Club-Convergence and Polarisation of States:
A Nonparametric Analysis of Post-Reform India

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ABSTRACT

The objective of this paper is to study the dynamics of the distribution of regional per capita income of Indian states in the post reform period, in order to identify trends towards convergence-club formation, polarisation or stratification during this period. We adopt the 'distribution dynamics' framework that uses kernel density estimates, stochastic kernels and ergodic distributions in order to identify these trends. The results show that there is polarisation in India in the post-reform period and this is due to the contrary growth dynamics of the middle income states resulting in the 'vanishing middle' of the relative income distribution. Since polarisation increases the possibility of conflict, this study highlights one of the undesirable consequences of the current growth process in India.

Keywords: Distribution Dynamics, Regional Convergence, Nonparametric estimation, Polarisation, India

JEL Classification : C14, O18, O53, R11

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1. INTRODUCTION

For most of its post independence history, the Indian economy adopted inward looking policies based on the import substitution framework. The low growth of the seventies and early eighties and the balance of payment crisis at the beginning of 90's however, forced the policy makers to change course and move towards a market oriented economy. A series of policy reforms followed and this opened up the economy and integrated it with the international markets. Since then, the national growth rates have been increasing and are expected to continue at these high levels in the future.

The high national growth rates however, hide an unpleasant fact - the emergence of two Indias – one getting prosperous while the other remains stagnated with low growth and development. This has been established by a number of studies that have shown that in the post reform period, the (per capita) income inequality between the states have gone up. In terms of the growth theory framework, this implies that the growth process during this period has exhibited 'divergence'. This finding challenges the Neoclassical Growth framework based on the Solow growth model, which concludes that the process of capital accumulation and growth leads to the 'convergence' between regions (in this case the states of India) and hence income inequality between these regions should decrease over time. Followers of the convergence hypothesis have however, defended themselves by showing that although there may not be any sign of 'absolute convergence' of the states, their growth dynamics can be shown to follow 'conditional convergence', i.e., states that have similar steady state growth rates do actually converge towards this growth rate.

There have been a number of contributions to the 'divergence versus convergence' literature in the Indian context and there is, as yet, no consensus on this issue. Meanwhile, in the cross-country growth literature, it has been argued that the framework used to study convergence (or divergence) is based on aggregate measures of distribution – for example measures of inequality or cross section regression coefficients – and this does not capture various aspects of the growth dynamics of regions that are of interest. In the Indian context for example, although the overall divergence in the post reform period is clear - with states like Delhi, Maharastra, Haryana and Punjab persistently situated in the top bracket while Bihar, Orissa, and Uttar Pradesh languish at the bottom – there is a lot of interesting growth dynamics involving the states in the middle and the implication of these dynamics do not get captured by the studies of divergence. A number of these states show constant upward or downward movements (relative to the national average) indicating mobility of these states. For example, over the years, Tamil Nadu and Karnataka have shown upward movement in terms of their relative position while Jammu & Kashmir and Madhya Pradesh have been losing its relative position consistently. A number of recent contributions to the growth literature have shown that such relative movements of regions can lead to club-convergence, and most importantly, the polarisation of regions over time.

The idea of club-convergence is best understood as an alternative to the idea of conditional convergence. In the latter case, regions that have a common steady state (that is determined by the conditioning variables) converge towards this steady state. Thus, it is possible that while the regions as a whole exhibit divergence, sub-groups of regions that have a common steady state exhibit convergence. Such within-group convergence in the midst of overall divergence is also possible within the club-convergence framework. However in this framework, such sub-groups are differentiated by the initial values of some important variables lying below or above a critical threshold value. In other words, regions with initial conditions above this threshold converge to form a club with a higher income while those below the threshold converge to form another club with a lower income. Now, there may be multiple threshold values leading to multiple clubs, but perhaps the most important case is the one where there is one threshold leading to the formation of two clubs. It is easy to understand in such a case, the regions within an economy get distributed into two groups over time, leading to the 'Polarisation' of the economy.

There are two important points about the process of polarisation that need to be recognized in order to understand the need to study this phenomenon. The first point is that polarisation is not the same as an increase in inequality, although both of them are related to the changes in the distribution. Thus, it is possible to have higher levels of polarisation even in the face of falling inequality, if the distribution gets more bunched over time. The second point is that more than rising inequality, it is increased polarisation that has the potential to foment social conflicts. This is due to the fact that with an increase in polarisation, members of the low income club start identifying and empathising with each other and feeling more and more alienated from the members of the high income club. This increases the possibility of conflicts between the two clubs where a large number of members can get involved. Clearly, if this were to happen between the regions of a country, then the size of the conflict will increase manifold. Particularly for a country like India, which is extremely varied in culture, language and religion, increasing polarisation can create tremendous social tension. This is the motivation behind the present study which examines the possibility of club-convergence and polarisation in post-reform India.

The cross-country study of club-convergence and polarisation has given rise to a large and growing literature. It has been shown that in order to study such phenomenon, it is necessary to develop a framework that analyses the evolution of the complete cross-section of income distribution over time. As we shall show in a subsequent section, a regression based approach does not throw sufficient light on club formation. Instead, the literature has used a non-parametric approach based on the estimation of a kernel density function and studied its dynamics over time. In this paper we use this approach to study the formation of convergence clubs and trends towards polarisation in the Indian economy in the post-reform period. The study covers a number of related issues. Firstly, it analyses the dynamics

of the distribution of per capita income of Indian states in the post-reform period. Secondly, it tests for the robustness of these results by repeating the exercise for alternative groups of states. Thirdly, it identifies the group of states that play important roles in the process of this transition and the formation of the convergence clubs. The rest of the paper is arranged as follows. Section 2 provides a detailed review of literature. Section 3 describes the conceptual framework used in the study. Section 4 discusses some details of the empirical work while section 5 presents the results. Section 6 concludes the paper.

2. CONVERGENCE AMONG INDIA STATES

The first comprehensive study on regional convergence in India is Cashin and Sahay (1996). The authors estimate Barro regressions covering the period 1961 to 1991 in 20 Indian states and find evidence of absolute convergence. They (Cashin and Sahay, 1996) also try to find out the factors responsible for this result. According to them interstate grants are mostly responsible for the above mentioned trend. Dholakia (1994) estimates growth acceleration in 20 major Indian states in the period 1960 to 1989 and reaches a similar conclusion of convergence. Patel (2003) also concludes that there is evidence of convergence in the period 1980 to 1999. He finds six statistically significant factors responsible for this trend. According to him high quality governance, human capital stock and job creation are the stimulants to growth.

Though the above studies show the existence of absolute or conditional convergence among Indian states, many studies find evidence of divergence. Marjit and Mitra (1996) was the first to point out that from 1960 the Indian states show a diverging trend instead of convergence. They argue that the trend line fitted by Cashin and Sahay (1996) from the scatter plot is wrongly fitted and only two points lie on the fitted line. They reproduce the scatter plot and show an upward trend or divergence in per capita income. Marjit and Mitra (1996) argue that the framework for studying regional convergence should not be similar to cross-country studies. Regional economies are different from the countries in the sense that the factor flow is perfect among the regions of a country compared to imperfect factor mobility or perfect immobility of the factors in cross-country studies. As a result if there is any difference in per capita incomes among the regions of a country, convergence should be instantaneous. However, the speed of convergence in Cashin and Sahay (1996) is 1.5 % only. Another paper by Ghosh et al. (1998) studies the period 1960-61 to 1994-95. They find strong evidence of divergence among states. They justify their findings with the argument that compared to the regions of a developed country, increasing returns operate for the states of India. Hence, the regions with higher capital labour ratio will attract more capital from the regions with scarce capital and the bias of capital flow will be to the richer states. They also add that with public sector intervention, free-market forces have limited impact. As a result there is a strong case of increasing returns to capital. Rao et al (1999) find the existence of absolute and conditional divergence during 1965 to 1995 among 14 major states. They identify unequal private

investment as contributing to divergence. Sachs et al. (2002) confirmed the above finding and found geographical variables to be responsible for this diverging trend. Ahluwalia (2000, 2002) using population weighted Gini Coefficient also confirmed these findings.

An alternative set of studies focus on the possibility of conditional convergence in India. Nagraj et al (1998), following the methodology proposed by Islam (1995), find that there is no evidence of absolute convergence in a panel of 14 states during the period 1970 to 1994. However, they find evidence of conditional convergence. They show that the share of agriculture in total output, infrastructure, political and institutional factors are the conditioning variables. Aiyar (2001) confirms the finding of conditional convergence. According to him, infrastructure, private investment and non-measured institutional factors are the conditioning variables.

Though most of the studies on convergence cover a large part of the post independence period, some recent studies look specifically at the post-reform period. Various economic reform measures have been implemented in India during the early 1990's and throughout the subsequent decade. Studies of the nature of the growth of per capita state domestic product in the post-reform period are important to understand the impact of reform on regional inequality and convergence. Ahluwalia (2000, 2002) focuses on the 1990's using a population weighted Gini coefficient, and show that inequality in real per capita regional output increased from 0.175 in 1991-92 to 0.233 in 1998-99 among 14 major states. Sachs et al (2002) using different measures of convergence found no sign of absolute as well as conditional convergence in post-reform India. The above studies have taken only major Indian states due to data limitations for union territories and small states. Shetty (2003) takes all the Indian states and union territories, and confirmed the trend of divergence among Indian states. According to Nagraj (1998), coefficient of variation of per capita regional output increased rapidly in 1990's after stabilization in the '80s. Rao et al (1999) also found evidence of divergence in the early '90s in a similar study. Bhattacharya and Sakthivel (2004) found that inequality in per capita regional output increased in post reform period compared to the '80s. Kar and Sakthivel (2007) using the "new geography" framework analyse the impact of reforms on per capita regional output. They also study the impact of reforms on the contributions from different sectors and confirm the evidence of post reform divergence in India. In summary the above studies show that regional inequality remained stable till 1986-87 and increased thereafter. In a more recent study, Ghosh (2008) show evidence of divergence in the post reform period. There exist some other studies which find no clear evidence of convergence or divergence in post reform India. Singh et al (2003) find no uniform trend of divergence in post reform period. Therefore, the results from the growth regression either using cross-section data or panel data are mostly inconclusive.

There is another set of studies which go beyond the issues of simple convergence or divergence among the states of India and look into the evidence of "convergence clubs" or "polarisation" in the per capita income distribution. Trivedi (2002) is one of the first attempts

to throw light on polarisation during the period 1960-1992 among the 16 Indian states. Using kernel density estimation the study showed that "a small group of states are pulling away from the rest of the distribution, causing an incipient second peak". Very recently, Ghosh (2008) using time series techniques to test convergence, concludes that there exist two distinct convergence clubs. The study test unit roots to the per capita regional output series for the period of 1960 to 2000 following the techniques of Bernard and Durlauf (1995). According to Bernard and Durlouf (1995), if the difference of the series is stationary, then the series converge. Ghosh (2008) test for the presence of unit root for difference in per capita regional output series and find that only four out of fifteen states approach a common steady state. Other eleven states diverged form each other. The author concludes that there is evidence of convergence club formation. Gunji et al (2004) use the transition probability matrix along with time series techniques to throw light on the possibility of convergence club formation for the period 1970 to 2000 in 14 major states. They estimate kernel density for the above mentioned period and show the existence of triple peaks in the distribution i.e., there exist high income, low income and middle income clubs. From Markov transition matrix they find that the low income states tend to become rich before economic liberalisation. However, the probability of poorer states becoming rich decreases after liberalisation. Although the Markov transition matrix can give results in terms of ergodic (long-run) distributions, it is not a very robust approach as the results are very sensitive to the choice of the discrete groups in the transition matrix. Quah (1997) provides a solution to this problem by formalizing the distribution dynamics approach to the analysis of convergence. Bandyopadhyay (2006) adopts this framework to analyse the Indian states for the period 1965 to 1997. The paper shows the there is evidence of convergence in the '60s and emergence of 'twin peaks' and 'polarisation' in the early '90s among 17 major Indian states. Comparing with the panel data regression approach, the study establishes the superiority of the distribution dynamics approach in the Indian context, and identifies infrastructural inequality as the main factor responsible for the emerging 'twin peaks'. In the next section, we explain the distribution dynamics approach in some details.

3. DISTRIBUTION DYNAMICS AND POLARISATION

Traditionally, there are two approaches to convergence analysis i.e., the regression based approach (using cross-section, panel and time series data) and the dispersion-based approach. The regression based studies focus on β-convergence, which is confirmed if the coefficient of initial per capita income in a regression of per capita growth rates is negative[4]. The focus

[4] This particular concept of convergence is known as unconditional β-convergence. There exists another concept of β-convergence, known as conditional β-convergence. In this case economies converge to different steady states where the steady states are determined by factors such as human capita etc. These factors are the controlling variables in the

of the dispersion-based approach is to look for σ-convergence, i.e., whether the dispersion of per capita income diminishes over time. Hence both these approaches are based on summary measures (the first on a regression coefficient and the second on a measure of dispersion) of the underlying distribution. In this section we discuss the conceptual and econometric problems associated with these two summary measures and try to develop a case for the distribution dynamics approach, where the evolution of the complete distribution (as opposed to a summary measure) is studied in a dynamic framework. This distinguishes the distribution dynamics approach from the σ and β convergence approaches.

The shortcoming of the summary measures (i.e., the σ and β convergence approaches) were pointed out by a series of papers starting with Friedman (1992) and Quah (1993a). These papers demonstrated that the idea of β-convergence suffered from 'Galton's fallacy'[5]. According to them the negative coefficient of initial per capita income in a regression of per capita growth rates (β-convergence) is a necessary but not sufficient condition for the dispersion of per capita income to diminish over time, which is the essence of convergence. They highlight this point by showing that β-convergence is compatible with constant or even increasing per capita dispersion of income. As a result of this critique, Barro and Sala-i-Martin (1992, 1996) introduced the distribution-based concept of σ-convergence to complement the idea of β-convergence. They argued that while β-convergence is a necessary condition, σ-convergence is the required sufficient condition for convergence. According to them, although σ-convergence gives us an idea about the convergence process, β-convergence is still important since it gives a measure of the speed of the catch-up of the poorer regions with the rich. Accordingly, they recommend using both β and σ-convergence together. However, Quah (1993b, 1996) show that the concept of σ-convergence is also incomplete as a tool for providing sufficient insight into the convergence process. He argued that the assumption behind σ-convergence is that there is a one-time shock to the cross-section of economies in the initial period and then the economies move towards their steady state following a smooth and monotonic path. However, the reality is that the time paths of the economies are affected by continuous shocks, instability or volatility and as a result the dispersion of their cross-section distribution does not diminish over time, but rather, remain more or less constant. Interestingly, while the overall dispersion is constant, there are various kinds of regional dynamics possible, which are of interest. These include criss-crossing, leapfrogging, persistence inequality and even poverty traps, all possible within a constant σ band. Clearly, σ-convergence is unable to capture all these possibilities. Quah (1993a, 1996, 1997) argue that to understand these different forms of convergence, one has to look at the evolution of the complete distribution of per capita income over time. In order to do this, he introduced the distribution dynamics framework to study convergence

corresponding regressions.

[5] This involves the fallacious logic that any regression of a growth rate on levels with a negative and statistically significant coefficient implies convergence towards the mean.

processes including the different possibilities mentioned above. This framework studies the evolution of the distribution of per capita income over time by analysing the kernel density plots of initial, final and the long-run distributions, identifying the formation of convergence clubs, polarisation or persistent inequality etc. Mobility or persistence within the distribution can also be studied using the 3-dimensional plots of a stochastic kernel and its corresponding 2-dimensional contour plots.

In the rest of this section we briefly discuss the conceptual framework of the distribution dynamics approach. Assume that the distribution of per capita income at time *t* is φ_t Then the simplest form of the dynamics of this distribution $\{\phi_t : t \geq 0\}$ can be represented using the Markov chain assumption (i.e., given the present state, future states are independent of the past). This is similar to the first order autoregressive process and hence the dynamics of the distribution at time *t* is given by

$$\varphi_t = T\ (\varphi_{t-1}, u_t), \quad t \geq 1 \tag{1}$$

Where, *ut* is the disturbance term. *T* is the operator that maps how one part of the distribution evolves to another from time *t-1* to *t*. When *T* absorbs the disturbance term it becomes a stochastic kernel. Therefore, the dynamics of the above process can alternatively be written as

$$\varphi_t = T_{ut}(\varphi_{t-1}), \qquad t \geq 1 \tag{2}$$

The above equation indicates that the cross-section distribution changes from its current state to another state according to a certain probability distribution. The changes of the state are called transitions, and the functional relationship of these transitions is called transition probability function or a stochastic kernel. In equation (2), *T* is the stochastic kernel which shows how the distribution evolves over time. It contains information about the shape and the dynamics of the distribution. Iterating the system using equation (2) and the Markov chain assumption, we get

$$\varphi_{t+1} = M'\varphi_t, t \geq 1 \tag{3}$$

or,

$$\varphi_{t+s} = (M^s)'\varphi_t \qquad \text{for all } s \geq 1 \tag{4}$$

Similarly, iterating the system up to infinity, we get the long-run (ergodic) distribution. Therefore, the ergodic distribution of per capita income is as follows

$$\varphi_\infty = M'\varphi_\infty, s \to \infty \tag{5}$$

φ_{∞} is the long-run limit of the distribution of income across regions. If the distribution after s periods (φ_{t+s}) and/or the ergodic (long-run) distribution (φ_{∞}) shows a tendency towards point mass, it is indicative of convergence over time. Alternatively, if φ_{t+s} or φ_{∞} shows a tendency towards bimodality, it can be concluded that the distribution tends towards polarisation. If more than two modes are identified, then it is evidence of stratification of the distribution.

In order to operationalize these concepts, the operator T^*_{ut} has to be represented in a continuous income space by a stochastic kernel (Quah, 1997). Let us assume that $\{(y_1, z_1),\ldots\ldots\ldots, (y_n, z_n)\}$ represents the set of a pair of per capita relative income of different regions in the cross-section and n represents the number of regions. Here, y and z denote the initial income and the income after s periods. If the cross-section distribution of income is represented by the density functions $f_t(y)$ and $f_{t+s}(z)$ at time t and $t+s$ respectively, then the stochastic kernel is defined by the equation

$$f_{t+s}(z) = \int_0^{\infty} g_s(z|y) f_t(y) dy \tag{6}$$

where $g_s(z|y)$ is the conditional distribution after time s and represents the stochastic kernel. Similarly, the ergodic (long-run) distribution is given by

$$f_{\infty}(z) = \int_0^{\infty} g_s(z|y) f_{\infty}(y) dy \tag{7}$$

The conditional distribution in equation (6) and (7) is by definition, the ratio between the corresponding joint distributions and the marginal distributions. The joint and the marginal distributions can be estimated using kernel density functions.

The concepts that have been discussed above provide the basis for the distribution dynamics approach. As discussed earlier, in this approach, the analysis of convergence is carried out by studying the kernel density estimates of the cross-section distribution of regional income over time as well as the ergodic distribution. The number of modes on the ergodic distribution determines whether the system is moving towards convergence, polarisation or stratification. This approach also uses the stochastic kernel to identify the intra-distributional dynamics that is responsible for these above results. The next step is the estimation of the kernel densities, the ergodic distribution and the stochastic kernel. The details of this exercise are presented in the next two sections.

4. SOME DETAILS OF THE STUDY

In this study we analyse the dynamics of the distribution of regional per capita income in India in the post-reform period. In order to do this we estimate kernel density functions, ergodic distributions and the stochastic kernel of per capita Gross State Domestic Product

(GSDP) over this period. The GSDP data has been taken from the Central Statistical Organisation (CSO) for the period 1993 to 2005 (base year 1999-2000) for twenty one major Indian states[6]. For our analysis, the per capita GSDP of each state has been normalised by the aggregate per capita output of the states in the sample, for the corresponding years. This normalisation ensures that the distribution dynamics ignores the aggregate growth effect of the states and reflects only the state specific (relative) growth effects. Next, we use these normalised outputs to estimate the univariate kernel densities and the stochastic kernels.

In the kernel density estimation procedure, there are two essential steps, i.e., the choice of the appropriate kernel function and the choice of the bandwidth. There are different kinds of kernel functions including the Uniform, Triangular, Epanechnikov and Gaussian kernels that are used for kernel density estimations. However, it has been recognised in the kernel density literature that the estimation is not very sensitive to the choice of the kernel function. In this study we use the Gaussian kernel function which is also used by other studies in the literature. The choice of an appropriate bandwidth is – on the other hand – a very important step as it has a significant impact on the density estimates. The prevalent practice involves choosing a bandwidth that minimises the asymptotic mean integrated square error (*AMISE*), in order to balance between the bias and the variance of the estimation[7]. The equation of the *AMISE* is

$$AMISE = (nh)^{-1} R(K) + \frac{1}{4} h^4 \acute{o}^4_k R(f'') \tag{8}$$

where, $R(K) = \int K(x)^2 dx$ is a measure of roughness of the kernel function (K). The first term in the above equation is the integrated variance, which is proportional to $(nh)^{-1}$. The second term is the integrated square bias and it is proportional to h^4. Therefore, in the above *AMISE* equation, there is a trade-off between the bias and the variance of the kernel density estimation and the choice of the bandwidth tries to establish a global compromise between the bias and the variance.

In this study, we use two different dimensions of the data, i.e., per capita income for the initial and final years (1993 and 2005). Therefore, we use two different bandwidths for two different dimensions. Hence, in this study we use diagonal bandwidth of the form

$$H = diag(h_y, h_z) \tag{9}$$

[6] The 21 states are Andhra Pradesh, Assam, Bihar, Chattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharastra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttranchal, West Bengal.

[7] One of the most important problems in the kernel density estimation is to strike a balance between bias and variance in the estimation. A large bandwidth may reduce the bias of the estimation but at the same time increase the variance. Similarly, a small bandwidth will do the opposite i.e., it reduces variance at the cost of increasing bias. Therefore, in estimating a kernel density there should be a balance between the bias and the variance. This can be done by minimising the asymptotic mean integrated square error (AMISE).

where, the two different bandwidths h_y and h_z are used for smoothing in the two different dimensions. Finally, within a single dimension, the observations are not always distributed regularly, and hence the bias-variance trade-off again appears with in the same dimensions. In this study we choose a variable bandwidth selector – that varies according to the density of the observation – in order to take care of this problem.

5. CONVERGENCE CLUB AND POLARISATION IN POST REFORM INDIA

In this section, we track the evolution of the distribution of real per capita income in post reform India and study the possible formation of convergence clubs, polarisation or stratification during this period. As explained earlier, the per capita GSDP of each state is normalized by the aggregate per capita output of the states in the sample for the corresponding years. This gives us the relative per capita outputs which are then used to estimate the kernel density and the Ergodic distribution (long-run distribution) for the years 1993 to 2005.

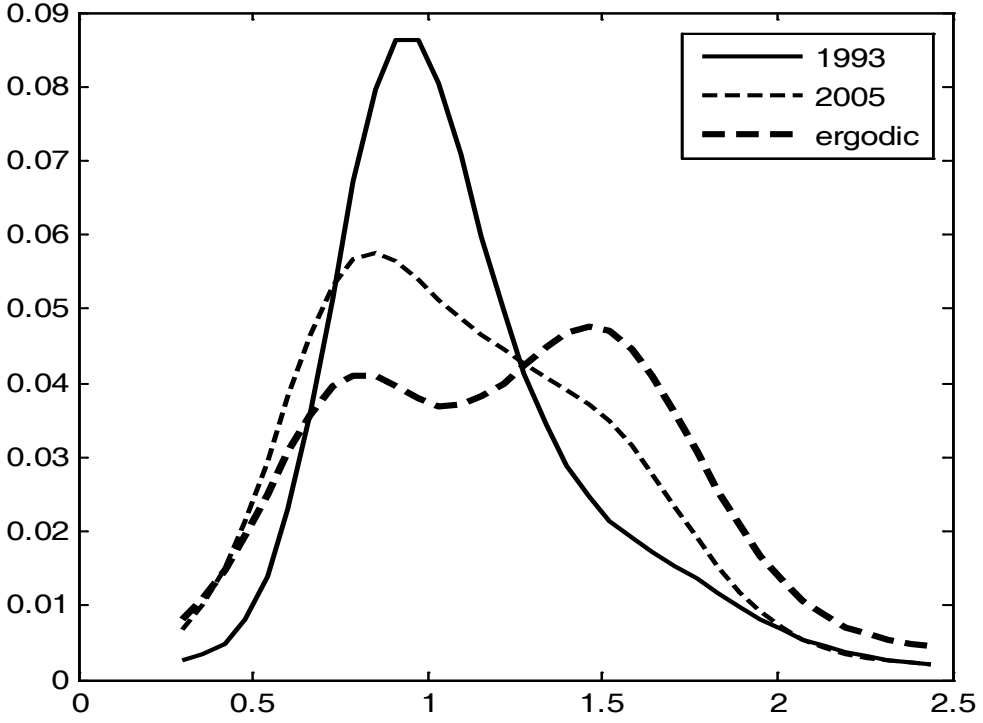

Figure 1: Kernel Densities and Ergodic Distribution for 21 states

The first set of estimations is based on a group of 21 major Indian states. The univariate kernel density plot (figure1) for this sample shows that in 1993 the distribution was unimodal, with more than 60 percent of the observations falling between 75 percent and 125 percent of the aggregate per capita output(for 21 states in this sample[8]). The mode of the distribution is slightly below the aggregate per capita output. In 2005, though the distribution is still unimodal, there is a distinct diminishing tendency in the mode of the distribution compared to the 1993 mode. As a result of these movements during the post reform period, there is a tendency towards another mode emerging at around 1.5 times the aggregate per capita output by 2005. The highest point of the distribution has shifted slightly leftwards as a result of the mobility of some middle income states towards low income values compared to the 1993 distribution. Therefore, during this period, there is a tendency to move from unimodality to bimodality. This tendency is clearly visible from the ergodic (long-run) distribution (figure1). In the ergodic distribution, the two modes exist very clearly. The lower mode is situated at about 75 percent of aggregate per capita output while the upper mode is at about 150 percent of the aggregate per capita output. From the above discussion it is clear that there is a tendency towards 'twin peak' formation in the distribution of per capita output among the Indian states in the post reform period. Interestingly, the upper mode is larger than the lower mode, due to the fact that many of the middle income states (Gujarat, kerala, Himachal Pradesh, Karnataka, Tamil Nadu, and West Bengal) have a tendency to move up to this mode while some of the richer states (like Punjab and Maharastra) have a tendency to fall back to the same.

The exercise is next repeated for different groups of states in order to study the robustness of the results. In the first set of estimates presented earlier the sample consisted of 21 major Indian states, which comprises more than 98.5 of the population of India. The second set of estimates is based on a sample of 18 states, formed by merging three newly formed states with their original counterparts. This exercise enables us to compare the results with earlier studies on convergence which were based on the undivided 18 major states. A third set of estimates is based on a sample that is similar to the second one, except that it leaves out Delhi, making the sample size 17. Delhi has been dropped as it is an artificial city-state and its growth dynamics are not similar to that of other Indian states.

[8] This aggregate per capita output is a proxy for the national per capita output. Although the sample does not include all the states of India, they jointly contribute about 95 percent of the national output.

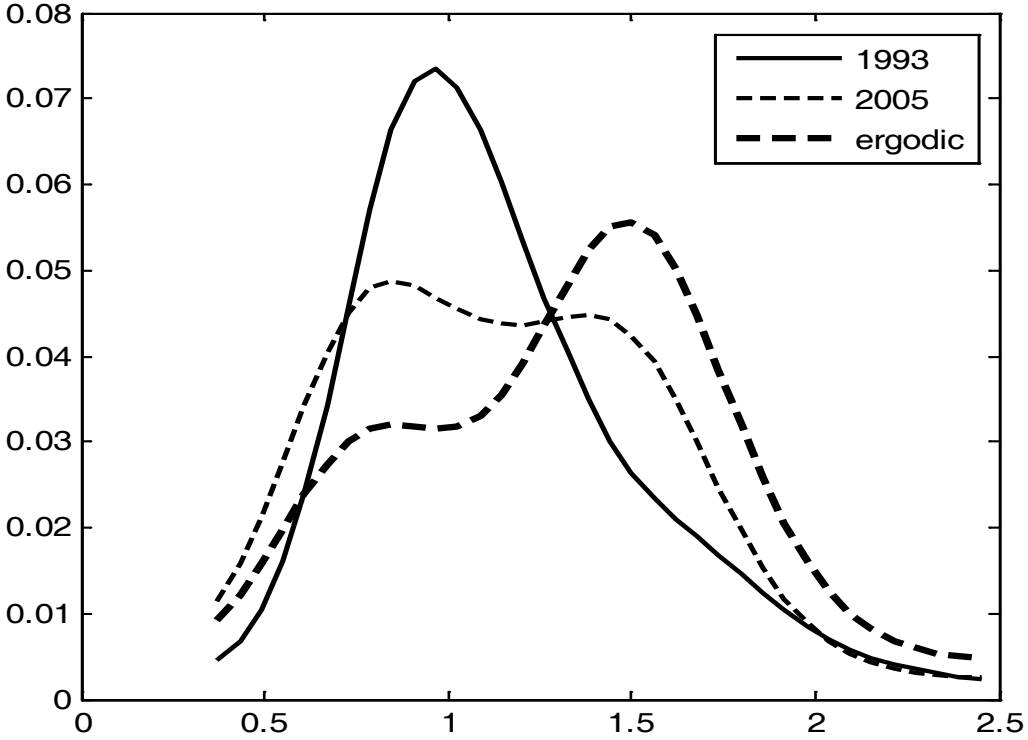

Figure 2: Kernel Densities and Ergodic Distribution for 18 states

The sample of 18 states - as we have mentioned above - has been formed by merging the newly formed states of Jharkhand, Chattisghar and Uttaranchal with their original counterparts (Bihar, Madhya Pradesh and Uttar Pradesh respectively). The univariate kernel density plot for these states in 1993 (figure 2) is unimodal, with a long right hand tail showing the existence of a large number of states in the right side of the distribution compared to the left side. As with the first set of estimates, the distribution of output is unimodal in 1993, and becomes bimodal by 2005. By that year, the lower mode is at about 75 percent of aggregate per capita output and the upper mode is around 150 percent of the same. Gujarat, West Bengal and Kerala are the middle income states that have reached the higher income group. Bihar and Uttar Pradesh constituted the lower income convergence club along with the middle income states like Assam, Madhya Pradesh and Jammu & Kashmir, with the later states showing a relative decline over this period. The ergodic distribution based on this sample show a high peak around 150 percent of aggregate per capita output and a small peak at around 50 percent of aggregate

per capita output and a vanishing act by some of the middle income states. This indicates that in the long-run a large number of states will be in the higher club, a comparatively lower number of states in the lower club and the middle of the distribution has a tendency to disappear.

The next set of estimates is formed by dropping Delhi from the second sample leaving a total of 17 states in the sample. In this case the results again show a clear shift from unimodality to bimodality and the formation of 'twin peaks' i.e., two convergence clubs around 75 percent and 150 percent of national average income (figure 3). The ergodic distribution further substantiates these results. They show that there is a clear tendency towards polarisation or convergence club formation in the post-reform period. The results are shown to be robust as they hold for three different groups of states.

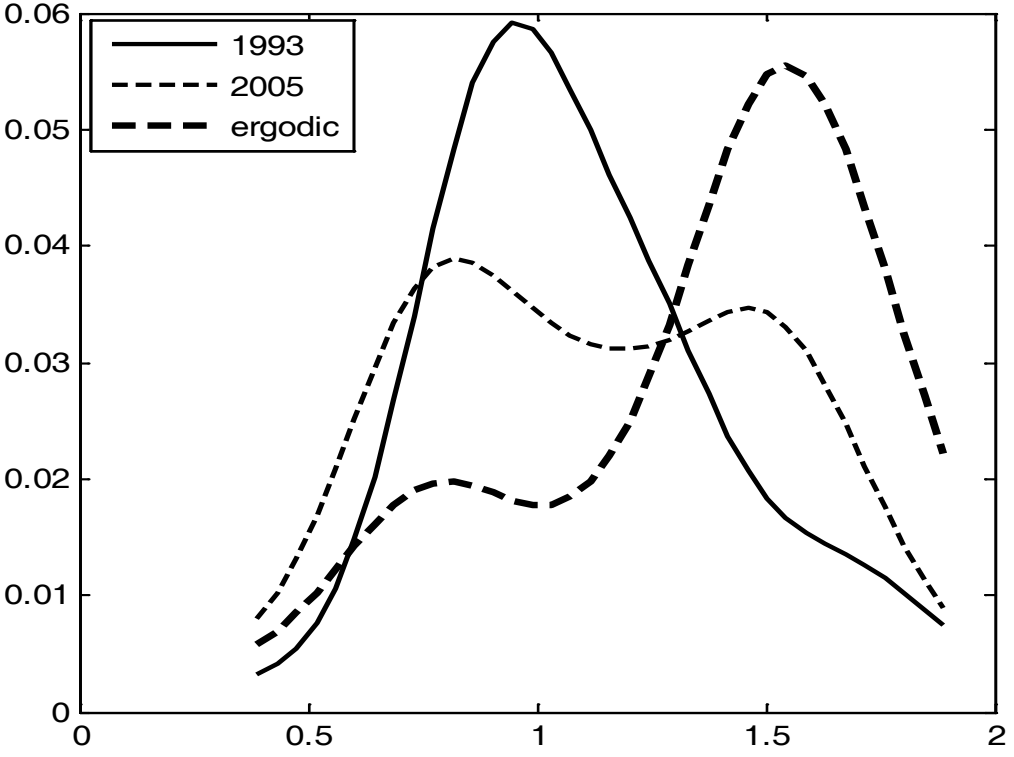

Figure 3: Kernel Densities and Ergodic Distribution for 17 states

The univariate kernel density estimates presented above, do not however, identify a particular group of states that are responsible for this trend towards polarisation. In order to identify these states we use the 3-dimensional plot of the stochastic kernel and the corresponding 2-dimensional contour plot for the 21 states, represented by figure 4 and figure 5 respectively. In figure 4, the y-axis represents the relative distribution of the per capita output for the year 1993 while the x-axis represents the same for the year 2005. The z-axis shows the stochastic kernel i.e., the conditional density with which a part of the distribution of per capita output corresponding to 1993, end up as another part of the distribution corresponding to 2005. The highest peaks of the stochastic kernel correspond to those parts of the distribution for the two years, between which the transitions are most probable. Similarly, the contour plot (figure 5) is the 2-dimensional counterpart of the 3-dimensional stochastic kernel. It represents a set of lines, each of which connects all the points on the stochastic kernel with a particular height.

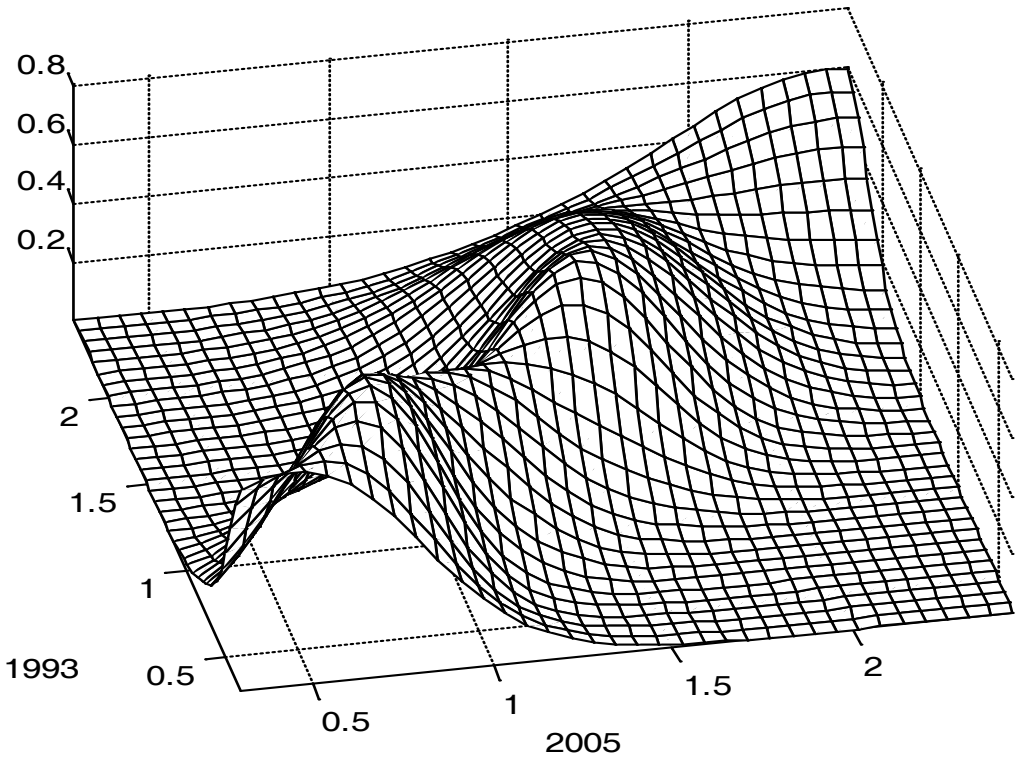

Figure 4: Three dimensional plot of the stochastic kernel for 21 states

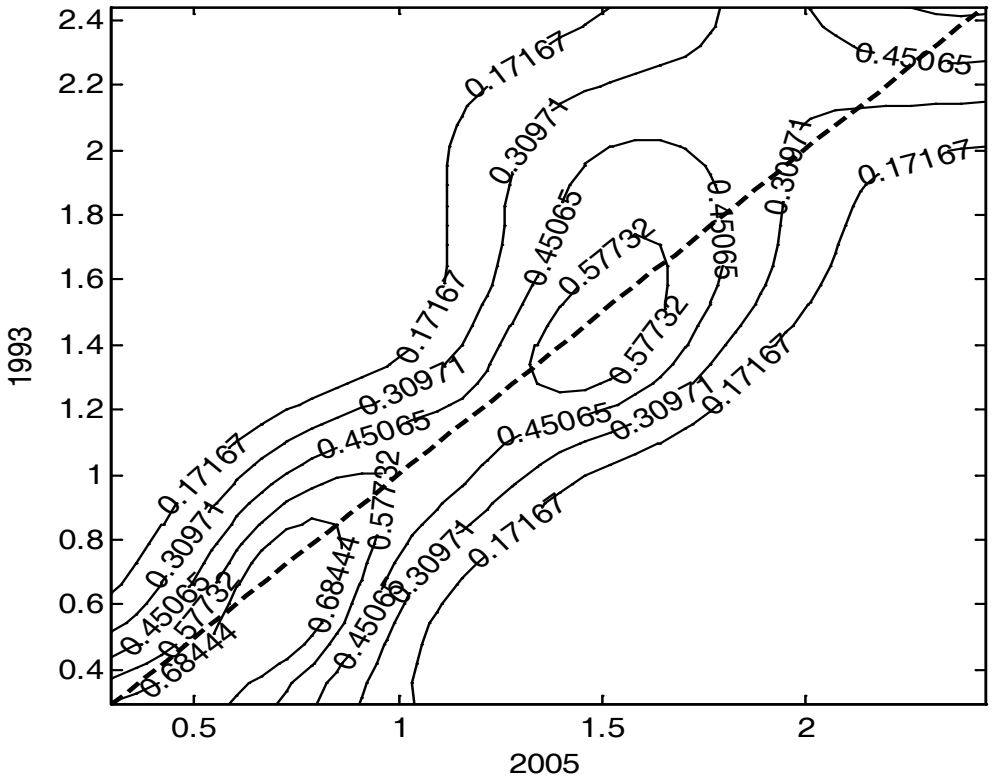

Figure 5: Contour plot of the stochastic kernel for 21 states

Inspecting the two graphs, particularly figure 5, we find that there are two peaks of the stochastic kernel around the 0.7 and 1.5 values on the x-axis. Since both these peaks lie on the 45-degree line, these imply a high degree of persistence corresponding to these values. In other words, states belonging to these two parts of the distribution in 1993 have a high probability of retaining their same relative positions in 2005. Compared to these two peaks, there is a trough in the stochastic kernel in the region between 1 and 1.3 on the x-axis. Figure 5 shows that the contour lines corresponding to this region have a large spread on both sides of the 45-degree line. This implies that some states belonging to this part of the distribution – that were middle income states in 1993 – have moved up in relative terms by 2005, while others have fallen back. Thus, from the plots of the stochastic kernel we can conclude that polarisation and convergence club formation in India in the post-reform period is due to the contrary growth dynamics of the middle income states resulting in the 'vanishing middle' of the relative income distribution by 2005.

6. CONCLUSION

According to recent contributions to the growing literature on polarisation "…formal and statistical research in political science and economics strongly indicates that various forms of political and social polarisation increase the risk of violent conflict within and between nation states..." (Esteban and Schneider, 2008). They argue that economic polarisation accentuate political and social polarisation. James Gustave, while presenting the World Bank Human Development Report, 1996, says that "unfortunately, we live in a world that has in fact become more polarized economically, both between countries and within them. If current trends continue, if they are not quickly corrected, economic disparities will move from inequitable to inhuman – from unacceptable to intolerable" (Esteban and Schneider, 2008). Studies on polarisation also highlight the fact that polarisation results in within-group bonding and across-group alienation (Esteban and Ray, 1994) i.e., in a polarised society, group members strongly identify with each other and feel alienated towards members of other groups. Clearly, the level of conflict increase with the amount of such polarisation in society. It has been found that a bimodal distribution has the highest amount of polarisation and hence a higher chance of conflict (Esteban and Ray, 1999). Therefore, the existence of two distinct groups in terms different social, political or economic characteristics increases the possibility of conflict in the society. Polarisation in a society also act as a hindrance to the development process, since in a polarised society the individuals or the economic agents do not work for common causes, obstructing the provision of public goods in a developing country (Esteban and Schneider, 2008).

In the context of these findings, this study analyses the distribution dynamics of Indian states in the post-reform period, and identifies trends towards polarisation during this period. The estimated stochastic kernel and the ergodic distribution show that the relative distribution of per capita income of the states moved from unimodality towards bimodality indicating the formation of two convergence clubs and polarisation. The alternative estimates of the kernel density functions based on different groups of states indicate the robustness of these results. Finally the plots of the stochastic kernel have shown that it is the differential growth dynamics of the middle income states that is responsible for the polarisation of the states in India. Thus, while some of the middle income states have moved up (relatively) towards the higher income states, other middle income states have fallen back (relatively) towards the lower income states. This explains the 'vanishing middle' and the formation of two convergence clubs over this period.

The growth dynamics of the middle income states throws up an interesting question: why did states that had similar per capita incomes in 1993, grow in such a dissimilar manner over the post reform period? Although a rigorous analysis of this issue is outside the scope of the study, table 1 throws some light on this issue by taking a closer look at the

middle income states that moved up and those that stagnated or fell back during this period.

Table 1: Relative per capita income of middle income states in India (1993-2005)

States	**1993**	**2005**	**Deviation (%)**
Gujarat	1.19	1.47	24.18
Kerala	1.26	1.47	16.31
West Bengal	0.92	1.06	15.12
Himachal Pradesh	1.30	1.49	14.92
Karnataka	0.98	1.13	14.91
Tamil Nadu	1.18	1.34	13.54
Andhara Pradesh	1.01	1.12	11.43
Uttaranchal	1.07	1.10	2.24
Rajasthan	0.83	0.83	0.74
Chattisgarh	0.92	0.83	-9.40
Jharkhand	0.79	0.70	-10.62
Jammu & Kashmir	1.04	0.89	-14.96
Madhya Pradesh	0.83	0.66	-20.43
Assam	0.96	0.75	-21.99

The upper panel of Table 1 denotes the middle income states whose relative incomes have moved up substantially in the post-reform period while those that have stagnated or fallen back are contained in the lower panel. The relative per capita income in 1993 and 2005 and the percentage change in the relative incomes over this period are given in the second, third and fourth columns, respectively. There are two interesting points that can be made about the differential growth dynamics of the two set of states from this table. The first

point is that with the exception of Himachal Pradesh, all the states in the upper panel are coastal states while all the states in the lower panel are inland states. The second point is that in a number of states in the lower panel, investment and growth is hampered by left-wing insurgencies (Chattisgharh, Madhya Pradesh) or terrorism (Jammu & Kashmir, Assam). To sum up, the middle income states that have stagnated or fallen back are either constrained by geographical features (inland as opposed to coastal) or by political unrest compared to those that have moved up. Further research on these issues is necessary in order to specify policies that can counter this trend towards polarisation that is resulting from these factors. These are however, beyond the scope of this present paper.

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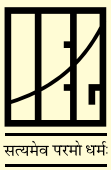

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