dipendra Sinha (2000): “No Virginia, States in India are NOT converging”, ***International Indian Economic Association, Working Paper No. 2000-09-01.***

Solow, Robert M. (1956): “A Contribution to the Theory of Economic Growth”, *Quarterly Journal of Economics*, 70:65-94.

Solow, Robert M. (2001): "Applying Growth Theory across Countries"***, The World Bank Economic Review, Vol.15, No. 2, pp. 283-288.***

State Finances, RBI- various issues.

Statistical Abstract of India 2001, Central Statistical Organization, Ministry of Statistics and Programme Implementation, Government of India, New Delhi.

Swan, Trevor, W. (1956): “Economic Growth and Capital Accumulation”, *Economic Record*, 32:334-361.

Woodridge, Jeffery M. (2002): *Econometric Analysis of Cross Section and Panel Data*, The MIT Press Cambridge, Massachusetts London, England.

Yao, Shujie, and Zongyi Zhang (2001): “Regional Growth in China Under Economic Reforms”, *The Journal of Development Studies*, Vol. 38, No. 2, pp. 167-186.