Convergence Club Empirics: Evidence from Indian States

Sanghamitra Bandyopadhyay
Department of Economics, University of Birmingham and
Department of Economics and STICERD, London School of Economics

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Abstract

The distribution dynamics of incomes across Indian states are examined using the entire income distribution. Unlike standard regression approaches this approach allows us to identify specific distributional characteristics such as polarisation and stratification. The period between 1965 to 1997 exhibits the formation of two convergence clubs: one at 50% and another at 125% of the national average income. Income disparities across the states declined over the sixties and then increased from the seventies to the nineties. Conditioning exercises reveal that the formation of the convergence clubs are associated with the disparate distribution of macroeconomic factors such as capital expenditure and fiscal deficits. In particular, capital expenditure, fiscal deficits and education expenditures are found to be associated with the formation of the upper convergence club.

Keywords: Convergence clubs, distribution dynamics, fiscal deficits, capital expenditure, panel data, India

JEL Classification: C23, E62, O23

Correspondence: s.bandyopadhyay@lse.ac.uk

1 Introduction

One of the paradoxes of our times is the co-existence of extreme economic affluence amidst enormous pockets of poverty. This phenomenon holds across countries and even more so within countries and across regions. Cross country and cross regional distributions of per capita incomes seem quite volatile. The extremes seem to be diverging away from each other – with the poor becoming poorer and the rich richer. This paper documents the dynamics of income across Indian states over three decades (1965-1997), and provides some explanations of the observed income dynamics.

Explaining why some countries or regions grow faster than others is important - persistent disparities in income across countries and across regions lead to wide disparities in welfare and is often a source of social and political tension, particularly so within national boundaries. Over the last decades, India's population has risen by almost 3 fold, and its GDP has increased almost 30 fold. This growth experience has not been evenly distributed - some of the richest states in India, like Gujarat and Maharashtra, are similar to middle-income countries such as Brazil and Poland in their levels of development while the poorest states of Bihar and Orissa are more akin to that of some of the poorest Sub-Saharan African countries.

In the recent empirical growth literature on the convergence of GDPs across regions and countries, the 'growth regression' approach (Barro and Sala-i-Martin 1992) is popularly used to establish empirics of convergence (and divergence). In this paper, however, I observe the distributional dynamics rather than just beta or sigma convergence. This approach moves away from establishing simply empirics of convergence and divergence, but describes the evolution of state-level income distribution over time. In doing so, one can identify the empirics of catch-up more accurately and the presence of long-run cohesive tendencies, polarization, stratification or the emergence of convergence clubs. I then provide some explanations of the observed dynamics: I find several macroeconomic indicators to be significantly associated with the evolution of the income distribution and the formation of convergence clubs.

The paper reveals the existence of two convergence clubs: in the late 1960s I observe that there were some tendencies of cohesion, but from the 1970s to the 1990s the income distribution spreads significantly and I observe the formation of two convergence clubs. The paper focuses in particular on the role of a set of macroeconomic indicators in explaining the observed polarisation. The results suggest that some macroeconomic indicators, namely capital expenditures, education expenditures and fisccal deficits robustly explain the formation of the upper convergence club.

This exercise follows from the new wave of empirical growth analyses across Indian states. Studies which use the popular cross-section regression approach, namely Bajpai and Sachs (1996), Cashin and Sahay (1996), Nagaraj et al. (1997), Aiyar (2000) and Trivedi (2003) uncover diverging distributional characteristics but are unable to describe intra-distributional mobility. Convergence as an empirical concept, as defined by Solow (1956), is understood as a single economy approaching its theoretically derived steady state growth path. Standard empirical analyses only study the behaviour of the representative economy. While such an empirical methodology can accurately uncover tendencies of divergence, it does not uncover the distributional patterns (of polarisation or stratification) that I wish to expose. Similarly, time series approaches as used by Carlino and Mills (1993) that estimate the univariate dynamics of income also remain incomplete in describing the dynamics of the entire cross-section. Several country studies have highlighted the emergence of such convergence clubs, such as for China (Maasoumi and Le Wang 2008), Greece (Fotopoulos 2006), the European Union (Pittau and Zelli 2006) and Brazil (Andrade et al 2004).

A large literature discusses what drives such income disparities (see Durlauf and Quah (1999)

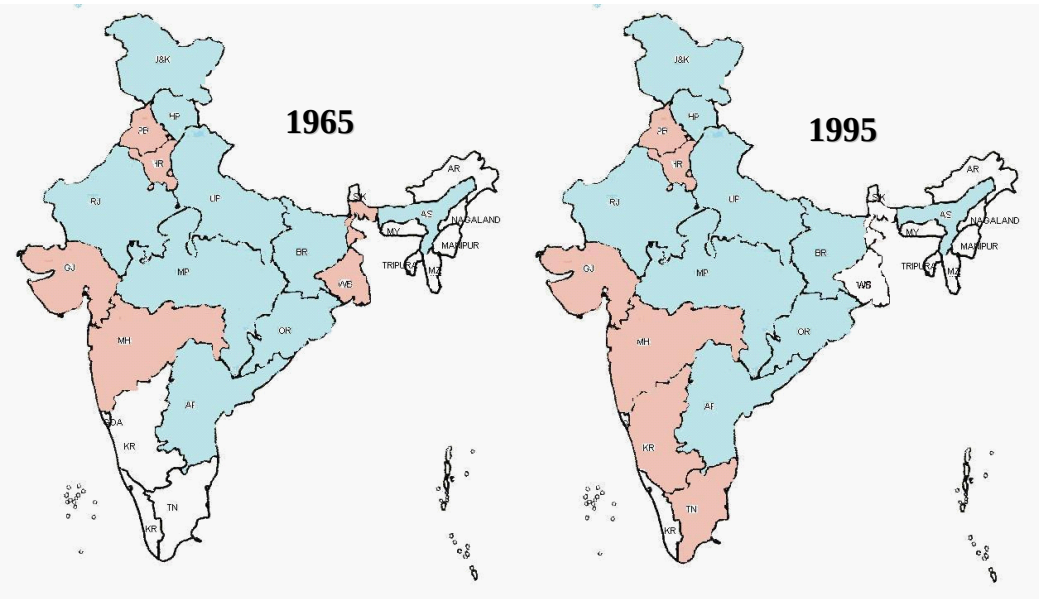
for an overview), though it is only recently that studies have emphasised the non-linear relationship of the many drivers of economic growth with growth outcomes. Kalaitzidakis (2000) and Fiaschi and Lavezzi (2003), for instance, focus on the non-linear impact of education on economic growth. Standard empirical tools of panel or cross section regression are not designed to explain or even detect the presence of convergence clubs at different parts of the income distribution. The presence of these convergence clubs correspond to the existence of multiple equilibria, as is conceived in the theoretical contributions of Bernaud and Durlauf (1996), Durlauf and Johnson (1995), Esteban and Ray (1994), Ben-David (1994), De Long (1988) and Galor and Zeira (1993). These models allow for explicit patterns of cross-economy interaction, where economies cluster together into groups to emerge endogenously. The focus of this literature is that economies do not evolve in isolation, but in clubs and groups. These distributional characteristics cannot be exposed under standard empirical techniques of panel regression or time series analyses for studying convergence. The analysis in this paper adopts this approach empirically.

Bianchi (1997), Jones (1997), Desdoigts (1994), Fiaschi (2003) and Grazia-Pittau and Zelli (2008) like the analysis undertaken in this paper, use non-parametric methods to track the distribution dynamics. In this paper I use the distribution dynamics approach as presented in Quah (1997). It encompasses both time series and cross section properties of the data simultaneously where the intra-distribution dynamics information is encoded in a transition probability matrix, and the ergodic distribution associated with this matrix describes the long term behaviour of the income distribution. I find evidence of two convergence clubs, namely a low income (poor) club of states and a high income club of states. There is also little evidence of mobility of states between the two clubs. This method can also be extended to identify factors governing the formation of these convergence clubs, and I focus on the non-linear effects of some macroeconomic factors on the distribution dynamics. I find that several macroeconomic factors, such as capital expenditure patterns, fiscal deficits and education expenditures that explain the formation of the upper income convergence clubs.

The rest of the paper is organised as follows. Section 2 presents some statewise basic statistics. Section 3 describes the observed distribution dynamics and polarisation, and Section 4 presents a number of explanatory macroeconomic factors which are associated with the observed distribution dynamics. Section 4.3 presents a brief discussion of the results and Section 5 concludes.

2 Some basic statistics

Let us have an initial look at the state-wise income distribution across Indian states. Some simple estimations clearly demarcate the rich states from the poorer states. GDP per capita and price data used for this paper has been obtained from Ozler et al (1996). GDP per capita data for 1989 to 1998 has also been obtained from the World Bank, compiled as a separate dataset, and from Government of India sources.



Indian states: Rich (pink), Poor (blue)

Figure 1: AS Assam, BR Bihar, GJ Gujarat, HP Himachal Pradesh, J&K Jammu and Kashmir, KR Karnataka, MH Maharashtra, MP Madhya Pradesh, OR Orissa, PB Punjab, RJ Rajasthan, TN Tamil Nadu, UP Uttar Pradesh, WB West Bengal.

Figure 1 highlights the states as 'rich' or 'poor' in 1965 and 1995 on the basis of GDP. One can see that there has been a lot of persistence for both the rich and poor states. There are some changes in the 1995 map: in particular the rich states group has seen the addition of Karnataka and Tamil Nadu but the loss of West Bengal. Therefore, some upward mobility has taken place.

Let us take a look at some simple statistics of these states. The richest state, Punjab, experienced a rise in GDP per capita of 34% between 1965 and 1988, reflecting an increase of 34% over the period, followed by another 21% rise by 1997. Similarly Gujarat's and Maharashtra's per capita income increased by 20% and 27% respectively, and by another staggering 40% and 51% by 1997, respectively. This is starkly against the fact that the Indian average per capita GDP rose by only 27% between 1965 and 1988, and increased by another 33% by 1997. Thus Punjab was already almost twice as rich as the Indian average in 1965, while Maharashtra, Gujarat and Haryana's per capita GDP were also almost twice the Indian average in 1965, and remained so in 1997. Averaging, Punjab, Haryana, Gujarat and Maharashtra were at 123% of the national average in 1965 and over 152% in 1988, and grew a further 36% as a group from 1988 to 1997.

The low income club states are mostly clustered in north India, namely those of Bihar and Orissa in the east, Rajasthan in the west, and Uttar Pradesh in the north. States of Bihar, Orissa and Uttar Pradesh and Rajasthan have had their GDPs per capita at 85% in 1965 and 80% in 1988 of the Indian average, respectively, and grew by only another 19% as a group by 1997. To summarise, over the time period studied, the income of the richer states has been almost three times that of the poor states. It is interesting to note that the six poorest states of Madhya Pradesh, Assam, Andhra Pradesh, Uttar Pradesh, Orissa, and Bihar, with average incomes significantly below the national growth rate, are home to more than half of the Indian population.

There have, however, been some experiences of mobility as well. West Bengal, which was a high growth state in the earlier time periods examined, notably, dropped from being the second highest income state to eighth by 1988. Again, the surge of growth in the 1980s pushed up Karnataka and Tamil Nadu, whose 1988 per capita income increased by 21% and 36% between 1980 and 1988, respectively, and by a further 45% for both states by 1997.

To further summarise the income dynamics, between 1965 and 1997 the standard deviation (SD) of per capita income increased by 192%, while the inter-quartile range (IQR) increased by 137%. With the SD almost double that of the IQR, the increase in spread is clearly evident. However, with the IQR accounting for the middle 50% of the distribution, the fact that the SD is significantly larger than the IQR implies that the rise in SD is attributable to some high performers outperforming the rest of the intermediate and poor states.

To summarise these basic statistics of the dynamic spatial patterns of Indian regional growth,

- There is evidence of both persistence and mobility.
- While some rich states have remained rich, and the poor have remained poor, there have been some instances of high performers who have declined in their performance over the period, such

as West Bengal, while others have picked up over the period, for example Karnataka and Tamil Nadu.

- Thus, apart from those consistent performers, there is plenty of evidence of relative success and failure all across India.

3 The Distribution Dynamics Approach

So far I have only taken a look at several snap-shots of how different Indian states have grown or fallen behind over time. For a more informative picture, I will now track the evolution of the entire income distribution over time; this will reveal the intra-distributional dynamics of GDP growth of the Indian states over the given period of time. Markov chains are used to approximate and estimate the laws of motion of the evolving distribution[1]. The intra-distribution dynamics information is then encoded in a transition probability matrix.

To set up the transition probability matrix, the income distribution is divided into a number of 'income states'; each spatial unit (i.e., Indian state) is then located within this income space. For example, in the lowest income state the poorest Indian states are included, while in the highest income state the richest Indian states are included. The transition probability matrix then describes the probabilities with which the Indian states would transit from one income state to another. If the probabilities of transition from one income state to another is non-zero, then one deduces mobility. If these probabilities are small, or almost zero, one deduces persistence.

There are, however, some drawbacks to the discretised approach. The most significant drawback is that the selection of income states is arbitrary. Such arbitrary sets of discretisations may lead to different results. The stochastic kernel improves on the transition probability matrix by allowing the space of income values to be a continuum of states[2]. Using the stochastic kernel removes the arbitrariness in the discretisation of the states. One now has an infinite number of rows and columns replacing the transition probability matrix and observes a probability mass (the sloping surface) recording the probabilities of persistence and mobility[3].

[1]The distribution dynamics approach (Quah 1997) is based on treating a single income distribution as a random element in a field of income distributions, called the random field. The density function of the income distribution is estimated at each point in time and is then observed how it evolves over time. A transition probability matrix records the probabilities of persistence and mobility across the income distribution. Stochastic kernels and transition matrices provide an estimate of intra-distribution mobility taking place. An economy (in our case, an Indian state) over a given time period (say, one year or five years) either remains in the same position, or changes its position in the income distribution. The transition probabilities are then encoded in the transition probability matrix for transitions over the income distribution. Low probabilities of transition indicate persistence, while higher probabilities indicate mobility.

[2]For further refinements proposed in discretising a continuous state-space Markov chain in the distribution dynamics context, see Bulli (2001).

[3]There are some other problems with the discretised approach. With the estimates being based on time stationary transition matrices, they are not reliable for long time periods for economic structural changes. Also, the number

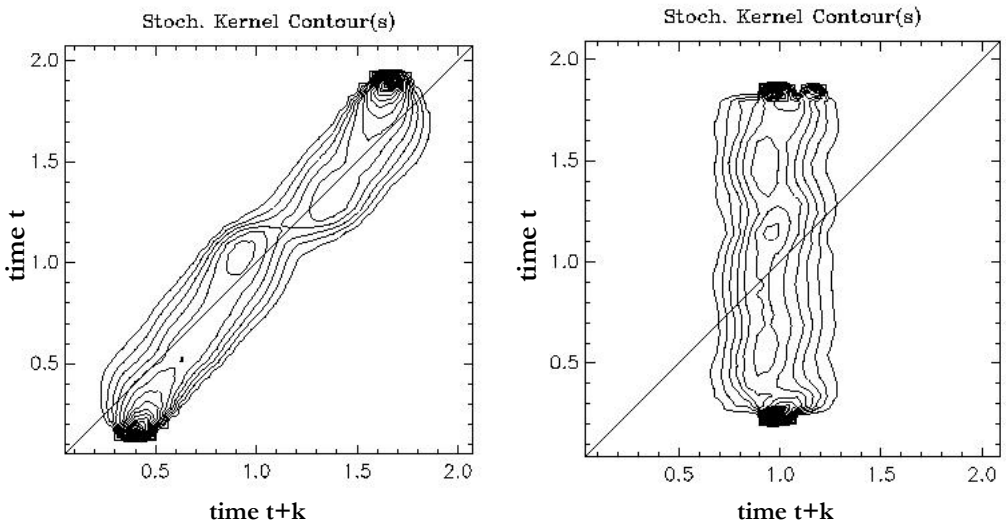


Figure 2: Benchmark stochastic kernels.

One can interpret the stochastic kernels as follows. Figure 2 presents two benchmark stochastic kernel contours. The vertical axis measures the time t income distribution, and the horizontal axis measures the time $t+k$ income distribution. If the probability mass runs along the diagonal, as in the first panel in Figure 2, it indicates persistence in the Indian states' relative positions and therefore exhibits low tendencies of mobility. Convergence is indicated when the probability mass runs parallel to the t axis in the second panel of Figure 2. If the probability mass were to run along the negative slope, it would imply overtaking of the economies in their rankings (not in figure). If the probability mass runs parallel to the $t + k$ axis, it indicates that the probability of being in any income state at period $t + k$ is independent of their position in period t; this, then, is evidence of low persistence (not in figure).

We can now present the salient distribution dynamics over time periods 1965-1970, 1971-1980, 1981-88 and 1990-97. Figures 3 to 6 present the stochastic kernels for relative per capita income of 1-year transitions for four sub-periods 1965-70, 1971–1980, 1981-88, and 1990-97.

Observation of the stochastic kernels and the contour plots reveal that the later years provide increasing evidence of persistence and low probabilities of changing their relative position. The most

of states with the Indian example are small, thereby I cannot make inferential statements by bootstrapped p-values associated with the probabilities. For further methods highlighting how more information may be obtained from such transition matrices, see Fiaschi (2003)

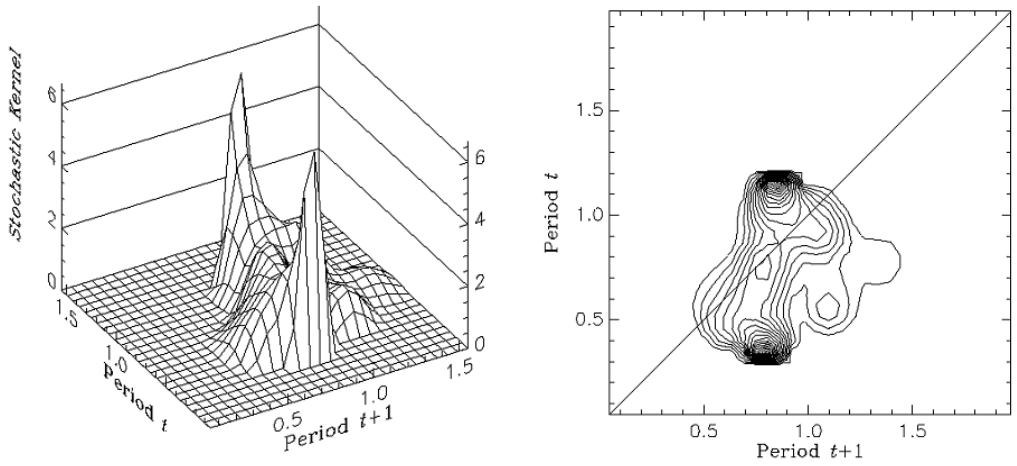


Figure 3: Relative per capita incomes across Indian states, 1 year transitions. 1965-1970

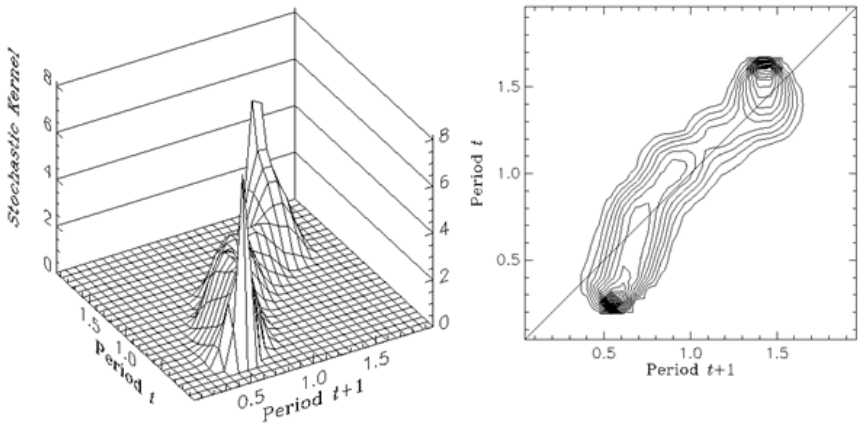


Figure 4: Relative per capita incomes across Indian states, 1 year transitions. 1971-1980

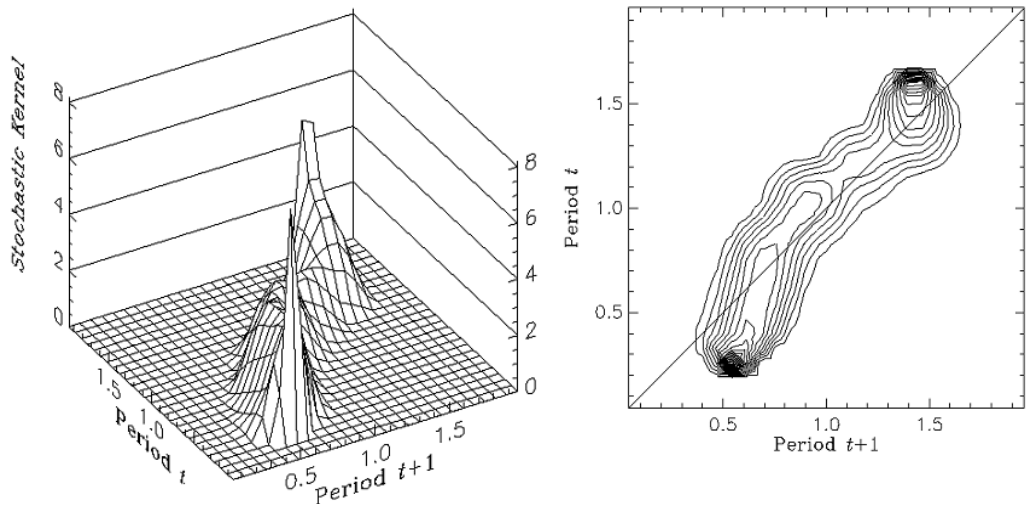


Figure 5: Relative per capita incomes across Indian states, 1 year transitions. 1981-1988

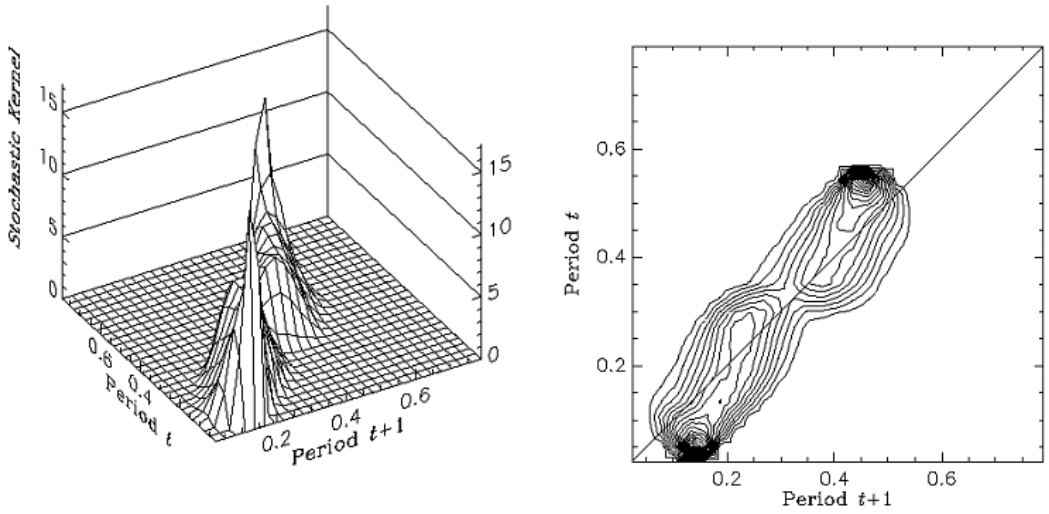


Figure 6: Relative per capita incomes across Indian states, 1 year transitions. 1991-1997

salient feature is that of the existence of two convergence clubs in all time periods. Over the periods 1965-70, 1971-80, 1981-88, 1989-1997 we observe in Figures 3 to 6 the probability mass lengthening and shifting totally in line with the positive diagonal, the two peaks still at the two ends of the mass. The cluster of States at the two peaks to consist of some low income economies at around 50% of the all India average and another at 150% of the average. The period 1965-70 shows some signs of cohesion: as is clearly revealed in the contour plot, the two clubs are aligned parallel to the original axis (vertical axis). This indicates some tendencies of convergence. The following time periods, particularly during the later years, have shown the cohesive forces substantially dissipating in influence.[4]

For robustness, I estimate stochastic kernels over the different sub-periods and over 5 and 10 year periods. The results obtained (not presented for brevity and obtainable from the author) reveal the the same results as above: there has been convergence over the late 1960s, with increasing divergence over the 1970s, 1980s and 1990s.

To summarise our findings,

- I obtain evidence of two convergence clubs are observed - a low income club and a high income club, one at 50% of the national average, another at 125% of the national average. I also obtain some tendencies of convergence in the time period 1965-70
- The periods1970s to the 1990s revceal evidence of persistence, and increasing divergence. Some evidence is also obtained of intra-distributional mobility over the late 1960s.
- The stochastic kernels also suggest that disparities have been widening. Robustness statistics (such as bootstrapped standard errors for the probabilities) are statistically irrelevant here and are therefore not presented.

We also observe that the composition of the two income convergence clubs does not drastically differ over the time periods. The Indian states at 50% of the national average are Assam, Bihar, Jammu and Kashmir, Orissa, Madhya Pradesh, Rajasthan, UP for all the four time periods examined, with the exception of Kerala. Kerala started in the 1960s in the low income club and has moved in and out of it over the time periods examined. For the high income club membership has changed over the four decades: while Delhi, Punjab, Haryana, Gujarat and Maharashtra have dominated the top five ranks for all four decades examined, West Bengal moved out of the high income club in the mid-1970s. Andhra Pradesh and Tamil Nadu have been the most recent entrants (1990s) into the high income club.

These results are in agreement with those of Trivedi (2003) where similar clubs are revealed with kernel estimates of the densities of the Indian state income distribution between 1960 to 1992. The stochastic kernels improve over these estimates by providing the intra-distribution dynamics of how these clubs evolve over time.

[4]The income distribution dynamics results are also established in Bandyopadhyay (2004)

4 What Explains Polarisation? The Role of Macroeconomic Factors

It is widely accepted that a stable macro-economic environment is required (though not sufficient) for sustainable economic growth. That taxation, public investment, inflation and other aspects of fiscal policy can determine an economy's growth trajectory has been articulated in the growth literature for the last three decades. Endogenous growth models have also stressed the long run role of fiscal policy as a key determinant of growth. Recent cross-country studies also provide evidence that the causation runs in good measure from good macro-economic policy to growth (Fischer 1991, 1993, Easterly and Rebelo 1993, Barro 1991).

The link between short run macroeconomic management and long run growth, however, remains one of the most controversial areas in the cross-country literature. A number of studies estimating regressions show significant correlations, with the expected signs, though it has been perniciously difficult to isolate any particular policy variable and demonstrate a robust correlation with growth, irrespective of endogeneity concerns and other variables. Endogeneity proves to be the hardest of problems to deal with as economic crises do not occur in isolation – inflation typically accompanies bad fiscal discipline, political instability and exchange rate crises.

The recent cross country literature deals with much of establishing such correlations, revealing the complexity of the relationships. Levine and Renelt (1992) show that high growth countries are with lower inflation, have smaller governments and lower black market premia. While their results show that the relationship between growth and every other macro-economic indicator (other than investment ratio) is fragile, Fischer (1991) extends the basic Levine and Renelt regression to show that growth is significantly negatively associated with inflation and positively with budget surplus as a ratio of GDP. Easterly and Rebelo (1992) also present convincing evidence of fiscal deficits being negatively related to growth. Recent studies also highlight the non-linear effects of fiscal deficits on economic growth outcomes. Adam and Bevan (2005) show for a panel of 45 developing countries that a contraction in fiscal deficit is positively associated with growth outcomes up to a threshold of 1.5% as a percentage of GDP. For further fiscal contraction below 1.5% the effect is reversed. Similar evidence is also presented in Giavezzi et al (2000) highlighting the non-linear effects of fiscal deficits on economic growth for a panel of industrial and developing countries. Links between inflation and growth are particularly controversial. Levine and Zervos (1992) show that inflation is significant, though not robust and relates to only high inflation countries. Their composite indicator of macro-economic performance, a function of inflation and fiscal deficit is shown to be positively related with growth performance (lower inflation, lower fiscal deficit). Bruno and Easterly (1998) also take a short run approach and find that high inflation crises are associated with output losses, but that output returns to the same long run growth path once inflation has been reduced. This may be the reason for the weak inflation and growth relationship. Some empirical studies highlight the non-linear nature

of the relationship between inflation and growth: Sarel (1996) highlights that for inflation below 8%, it has no effect (or possibly positive effect) on economic growth; for values above 8%, it's negative effect is strong and robust.

In the following section I discuss the macro-economic crisis that has been faced by the Indian states over the late 1980s into the 1990s which may have perpetuated uneven growth experiences.

4.1 The Macro-economic Crisis in India in the late 1980s and 1990s

Recent years have seen fundamental economic transformation in India which has resulted in improved aggregate and state-wise economic growth. India's trend growth rate of 5.8% per annum since 1980 is the highest outside South East and East Asia among large developing countries. However, while the short term outlook has improved, current policies have been deemed as insufficient to sustain the 7-8% growth rate that the Indian government considers necessary for poverty reduction. Recent estimates suggest that every third person in India lives below the poverty line (Ozler et al. 1996). Further, this growth trajectory is accounted for by agriculture growing at an average rate of 7%, while growth in all other major sectors have been on the decline.

One of the biggest problems facing policy makers has been the unsustainable fiscal deficits generated at both the centre and state levels. Gross fiscal deficit to GDP ratio of all state governments touched a high of 4.2% in 1998-99 - the highest in Indian fiscal history. The fiscal performance of the individual states varied widely over the 1990s, with the most marked deterioration observed in some of the poorer states. In Uttar Pradesh, the fiscal deficit rose from 4.5% of GDP in 1993-4 to 8.6% in 1997-8; in Bihar, from 4.0% to 6.2%; and in Orissa from 5.7 % to 6.3%. Fiscal turbulence was not limited to only the poorer states - Kerala and Rajasthan, which are middle income states, also observed the fiscal deficit deteriorating to 7.3% and 4.6%. The central government's deficit of 1998-99 was 6.5 % of GDP - the same as that of the crisis year of 1990-1. To add to that the revenue deficit , at 6.2% of GDP, is substantially higher than that of 1990-91, the worst of the decade, continuing the long run trend of increased government dis-saving to finance consumption.

As an immediate fall-out of such deficits, the poorer states in particular, have become highly indebted; in Uttar Pradesh the debt-GDP ratio rose from 26% to 31%; in Bihar it increased from 35 to 42%, while in Orissa, from 41 to 43%. Financing such large deficits has meant increased borrowings and issuing state government guarantees. The states are constitutionally prohibited from borrowing internationally and have tight limits on overdrafts from the Reserve Bank of India (the Central Bank of India). Thus, Indian states face a relatively hard budget constraint. The state government guarantees have often been used as a convenient means to circumvent the ceiling imposed on borrowing (of the central government on it's behalf) from the RBI. This, however, has led to a huge debt bill - total outstanding guarantees now account for about 9-10% of states' combined GDP. Variation among states is large - as a percentage of GDP, state guarantees range from 4% in UP to 14% in Punjab.

Such high deficits, thus, have a telling effect on macro-economic management. They crowd out private sector borrowing by keeping interest rates higher than they would otherwise be, and crowd out public development spending within government budgets due to high interest costs of the government debt. The real cost of such interest repayments was realised particularly after financial liberalisation in the early 1990s. With financial liberalisation, the interest costs of central and state governments have risen by over 1 per cent of GDP since 1990-1.

On the other hand, investors' and rating agencies' concerns over the high fiscal deficits tend to increase international risk premia and lower the bond ratings that India faces, pushing up real interest costs, even if one were to maintain macroeconomic stability .

Much of this deterioration in the fiscal performance in recent years is attributed to the unstable nature of the governments at both the state level and the centre. Unstable coalition governments at the centre resulting from the elections of 1996 and 1998 have resulted in four offices with four prime ministers and finance ministers. Though all offices have followed in line with the 1991 reforms of the Congress office, internal disagreement over policy due to unstable political coalitions has resulted in many withdrawals of various ongoing reforms. This has been accompanied by the frequent changes of offices in the state governments themselves. For example, states of Bihar, Uttar Pradesh, and Himachal Pradesh have seen changes of up to three times in one year, during the volatile years of the 1990s. Curiously, much of the instability in local governments has been observed in some of the poorest states - for example, that of Bihar, Orissa and Uttar Pradesh. Such weak and unstable governments are also characterised by endemic corruption and a general lack of social and political governance. Such corruption is known to discourage investment, limit economic growth and to even alter the composition of government spending, often to the detriment of future economic growth .

The 1991 reforms changed the policy environment significantly after the central government's liberalisation of trade and investment. These reforms and other policy changes allowed the states a larger role in determining their development paths and attracting investment. Gujarat, Maharashtra and other middle income states were able to take greater advantage of the new conditions, because of better initial conditions, infrastructure and human resources, than other low income states. The poorer states on the other hand, with the exception of Orissa, failed to improve state policies to off-set their initial disadvantage in attracting new investment.

In light of the factors discussed above, I will empirically investigate the role of a number of macroeconomic indicators in the following section for the period 1986-1998. I will be using panel data for indicators of capital expenditure, education expenditure, fiscal deficit, inflation, and interest expenditure.

4.2 Conditioning with indicators of macroeconomic stability

Recent studies have already sought to identify such non-linear relationships using non-parametric methods, for example Kalaitzakis (2000) and Fiaschi (2003). The distribution dynamics method is

an appropriate method to explore non-linear relationships. The conditioning methodology in the distribution dynamics approach is similar to that of traditional panel or cross section regression approaches. While with standard methods of panel regression one compares E(Y) and E(Y|X) to deduce conditional convergence, the distribution dynamics approach compares the entire distributions of Y to Y|X. When no change in the conditioned and unconditioned distributions is observed, one concludes that the conditioning variable does not explain the distribution dynamics. Quah (1997) shows that just as stochastic kernels can provide information about how distributions evolve over time, they can also describe how a set of conditioning factors alter the mapping between any two distributions. Hence, in order to understand if a hypothesised set of factors explains a given distribution one can estimate a stochastic kernel mapping the unconditioned distribution to the conditioned one. If one then obtains convergence, one deduces conditional convergence.

In the next section the data used for the conditioning analysis is described and then the results of the conditioning exercise are presented. To test for associations of macroeconomic stability with the observed convergence dynamics, I will use the following macroeconomic variables, for the period 1986-1997, obtained from the World Bank (2000):

- Fiscal deficit as a ratio to state GDP
- Interest and administrative expenditure as a ratio to state GDP
- Capital expenditure as a ratio to state GDP
- Expenditure on education and other social services as a ratio to state GDP
- Inflation.

To construct the conditioned distribution with the variables discussed above, it is first important to ascertain the exogeneity/endogeneity of the variables. Granger causality tests confirm the endogeneity of the capital expenditure .To allow the conditioned distribution to be free from feedback effects (or bi-directional causality), it is estimated by regressing state GDPs on a two-sided distributed lag of the time varying conditioning variables. I then extract the fitted residuals for subsequent analysis. This will result in a conditioned distribution free from feedback effects irrespective of the exogeneity of the right hand side variables. The method derives from Sims (1980), implemented in Quah (1996), where endogeneity (or the lack of it) is determined by regressing the endogenous variable on the past, current and future values of the exogenous variables, and observing whether the future values of the exogenous variables have significant zero co-efficients. If they are zero, then one deduces that there exists no 'feedback' or bi-directional causality. The residuals constitute the variation of the dependent variable unexplained by the set of exogenous variables, irrespective of endogeneity. The results for these two-sided regressions are tabulated in Table 1.

All projections in Table 1 suggest that capital expenditure at lead 1 though lag 2 is significant for predicting GDP, but not consistently for other leads and lags. Fit does not improve with increasing

capital expenditure	Co-efficients in two-sided projections		
Lead 4			-0.00 (0.003)
3		0.01 (0.008)	0.012 (0.009)
2	0.013(0.008)	-0.018 (0.01)	-0.019 (0.016)
1	0.020(0.01)	0.021 (0.012)	0.024 (0.019)
0	-0.022 (0.016)	-0.024 (0.018)	-.0.029 (0.019)
Lag 1	-0.021 (0.014)	-0.02 (0.016)	-0.022 (0.015)
2	-0.01(0.010)	-0.01(0.011)	-0.01(0.011)
3		-0.00 (0.007)	-0.00(0.010)
4			-0.005 (0.004)
Sum of co-efficients	-0.02	-0.051	-0.034
R^2	0. 17	0. 13	0. 11

Table 1: Lead-Lag regressions of growth rates on capital expenditures

lags (or leads). There is a fairly stable set of co-efficients of the two-sided projections. The residuals of the second lead-lag projections are used as the conditioned distribution of GDP on capital expenditure, though the final results are unaltered by using residuals from other projections.

What is observable in all projections is that capital expenditure at lead 1 though lag 2 appears significant for predicting growth, but other leads and lags, not so consistently. Fit does not seem to improve with increasing lags (or leads). We seem to have a fairly stable set of co-efficients of the two-sided projections. The residuals of the second lead-lag projections are saved for the conditional distribution of growth on capital expenditure. Conditioning two sided projections are also derived for the other auxiliary variables, namely, capital expenditure, and education expenditure, fiscal deficits, interest expenditure and inflation. We discuss the results for each of these variables in turn.

Figures 7 to 9 present the stochastic kernels mapping the unconditioned to conditioned distributions, for capital expenditure, fiscal deficits and education expenditures. Figure 7 presents the stochastic kernel representing conditioning with capital expenditure. The appropriate conditioned distribution has been derived by extracting the residuals from our earlier two-sided regressions. The probability mass lies predominantly on the diagonal, though one can observe some local clusters running off the diagonal at the very low and high ends of the distribution. These clusters are more clearly revealed in the contour plot. In particular, one can observe a local cluster at the bottom end of the stochastic kernel running parallel to the vertical axis. This is also the case at the upper end of the distribution, where two individual clusters - one at 0.4 of the national average, and another at 0.5 of the national average - are parallel to the vertical axis.

Figure 8 maps the conditioning stochastic kernel with fiscal deficit. The appropriate conditioned distribution has been derived by extracting the residuals from the two-sided lead-lag regressions[5].Here

[5]The table of results for the lead-lag regressions for fiscal deficits is not presented for brevity and is obtainable from

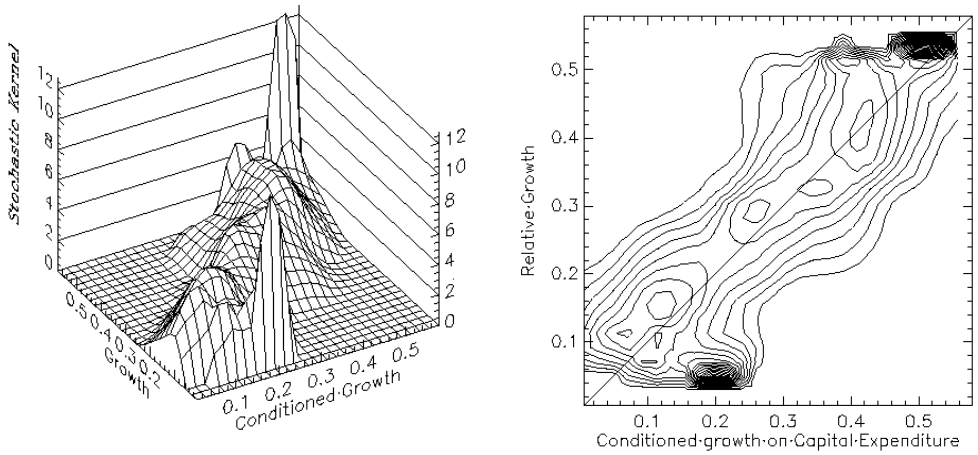


Figure 7: Relative per capita incomes across Indian states: Capital expenditure conditioning

I find that there are several convergence clubs. Of the five identifiable convergence clubs, one can observe that one of the clusters at the upper end of the distribution lies off the diagonal, aligned parallel to the original axis. The club lying at 0.4 of the national average, while predominantly lying on the diagonal is twisted such that it is parallel to the original axis. Similar dynamics are also observed with respect to the lowest convergence club - it twists such that it is parallel. The middle convergence club also while lying mostly on the diagonal has tendencies to lie to parallel to the original axis. In short, all five convergence clubs exhibit tendencies to run parallel to the original axis, with the upper two clubs the most clearly lying parallel to it. These results suggest that fiscal deficits are associated with individual convergence clubs at several parts of the income distribution, mostly clearly with clubs at the upper end of the distribution.[6]

Figure 9 maps the conditioning stochastic kernel with education expenditure as auxilliary variable. The appropriate conditioned distribution has been derived by extracting the residuals from the two-sided lead-lag regressions, as in earlier exercises[7]. In this case I observe that the stochastic kernel runs mainly along the diagonal, with the upper and lower tails tending to run off parallel to the unconditioned axis. In particular, I observe in the contour plot that the stochastic kernel is clearly divided into two clubs, with the upper club parallel to the original axis. The lower convergence club also shows tendencies to run parallel to the original axis. In short, I find the two convergence clubs to be associated with education expenditure, in particular the upper convergence club.

I also undertake similar conditioning exercises with inflation and interest expenditure, both results presented in the Appendix. Here the effects of these auxilliary factors do not reveal significant insights of the convergence clubs being associated with specific convergence clubs. I observe that most of the stochastic kernel lies mainly on the diagonal, with none of the convergence clubs showing any tendencies to align themselves parallel to the original axis.

To summarise:

- I observe tendencies for conditional convergence for the upper income club when conditioning with the capital expenditure index.
- Several convergence clubs are obtained when conditioning with fiscal deficits. I observe instances of conditional convergence for the two upper convergence clubs, and with tendencies for conditional covergence at the lower end of the income distribution.

the author. The projections suggest that fiscal deficits at lead 1 though lag 2 is significant for predicting GDP, but not consistently for other leads and lags. Fit again does not improve with increasing lags (or leads). The residuals of the second lead-lag projections are used as the conditioned distribution of GDP on fiscal deficits, though the final results are unaltered by using residuals from other projections.

[6] All these 'explanatory factors' were also tested using standard panel regression methods, i.e., standard 'growth regressions', where each one of these factors was found to be significantly associated with the state level growth rates and no conditional convergence. The distribution-specific effects of these variables cannot be identified using the panel regression method, but these are highlighted using the distribution dynamics method.

[7] Results again, are not presented for brevity and are obtainable from the author.

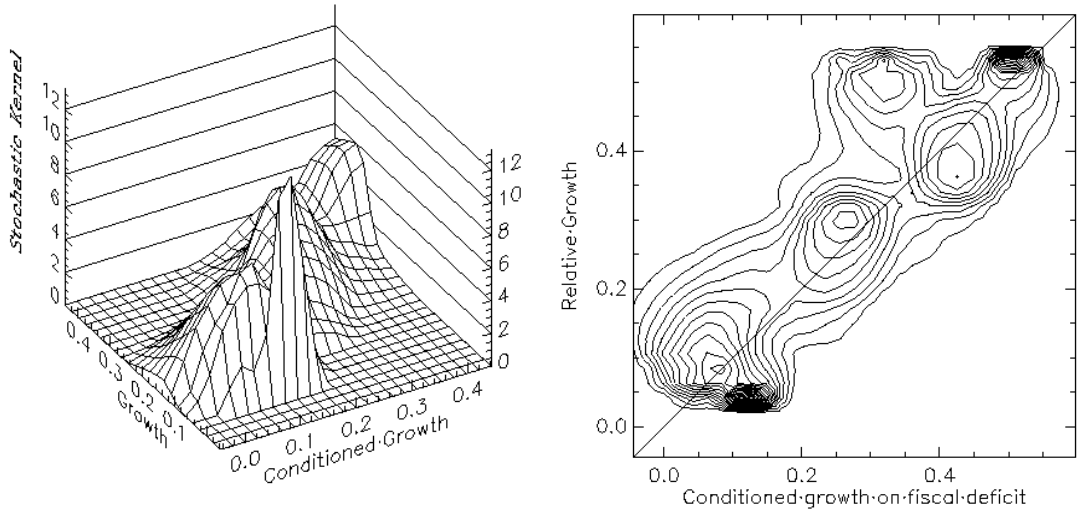


Figure 8: Relative per capita incomes across Indian states: Fiscal deficit conditioning

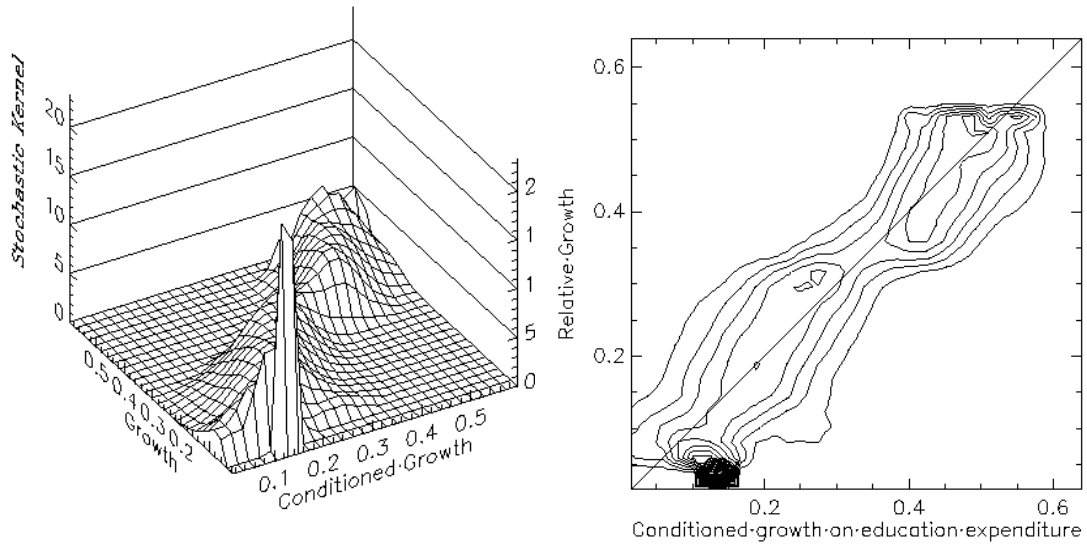


Figure 9: Relative per capita incomes across Indian states: Education expenditure conditioning

- I also observe similar tendencies when conditioning with education expenditure. Both convergence clubs exhibit tendencies of conditional convergence, particularly at the upper end of the income distribution.

- The results obtained depart from those found by earlier empirical studies by isolating conditional convergence at specific parts of the income distribution. These results would go uncovered by using standard methods of estimating conditional convergence with regression analysis. I have uncovered specific factors (fiscal deficits, captial expenditure, education expenditure) which are associated with GDP outcomes at different parts of the income distribution. In particular, I find that these factors are associated GDP outcomes at the upper end of the income distribution[8].

4.3 Interpretation of Results

The results on the association of capital expenditures with the higher income clubs is strongly suggestive of the successful high investment strategy undertaken in the high growth states. The high income states of Gujarat, Maharastra, Tamil Nadu and Andhra Pradesh are characterised by heavy industries, mostly in iron and steel based-, and derivative industries. Karnataka in recent years has also seen a surge in growth rates, due to the development of the service sector based industries and in software consulting. States of Punjab and Haryana, which are rich income states as well, are though not characterised by industrial growth, but by agricultural growth. The two states combined constitute a significant part of the aggregate agricultural GDP in India (contributing to almost 100% of India's wheat produce and the second largest contributor to rice production, after West Bengal). Capital expenditures, therefore, in these two states are mostly devoted to infrastructures in the agricultural sector and not in capital based industries as in the other states belonging to the high income club.

The second result worth noting is that of the association of fiscal deficits with the high income convergence club. Indeed, the result conforms with recent findings of the non-linear relationship of fiscal deficits with economic growth outcomes. Adam and Bevan (2005) identify that the effects of fiscal contraction are positive for fiscal defcits up to 1.5%, and negative thereafter. The respective sizes of the fiscal deficits of the states concerned are all above 1.5% (an average of 4-5% for the period concerned). That these high income states are associated with high level of fiscal deficits, and lesser so for the low income club of states also alludes to the recent studies on the expansionary effects of fiscal deficits - Romer and Romer (2010) provide empirical evidence using US the expansionary effects

[8]These results complement the results that are obtained using standard panel regression and pooled OLS analysis. Fiscal deficits are significantly and negatively correlated with growth, as is also the case for the effects of inflation on growth. Expenditure on education is observed to have a positive impact on growth, especially in the later years of the 1990s. Interest expenditure, in our short run OLS regressions has a negative effect on growth – this is one of the results most robust to the different specifications used. The results obtained with the distribution dynamics method

of fiscal shocks. Christiano et al (2009) in their recent paper also highlight specific conditions under which an expansionary fiscal policy may result in large multiplier effects [9]. In short, the evidence is telling that the non-linear relationship that fiscal deficits have economic growth, though economists are not unified on the conditions under which the non-linearity rests. That high growth outcomes are found to be associated with large fiscal deficits and capital expenditures is an important finding given that the size of the fiscal deficits (in particular) of the richer states and poorer states are not significantly different from each other. the results in the paper suggest that the state-level fiscal policies could well determine the growth outcomes of these states and could be emulated by the poorer states.

5 Conclusion

In this paper I have examined the convergence of growth and incomes across the Indian states using an empirical model of dynamically evolving distributions, and present some explanations of the observed dynamics. The model reveals "twin peaks" dynamics, or polarisation across the Indian states, over 1965-1997 - empirics which would not be revealed under standard empirical methods of cross section, panel data, and time series econometrics. I find that the dominant cross-state income dynamics are that of persistence, immobility and polarisation, with some cohesive tendencies in the 1960s, only to dissipate over the following three decades. These findings contrast starkly with those emphasised in works of Bajpai and Sachs (1996), Nagaraj et al (1998), and Rao et al. (1999).

A conditioning methodology using the same empirical tools further reveals that such income dynamics are associated with the disparate distribution of capital expenditure, fiscal deficit and education expenditure patterns. Unlike standard methods, this model allows us observe the income dynamics at different levels of the distribution. I obtain conditional convergence for the upper convergence club with capital expenditure, fiscal deficits and education expenditure. Capital expenditure is found to be strongly associated with the formation of the upper convergence club; fiscal deficits are associated with the upper income club, and with some smaller convergence clubs at the upper end of the income distribution. Similar results are also observed with education expenditure: it is again found to be associated with the upper income club, though not as clearly as with the case of capital expenditure and fiscal deficits. These stylised facts are interesting for policy purposes in tracking the forces which govern growth dynamics across the Indian states.

The empirical results suggest that the association between these macroeconomic factors and growth outcomes across Indian states is significant. The associatons identified are prominent for the upper income club of states. The findings thus have strong policy implications for these macroeconomic indicators of these states: while the upper income group states have been experiencing high

[9] Giavazzi and Pagano (1999) on the other hand have shown the reverse - they use the example of Denmark and Ireland in the 1980s whereby fiscal expansion has a contractionary effect on the economy.

levels of economic growth and development, they are also characterised by macroeconomic imbalances. On the other hand, that capital expenditures are found to be associated with the upper income club is suggestive of the specific investment strategies that has been successful in catapulting these states into high growth states. This is also reflected in education expenditure being associated with the upper income club as well. It is interesting to note that these factors do not yield conditional convergence for the lower income group of states.

The results with respect to capital expenditure suggest that the macroeconomic indicators of high growth outcomes for the upper income clubs are succesful strategies that can be emulated by the low growth states. The association of high capital expenditures with high growth outcomes is illustrative of the high investment-high growth strategy undertaken in these states. The particular results with fiscal deficits are also strongly suggestive of the non-linear nature of the relationship of fiscal deficits with growth outcomes. Indeed, the Indian government (and the respective state governments) have undertaken relevant strategies in reduction of the fiscal deficits, but the empirics in this paper suggest that their efforts have not yet been fully successful.

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A Data Appendix

States used in the study:

Andhra Pradesh
Assam
Bihar
Delhi
Gujarat
Haryana
Jammu and Kashmir
Karnataka
Kerala

Madhya Pradesh
Maharashtra
Orissa
Punjab
Rajasthan
Tamil Nadu
Uttar Pradesh
West Bengal

Other states were excluded from the study due to the incomplete data available over the given period. These states together constitute for over 80% of the national population.

Price data that has been used to deflate the nominal GDPs has also been obtained from the above mentioned data set, and is the adjusted CPIAL index.

B The distribution dynamics approach

Quah (1997) exploits a duality property from Markov process theory to provide a model of distribution dynamics. To model the distribution dynamics, one observes a scalar stochastic process, and then derives the implied unobservable sequence of distributions associated with this process. This hypothesised distribution sequence is then defined to be the dual to the observed scalar stochastic process. The property is reversed (the mathematics involved, However, remaining unaffected) to track the distribution dynamics as follows: while the sequence of distributions is observed, its dual, the scalar stochastic process, is implied, though unobserved. The dynamics of the scalar process is described in a transition probability matrix, while the dual to this, the stochastic kernel, describes the "law of motion" of the sequence of distributions. These will serve as models which describe the distribution dynamics across the Indian states.

The following clarifies the concepts discussed above. Let F_t be the measure corresponding to the cross-country income distribution at time t. The stochastic kernel which measure the evolution from F_t to F_{t+1} is a mapping M_t from the Cartesian product of income values and Borel measurable sets to $[0, 1]$, such that

$$\nabla Borel - measurable A, F_{t+1}(A) = \int M(A, y) dF_t(y) \tag{1}$$

It is M_t which encodes all the information about the evolution, or the law of motion of the sequence of distributions over time periods t and $t + 1$. It contains information of the intra-distributional dynamics, hence revealing specific external shapes of the distribution, unrevealed in standard empirical

proced. M_t is assumed to be time-invariant, (and in this case, leaving out an error term, inclusion of which would render the model as analogous to a first order vector auto-regression in distributions rather than scalars or finite dimensional vectors), one can re-write the above expression as

$$F_{t+1} = MF_t \tag{2}$$

For simplicity in calculations, iterating the above equation and leaving out the error term, one can write:

$$F_{t+s} = M^s F_t \tag{3}$$

As $s \to \infty$ it is possible to characterise the long run distribution - this is called the ergodic distribution and it predicts the long term behaviour of the underlying distribution. If F_{t+s} degenerates to a point mass one can conclude that there is a tendency towards global convergence. If F_{t+s} tends towards a bi-modal distribution (the case with the Indian states) one can conclude that there tendency to polarization, with the rich and the poor being pulled apart. Different variants of equation (1) allow the researcher to derive the various spectral characteristics of M_t, such as intra-distributional mobility and the speed of convergence.